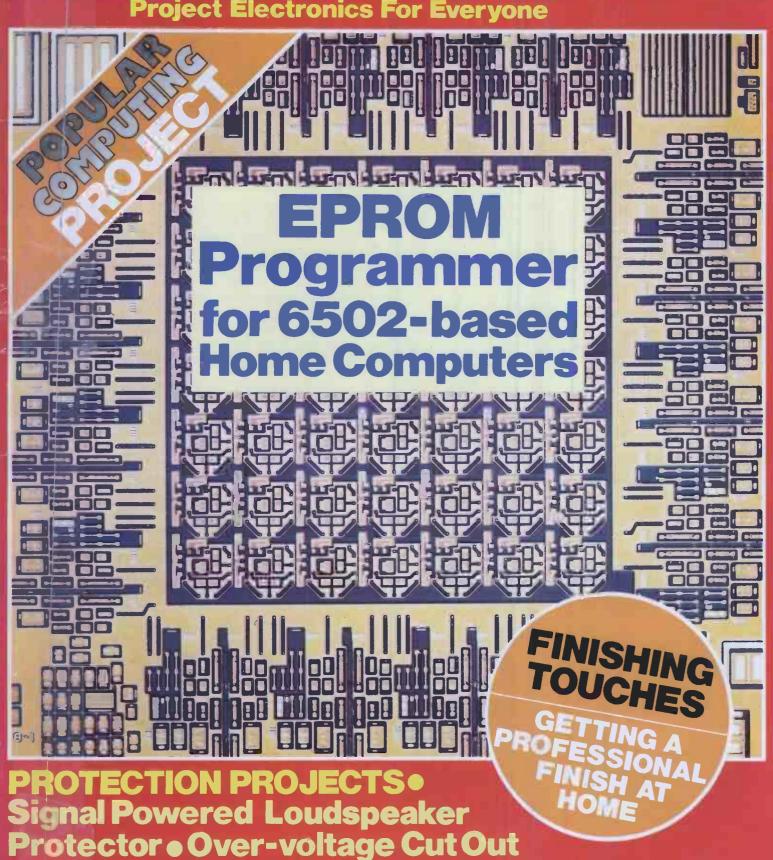
etronics

Project Electronics For Everyone



THE MOST COMPREHENSIVE RANGE OF COMPONENTS, KITS AND MODULES IN THE WORLD & THERE'S ONLY ROOM FOR A FRACTION HERE, GET THE CATALOGUE AND FIND THE REST.

	CMOS-T1	FI ·						
	4001	0.11	4515	1.25	74LS10	0.12	74LS138 74LS139	0.30
	4007 4009UB	0.13	4516 4518	0.60	74LS11 74LS12	0.12	74LS139 74LS145	0.30 0.30 1.20
	4010	0.30	4520	0.60	74LS13 74LS14	0.20	74LS151	0.30
	4011 4012	0.11	4521 4522	1.30 0.89	74LS20	0.12	74LS153 74LS154 74LS155	0.99
	4013	0.25 0.22 0.40	4526 4527	0.60	74LS21 74LS22	0.12	74LS155	0.35
	4017	0.40	4528	0.65	74LS26	0 14	74LS156 74LS157	0.30
	4019 4020	0.38	4529 4531	0.70 0.65	74LS27 74LS28	0.12	74LS158 74LS160	0.30
	4021	0.55	4532	0.80	74LS30	0.12	74LS161	0.37
	4022 4023	0.55	4534 4536	4.00 2.50	74LS32 74LS33 74LS38	0.12	74LS162 74LS163	0.37
	4024	0.33	4538	0.85	74LS38 74LS40	0.14	74LS164	0.40
	4025 4027	0.15	4539 4543	0.80	74LS42	0.13	74LS165 74LS168	0.60 0.70
02	4030 4043	0.35	4549 4553	3.50	74LS47 74LS48	0.35	74LS169 74LS170	0.85
£3.	4044	0.60	4554	1.20	741 549	0.55	74LS173 74LS174	0.60
4	4046 4049UB	0.60	4555 4556	0.35	74LS51 74LS54	0.13	74LS174 74LS175	0.40
ဗ္ဗ	4050	0.24	4557	2.30	74LS55 74LS73 74LS74	0.14	74LS181	1.05
PP3	4051 4060	0.55	4558 4 5 59	0.80 3.50	74LS74	0.21	74LS190 74LS191	0.60
***	4066 4068	0.30	4560 4561	2.50 1.00	74LS75 74LS76	0.22	74LS192 74LS193	0.45
ő	4069UB	0.14	4562	2.50	741 578	0.19	74LS194	0.35
£3.05;	4070 4071	0.16	4566 4568	1.20	74LS83 74LS85	0.40	74LS195 74LS196	0.35 0.55
	4072	0.16	4569	1.70	741 586	0.14	74LS221 74LS240	0.50 0.80
Ü	4073 4075	0.16	4581 4572UB	0.18 0.22	74LS90 74LS92	0.31	74LS241 74LS242	0.80
5:	4076 4077	0.55	4580 4581	3.25 1.40	74LS93 74LS95	0.31	74LS242 74LS243	0.70
1.	4078	0.18	4582	0.70	74LS96 74LS107	1.20	74LS244	0.60
£2.	4081 4093	0.12	4583 4584	0.80	74LS109	0.25	74LS245 74LS257	0.40
А	4175 4502	0.80	4585 40174	0.45 1.05	74LS112 74LS113	0.20	74LS258 74LS260	0.37 0.50
Sub	4503	0.50	40195	1.08	74LS113 74LS114	0.19	741 5266	0.22
Su	4506 4 5 07	0.70	74LS00 74LS01	0.10	74LS122 74LS124	0.35 1.80	74LS273 74LS279	0.70 0.35
.35;	4508 4510	1.50	74LS02 74LS03	0.11	74LS123 74LS125 74LS126 74LS132	0.35	74LS365 74LS366	0.32
ä	4511	0.45	74LS04	0.12	74LS126	0.24	74LS367	0.32
£2.	4512 4514	0.55	74LS05 74LS08	0.13	74LS132 74LS133	0.42	74LS367 74LS368 74LS373	0.35
ಬ			Mem	ory Mic	ros Linea	rs:		- 1
80p;	LM10CN	3.88	S L1611	1.60	KB4433	1.52	U265	3.16
Ö	L149	3.88 1.86	SL1612	1.60	KB4413 KB4436	1.95	U266 LC7137	2.43 7.50
A 8	U237B U247B	1.28	SL1613 SL1620	2.17	KB4437	2.53 1.75	ICM7216B	19.50
AA	U2578	4 70						
		1.28	SL1621	2.17	KB4445	1.29	ICM7216C	19.95
	U267B LM324	1.28	SL1623 SL1625	2.44	KB4446 NE5044	2.75 2.26	ICM7217A SP8647	9.50 6.00
	LM324 LM339N	0.45 0.66	SL1623 SL1625 SL1630	2.44 2.17 1.62	KB4446 NE5044	2.75 2.26 9.60	ICM7217A SP8647 95H90	9.50 6.00 7.80
	LM324 LM339N LF347 LM348	1.28 0.45 0.66 1.60 0.90	SL1623 SL1625 SL1630 SL1640 SL1641	2.44 2.17 1.62 1.89 1.89	KB4446 NE5044 MC5229 SL6270 SL6310	2.75 2.26 9.60 2.03 2.03	ICM7217A SP8647 95H90 HD10551 HA12009	9.50 6.00 7.80 2.45 6.00
	LM324 LM339N LF347 LM348 LF351	1.28 0.45 0.66 1.60 0.90 0.49	SL1623 SL1625 SL1630 SL1640 SL1641 TDA2002	2.44 2.17 1.62 1.89 1.89 1.25	KB4446 NE5044 MC5229 SL6270 SL6310 SL6440	2.75 2.26 9.60 2.03 2.03 3.38	ICM7217A SP8647 95H90 HD10551 HA12009 HD44015	9.50 6.00 7.80 2.45 6.00 4.45
	LM324 LM339N LF347 LM348 LF351 LF353 LM380N	1.28 0.45 0.66 1.60 0.90	SL1623 SL1625 SL1630 SL1640 SL1641 TDA2002 ULN2242 ULN2283	2.44 2.17 1.62 1.89 1.89 1.25 3.05	KB4446 NE5044 MC5229 SL6270 SL6310 SL6440 SL6600 SAS6610	2.75 2.26 9.60 2.03 2.03 3.38 3.75 1.48	ICM7217A SP8647 95H90 HD10551 HA12009 HD44015 HD44752 MC145151P	9.50 6.00 7.80 2.45 6.00 4.45 8.00 6.00
NICADS	LM324 LM339N LF347 LM348 LF351 LF353 LM380N ZN419CE	1.28 0.45 0.66 1.60 0.90 0.49 0.76 1.00 1.98	SL1623 SL1625 SL1630 SL1640 SL1641 TDA2002 ULN2242 ULN2283	2.44 2.17 1.62 1.89 1.89 1.25 3.05 1.00 1.84	KB4446 NE5044 MC5229 SL6270 SL6310 SL6440 SL6600 SAS6610 SL6640	2.75 2.26 9.60 2.03 2.03 3.38 3.75 1.48 2.75	ICM7217A SP8647 95H90 HD10551 HA12009 HD44015 HD44752 MC145151P Z80A	9.50 6.00 7.80 2.45 6.00 4.45 8.00 6.00 3.75
NICADS	LM324 LM339N LF347 LM348 LF351 LF353 LM380N ZN419CE ZN427E/8 NE544	1.28 0.45 0.66 1.60 0.90 0.49 0.76 1.00 1.98 6.28 1.80	SL1623 SL1625 SL1630 SL1640 SL1641 TDA2002 ULN2242 ULN2283 CA3089 CA3130E CA3130T	2.44 2.17 1.62 1.89 1.25 3.05 1.00 1.84 0.80	KB4446 NE5044 MC5 229 SL6270 SL6310 SL6440 SL66600 SAS6610 SL66600 SL66690 SL6700	2.75 2.26 9.60 2.03 2.03 3.38 3.75 1.48 2.75 3.20 2.35	ICM7217A SP8647 95H90 HD10551 HA12009 HD44015 HD44752 MC145151P Z80A Z80A P10 Z80A CTC	9.50 6.00 7.80 2.45 6.00 4.45 8.00 6.00 3.75 3.50 4.00
NICADS	LM324 LM339N LF347 LM348 LF351 LF353 LM380N ZN419CE ZN427E/8 NE544	1.28 0.45 0.66 1.60 0.90 0.49 0.76 1.00 1.98 6.28 1.80 0.20	SL1623 SL1625 SL1630 SL1640 SL1641 TDA2002 ULN2242 ULN2242 ULN2283 CA3089 CA3130E CA3130T CA3140E	2.44 2.17 1.62 1.89 1.89 1.25 3.05 1.00 1.84 0.80 0.90 0.46	KB4446 NE5044 MC5229 SL6270 SL6310 SL66400 SAS6610 SL6640 SL6640 SL6640 SL6640 SL6690 SL6700 SAS6710 SAS6710	2.75 2.26 9.60 2.03 2.03 3.38 3.75 1.48 2.75 3.20 2.35 1.48	ICM7217A SP8647 95H90 HD10551 HA12009 HD44752 MC145151P Z80A Z80A P10 Z80A CTC Z80A DMA	9.50 6.00 7.80 2.45 6.00 4.45 8.00 6.00 3.75 3.50 4.00 9.95
NICADS	LM324 LM339N LF347 LM348 LF351 LF353 LM380N ZN419CE ZN427E/8 NE544 NE555N SL560C NE564	1.28 0.45 0.66 1.60 0.90 0.49 0.76 1.00 1.98 6.28 1.80 0.20 1.98 4.29	SL1623 SL1625 SL1630 SL1640 SL1641 TDA2002 ULN2242 ULN2283 CA3089 CA3130T CA3140E CA3140E CA3140E	2.44 2.17 1.62 1.89 1.89 1.25 3.05 1.00 1.84 0.90 0.46 2.20 1.27	KB4446 NE5044 MC5229 SL6270 SL6310 SL6440 SL66600 SL66600 SL66700 SL67700 SAS6710 LS7225 ICM7555	2.75 2.26 9.60 2.03 2.03 3.38 3.75 1.48 2.75 3.20 2.35 1.48 3.65 0.94	ICM7217A SP8647 95H90 HD10551 HA12009 HD44015 HD44752 MC145151P Z80A Z80A P10 Z80A P10 Z80A CTC Z80A DMA Z80A DMA Z80A DMA Z80A DART Z80A S10/1	9.50 6.00 7.80 2.45 6.00 4.45 8.00 6.00 3.75 3.50 4.00 9.95 7.50
PRICED NICADS	LM324 LM339N LF347 LM348 LF351 LF353 LM380N ZN419CE ZN427E/8 NE544 NE555N SL560C NE564	1.28 0.45 0.66 1.60 0.90 0.49 0.76 1.98 6.28 1.80 0.20 1.98 4.29 1.30	SL1623 SL1625 SL1630 SL1640 SL1641 TDA2002 ULN2242 ULN2283 CA3130E CA3130E CA3130E CA3140E CA3140E CA3240E MC3357	2.44 2.17 1.62 1.89 1.89 1.25 3.05 1.00 1.84 0.90 0.46 2.20 1.27 2.85	KB4446 NE5044 MC5229 SL6270 SL6310 SL6440 SL6660 SL6660 SL6690 SL6690 SL6700 SAS6710 LS7225 ICM7555 ICL8038CC	2.75 2.26 9.60 2.03 3.38 3.75 1.48 2.75 3.20 2.35 1.48 3.65 0.94 4.50	ICM7217A SP8647 95H90 HD10551 HA12009 HD44015 HD44752 MC145151P Z80A P10 Z80A CTC Z80A DMA Z80A DART Z80A S10/1 Z80A S10/1 Z80A S10/1	9.50 6.00 7.80 2.45 6.00 4.45 8.00 6.00 3.75 3.50 4.00 9.95 7.50 11.00
PRICED NICADS	LM324 LM339N LF347 LM348 LF351 LF353 LM380N ZN419CE ZN427E/8 NE544 NE555N SL560C NE564 NE567 UA741CN TBA820M	1.28 0.46 1.60 0.90 0.49 1.00 1.98 6.28 1.80 0.20 1.98 4.29 1.30 0.20 0.78	SL1623 SL1625 SL1630 SL1640 SL1641 TDA2002 ULN2242 ULN2283 CA3089 CA3130T CA3140E CA3140E CA3240E MC3357 ULN3859 UM3859 UM3859	2.44 2.17 1.62 1.89 1.25 3.05 1.00 1.84 0.80 0.90 0.46 2.20 1.27 2.85 2.95 0.60	KB4446 NE5044 MC5229 SL6270 SL6310 SL6440 SL6600 SA56610 SL6690 SL6700 SA56710 LS7225 ICM 7555 ICM 7555 TK 10170 TK 10170	2.75 2.26 9.60 2.03 3.38 3.75 1.48 2.75 3.20 2.35 1.48 3.65 0.94 4.50 1.87 2.75	ICM7217A \$P8647 95H90 H010551 HA12009 H044015 H0440	9.50 6.00 7.80 2.45 6.00 4.45 8.00 6.00 3.75 3.50 4.00 9.95 11.00 11.00 9.95 65.00
PRICED NICADS	LM324 LM339N LF347 LM348 LF351 LF353 LM380N ZN419CE ZN427E/8 NE544 NE555N SL560C NE564 NF567 UA741CN TBA820M ZNA1034	1.28 0.45 1.60 0.90 0.76 1.00 1.98 6.28 1.80 0.20 1.98 4.29 1.30 0.20 0.78 2.10	SL1623 SL1625 SL1630 SL1640 SL1641 TDA2002 ULN2242 ULN2283 CA3089 CA3130E CA3130E CA3140E CA3240E MC3357 ULN3859 UM3900 LM3990 LM3990 LM39914N	2.44 2.17 1.62 1.89 1.25 3.05 1.00 1.84 0.90 0.46 2.20 1.27 2.85 2.85 0.60 0.68	KB4446 MC5229 SL6270 SL6310 SL6440 SL6600 SA56610 SL6690 SL6700 SA56710 LS7225 ICM7555 ICL8038CC TK10170 TK10321 HA11223	2.75 2.26 9.60 2.03 3.38 3.75 1.48 2.75 3.20 2.35 1.48 4.50 0.94 4.50 2.75 2.75 1.45	ICM72174 58190 HD10551 HA12009 HD404752 MC145151P 280A 280A P10 280A CTC 280A DMA 280A DMAT 280A S10/1 280A S10/1 280A S10/9 2800	9.50 6.00 7.80 2.45 6.00 4.45 8.00 6.00 3.75 4.00 9.95 11.00 11.00 11.00 2.58 2.90
PRICED NICADS	LM324 LM339N LF347 LM348 LF351 LF353 LM380N ZN419CE ZN427E/8 NE554 NE564	1.28 0.45 1.60 0.90 0.76 1.00 1.98 6.28 1.80 0.20 1.98 4.29 1.30 0.78 2.10 0.78 2.10	SL1623 SL1625 SL1630 SL1640 SL1641 TDA2002 ULN2242 ULN2242 ULN2242 ULN2283 CA3130E CA3130T CA3140E MC3357 ULN3859 LM3909 LM3909N LM3914N KB4412	2.44 2.17 1.62 1.89 1.25 3.05 1.00 1.84 0.90 0.46 2.20 1.27 2.85 0.68 2.80 1.95	KB4446 MC5229 SL6270 SL6310 SL6440 SL6660 SA56610 SL6690 SL6700 SA56710 L57225 ICM7555 ICL8038CC TK10170 TK10321 HA11223 HA11223 HA12002	2.75 2.26 9.60 2.03 2.03 3.38 3.75 1.48 2.75 3.20 2.35 1.48 3.65 4.50 1.87 2.15 1.45	ICM72174 58190 HD10551 HA12009 HD44015 HD44752 MC145151P Z80A Z80A P10 Z80A CTC Z80A DMA Z80A DMA Z80A DART Z80A S10/1 Z80A S10/9 Z80A S10/9 Z80A S10/9 Z80B	9.50 6.00 7.80 2.45 6.00 4.45 8.00 6.00 3.75 4.00 9.95 7.50 11.00 11.00 2.58 2.90 2.58
LOWEST PRICED NICADS	LM324 LM339N LF347 LM348 LF351 LF353 LM389N ZN419CE ZN427E/8 NE554 NE554 NE564 NE564 NF567 UA741CN TBA820M ZNA1034 LM1035 TDA1083 TDA1080	1.28 0.45 1.60 0.90 0.49 0.76 1.00 1.98 6.20 1.98 4.29 0.20 1.30 0.20 0.78 2.10	SL1623 SL1625 SL1630 SL1640 SL1641 TDA2002 ULN2242 ULN2242 ULN2242 OCA31305 CA31305 CA31305 CA31305 CA31895 CA32406 MC3357 ULN3859 LM3900 LM3900 LM3914N KB4412 KB4412	2.44 2.17 1.62 1.89 1.25 3.05 1.00 1.84 0.80 0.90 0.46 2.20 1.27 2.95 0.68 2.80 0.68 2.80	KB4446 MC5229 SL6270 SL6310 SL66440 SL66690 SL66690 SL6700 SAS6710 L57225 ICM7555 ICM7555 ICM7555 ICM8038CC TK10170 TK10321 HA11223 HA112202 HA12002	2.75 2.26 9.60 2.03 3.38 3.75 1.48 2.75 3.20 4.50 0.94 4.50 4.50 2.75 1.45 1.22 1.92	ICM72174 58190 HD10551 HA12009 HD44015 HD44752 MC145151P Z80A Z80A P10 Z80A CTC Z80A CTC Z80A S10/1 Z80A S10/2 Z80A S10/9 Z80A S10/9 Z80A S800 G809 G809 G809 G809 G809 G800 G80	9.50 6.00 7.80 2.45 6.00 3.75 3.50 9.95 7.100 11.00 11.00 2.58 2.90 2.59 3.50 4.25
LOWEST PRICED NICADS	LM324 LM339N LF347 LM348 LF351 LF353 LM380N ZN419CE ZN427E/8 NE544 NE555N SL560C NE564 NE567 UA741CN TBA820M ZNA1034 LM1035 TDA1062 TDA1083 TDA1099 HA1197	1.28 0.45 0.66 1.60 0.90 0.49 0.76 1.98 6.28 0.20 1.98 4.29 1.30 0.20 4.50 1.95 1.95 1.95	SL1623 SL1625 SL1630 SL1640 SL1641 TDA2002 ULN2242 ULN2283 CA3130E CA3130E CA3140E CA3140E CA3140E MC3357 ULN3859 UM3909 LM3900 LM3900 LM3914N KB4412 KB4412 KB4420B	2 .44 2 .17 1 .62 1 .89 1 .25 1 .00 1 .80 0 .90 0 .90 2 .20 0 .46 2 .20 0 .60 0 0 .60 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0	KB4446 MC5229 SL6270 SL6310 SL66440 SL66690 SL66690 SL6700 SAS6710 L57225 ICM7555 ICM7555 ICM7555 ICM8038CC TK10170 TK10321 HA11223 HA112202 HA12002	2.75 2.26 9.60 2.03 3.38 3.75 2.35 1.48 2.75 2.35 1.485 0.94 4.50 1.87 2.75 1.45 1.45 1.45 1.45 1.45 1.45 1.45 1.4	ICM7217A SP8647 SP8647 SP8647 SP8647 SP8647 SP864 SP86	9.50 6.00 7.80 2.45 6.00 3.75 3.50 4.00 9.95 7.50 11.00 9.95 05.58 2.90 4.25 3.50 4.46 5.46 6.50 6.60 6.60 6.60 6.60 6.60 6.60 6.6
LOWEST PRICED NICADS	LM324 LM339N LF347 LM348 LF351 LF353 LM389N ZN419CE ZN427E/8 NE544 NE555N SL580C NE564 NF567 WA741CN TBA820M ZNA1034 LM1035 TDA1083 TDA1080 HA1197 MC1350	1.28 0.46 1.60 0.90 0.49 0.70 1.98 6.28 0.20 1.98 4.29 1.30 0.78 2.10 1.95 1.95 1.95 1.95	SL1623 SL1625 SL1630 SL1640 SL1641 TDA2002 ULN2242 ULN2283 CA31305 CA31305 CA31405 CA31405 CA31405 CA31405 CA31405 CA31405 KC3357 ULN3859 UM3909 LM3900 LM3999N LM3914N KB4412 KB4420 KB4420 KB4423 KB4423	2 .44 2 .17 1 .62 1 .89 1 .25 1 .00 1 .00 0 .90 0 .46 2 .20 0 .46 2 .20 2 .80 1 .95 0 .60 0 0 .60 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0	KB4446 MC5529 \$1.6270 \$1.6310 \$1.6440 \$1.6600 \$1.6640 \$1.6690 \$1.6690 \$1.6725 ICM7555 ICM7555 ICM7555 ICM321 HA11223 HA11225 HA12002 HA12411 LF13741 MK50375	2.75 9.60 2.03 3.38 3.75 1.48 2.75 3.20 2.35 1.48 2.75 1.48 2.75 1.48 2.15 1.49 1.87 2.75 1.45 1.95 1.25 1.25 1.25 1.25 1.25 1.25 1.25 1.2	ICM7217A SP8647 95H90 HD10551 HA12009 HD44015 HD44752 MC145151P Z80A P10 Z80A P10 Z80A P10 Z80A DMA Z80A DMA Z80A DMA Z80A S10/1 Z80A S10/1 Z80A S10/9 Z80A S10/9 Z80	9.50 6.00 2.45 6.00 4.45 8.00 3.75 4.00 9.95 65.00 9.95 65.08 2.90 4.25 8.75 3.50 4.65 1.49
THE LOWEST PRICED NICADS	LM324 LM339N LF347 LM348 LF351 LF353 LM380 EF353 LM380 XN419CE ZN427E/8 NE555N SL560C NE564 NE564 NE567 UA741033 LM1035 TDA1083 TDA1083 TDA1090 HA11350 HA1350 HA1388	1.28 0.45 0.66 1.60 0.90 0.49 1.00 1.98 1.80 0.20 0.78 4.29 0.20 0.78 4.50 1.95 3.05 1.95 3.05 1.20 1.20 1.20 1.20 1.20 1.20 1.20 1.20	SL1623 SL1625 SL1630 SL1640 SL1641 TDA2002 ULN2242 ULN2242 ULN2242 ULN2242 ULN2242 ULN3249 CA3130T CA3140E CA3140E CA3140E MC3357 ULN3859 LM3909 LM3999N LM3914N KB4412 KB44420 KB4420 KB44431	2.44 2.17 1.62 1.89 1.29 3.05 1.00 0.90 0.46 2.20 0.68 2.80 0.68 2.80 1.95 1.89 1.09 2.30 1.95 1.95	KB4446 MC5229 SL6270 SL6370 SL6310 SL6440 SL6660 SL6660 SL6660 SL6700 SAS6610 SL67225 ICM7555 ICM7555 ICM8038CC TK 10170 TK 10321 HA11225 HA12402 HA12411 HA12412 LF13741 MK50375 MM532200	2.75 2.26 9.60 2.03 3.38 2.73 1.48 2.75 3.20 2.35 4.50 1.87 2.15 1.22 1.25 1.20 1.53 3.38 1.20 1.20 1.20 1.20 1.20 1.20 1.20 1.20	ICM72174 SP8647 SP8647 SP8647 SP8647 HD10551 HA12009 HD44015 HD44752 MC145151P Z80A Z80A P10 Z80A CTC Z80A CTC Z80A DMA Z80A DMA Z80A DMA Z80A S10/1 Z80A S10/1 Z80A S10/9 Z80A S1	9.50 6.00 2.4.5 6.00 4.45 8.00 6.00 3.75 7.50 4.00 9.95 7.50 11.00 11.00 8.75 3.55 4.25 4.25 4.25 4.25 4.00
- THE LOWEST PRICED NICADS	LM324 LM339N LF347 LM348 LF351 LF353 LM380N ZN4190E ZN427E/8 NE554 NE554 NE564 NE565 NE564 NE567 ZNA1034 LM1035 TDA1083 TDA1082 TDA1083 TDA1083 HA1197 MC1350 HA1370 HA1388 SL1610	1.28 0.46 1.60 0.90 0.49 1.00 1.98 1.80 0.20 0.20 0.78 4.29 1.30 0.20 0.78 4.50 1.95 3.05 1.95 1.95 1.95 1.95	SL1623 SL1625 SL1630 SL1640 SL1640 SL1641 TDA2002 ULN2283 CA3130E CA3130E CA3130E CA3130E CA3140E CA3240E MC3357 ULN3859 LM3909 LM3909 LM3909 LM3914N KB4417 KB4420 KB4423 KB4423 KB4423 KB4431 KB4431 KB4431	2.44 2.17 1.62 1.89 1.89 1.25 3.05 1.05 0.90 0.46 2.20 7.285 2.95 0.60 0.60 0.60 0.60 0.60 0.60 0.60 0.6	KB4446 ME5044 MC5229 SL6270 SL6270 SL6270 SL6640 SL6660 SL6660 SL66690 SL6700 SAS6610 SL7225 ICM7555 ICL8038CC TK10170 TK10321 HA11223 HA11223 HA1122411 HA12412 HA12411 HA12412 LF13741 MK50375 MM53200	2.75 2.26 9.60 2.03 3.38 3.75 1.48 2.75 2.35 0.94 4.50 1.87 2.15 2.15 1.22 1.95 1.22 1.95 1.22 1.95 1.22 1.95 1.22 1.33 3.85 1.22 1.35 1.35 1.35 1.35 1.35 1.35 1.35 1.35	ICM72174 58H90 HD10551 HA12009 HD44015 HD44752 MC145151P Z80A P10 Z80A P10 Z80A DART Z80A S10/2 Z80A S10/2 Z80A S10/9 Z80A S1	9.50 6.00 2.45 6.00 4.45 8.00 6.00 3.75 7.50 11.00 9.95 7.50 11.00 2.58 2.58 3.59 8.75 3.59 4.25 4.65 1.49 1.59 4.00
- THE LOWEST PRICED NICADS	LM324 LM339N LF347 LM348 LF351 LF353 LM380N ZN419CE ZN427E/8 NE544 NE555N SL560C NE564 NE567 UA741CN TBAB20M ZNA1034 LM1035 TDA1062 TDA1083 TDA1083 TDA1080 AND THE1	1.28 0.46 0.66 1.60 0.90 0.76 1.08 6.28 1.80 0.20 0.78 4.29 1.30 0.78 2.10 4.50 1.95 1.95 1.95 1.95 1.90 2.75 1.90 1.90 2.75 1.90 1.90 1.90 1.90 1.90 1.90 1.90 1.90	SL1623 SL1625 SL1630 SL1640 SL1641 TDA2002 ULN2242 ULN2283 CA31305 CA31305 CA31405 CA31405 CA31405 CA31405 CA31405 CA31405 CA31405 CA31405 KB4412 KB4412 KB4417 KB44208 KB4420 KB4420 KB4423 KB4421 KB4431 KB4431 KB4431	2.44 2.17 1.62 1.89 1.89 1.25 3.05 1.00 0.40 0.90 0.40 2.20 1.27 2.85 2.95 0.60 0.68 1.95 1.95 1.95 1.95 1.95 1.95 1.95 1.95	KB4446 MC5229 SL6270 SL6310 SL6310 SL640 SL6600 SAS6610 SL6690 SL6725 ICM7555 ICM7555 ICM7555 ICM7555 HA11223 HA11225 HA12002 HA12411 HA12412 LF13741 MK50375 MM53220 U264 IN THE C	2.75 2.26 9.60 2.03 3.38 2.75 1.48 2.75 3.20 2.35 1.48 3.65 0.94 4.50 1.87 2.75 2.15 1.45 1.20 1.55 0.38 5.3.90 0.38 5.30 0.38 5.30 0.38 5.30 0.38 5.30 0.30 0.30 0.30 0.30 0.30 0.30 0.30	ICM7217A SP8647	9.50 6.00 2.45 6.00 4.45 8.00 6.00 3.75 7.50 11.00 9.95 7.50 11.00 2.58 2.58 3.59 8.75 3.59 4.25 4.65 1.49 1.59 4.00
EMBER — THE LOWEST PRICED NICADS	LM324 LM339N LF347 LM348 LF351 LF353 LM380N ZN419CE ZN427E/8 NE5544 NE555N SL560C NE564 NE564 NE564 NE564 NE564 NE565N SL560C NE564 NE565 NE564 NE565 NE564 NE564 NE564 NE564 NE564 NE565 NE564 NE564 NE564 NE565 NE564 NE564 NE564 NE565 NE565	1.28 0.45 0.66 1.60 0.90 0.76 1.98 6.28 1.80 0.20 0.78 1.90 1.30 0.20 0.70 1.95 1.95 1.95 1.95 1.95 1.95 1.95 1.95	SL1623 SL1625 SL1630 SL1640 SL1640 SL1641 TDA2002 ULN2242 ULN2283 CA3130E CA3130E CA3130E CA3130F CA3140E CA31240E MC3357 ULN3859 LM3990 LM3990 LM3914N KB4412 KB4417 KB44208 KB4423 KB4423 KB4423 KB4423 KB4431 KB4431	2.44 2.17 1.62 1.89 1.89 1.25 3.05 1.00 0.80 0.40 0.80 0.40 0.40 0.40 0.40 0	KB4446 MC5229 SL6270 SL6310 SL6400 SL6600 SA56610 SL6640 SL6640 SL6690 SL6700 SA56710 L57225 ICM7555 ICM7555 ICM7555 HA11223 HA11223 HA11225 HA12002 HA12412 LF13741 MK50375 MK50375 MK50375 MK50375 MK50375 MK50375 MK50375	2.75 2.26 9.60 2.03 3.38 3.75 1.48 3.65 0.94 4.50 1.87 2.75 2.15 1.48 1.27 2.75 2.15 1.45 1.27 1.27 1.27 1.27 1.27 1.27 1.27 1.27	ICM7217A SP8647 95H90 HD10551 HA12009 HD44015 HD44752 MC145151P Z80A P10 Z80A P10 Z80A B10/1 Z80A S10/1 Z80A S10/1 Z80A S10/1 Z80A S10/1 Z80A S10/1 Z80A S10/1 Z80A S10/1 Z80A S10/1 Z80A S10/2 Z80A S	9.50 6.00 7.80 6.00 4.45 8.00 6.00 3.75 3.50 4.05 9.95 7.50 11.00 9.95 8.75 8.75 8.75 1.40 8.75 1.50 1.50 8.75 1.50
EMBER — THE LOWEST PRICED NICADS	LM324 LM339N LF347 LM348 LF351 LF353 LM380N ZN419CE ZN427E/8 NE544 NE555N SL560C NE564 NE567 UA741CN ZNA1034 LM1035 TDA1082 TDA1082 TDA1083 TDA1083 TDA1083 SL1610 AND THE3	1.28 0.46 0.49 0.49 0.76 1.00 0.49 0.76 1.20 0.20 1.98 4.29 0.78 2.10 1.95 3.05 1.95 3.05 1.90 2.75 3.05 1.90 2.75 3.05 1.90 2.75 3.05 3.05 3.05 3.05 3.05 3.05 3.05 3.0	SL1623 SL1625 SL1630 SL1640 SL1640 SL1641 TDA2002 ULN2242 ULN2242 ULN2242 ULN2242 ULN2283 CA3130T CA3140E CA3140E CA3140E MC3357 ULN3859 UM3909N LM39914N KB4412 KB4417 KB44208 KB4420 KB4420 KB4420 KB4420 KB4420 KB4420 KB4420 KB4431 KB4432 KB4431 KB4432 KB4431 KB4432 KB4431 KB4432 KB4431 KB4432 KB4431 KB4432 KB4431 KB4430 KB4431 KB4431 KB4432 KB4431 K	2.44 2.17 1.62 1.89 1.29 1.29 1.29 1.29 1.29 1.20 1.84 0.80 0.90 0.40 2.20 1.27 2.85 2.95 2.80 1.95 1.95 1.95 1.95 1.95 1.95 1.95 1.95	KB4446 MC5229 SL6270 SL6310 SL6440 SL6600 SAS6610 SL66600 SAS6610 SL6690 SL6700 CL87225 ICM7555 ICM7555 ICM7555 ICM8038CC TK10321 HA11223 HA11225 HA12002 HA12411 HA12412 LF13741 MK50375 MM53200 U264 IN THE C	2.75 2.26 9.60 2.03 3.38 3.75 1.48 2.75 3.20 2.35 1.48 5.09 4.50 1.87 2.75 1.25 1.25 1.25 1.25 1.25 1.25 1.25 1.2	ICM7217A SP8647	9.50 6.00 7.80 6.00 4.45 8.00 6.00 9.95 11.00 9.95 11.00 2.58 2.90 8.75 3.50 4.25 4.65 1.49 1.59 4.00 9.95 1.59 4.00 8.75 1.59 4.00 8.75 8.75 8.75 8.75 8.75 8.75 8.75 8.75
- THE LOWEST PRICED NICADS	LM324 LM339N LF347 LM348 LF351 LF353 LM380N ZN419CE ZN427E/8 NE5544 NE555N SL560C NE564 NE564 NE564 NE564 NE564 NE565N SL560C NE564 NE565 NE564 NE565 NE564 NE564 NE564 NE564 NE564 NE565 NE564 NE564 NE564 NE565 NE564 NE564 NE564 NE565 NE565	1.28 1.20 1.20 1.20 1.20 1.20 1.20 1.20 1.20	SL1623 SL1625 SL1630 SL1640 SL1640 SL1641 TDA2002 ULN2242 ULN2283 CA3089 CA3130T CA3140T CA3140T CA3140T CA3140T CA3140T CA3140T CA3140T CA3140T CA3140T CA3140T CA3140T CA3140T CA3140T CA3140T CA3140T ULN3859 UM3990 LM3990 LM39914N KB4412 KB4417 KB4420 KB4420 KB4420 KB4420 KB4421 TKB4431 KB4431 KB4431 CB4431 KB4431	2.44 2.17 1.62 1.89 1.89 1.25 3.05 1.00 0.40 0.80 0.90 0.40 2.20 1.27 0.60 0.68 2.85 2.95 2.95 2.95 2.95 2.95 2.95 2.95 2.9	KB4446 MC5229 SL6270 SL6310 SL6440 SL6640 SL66690 SL6700 SAS6610 SL66690 SL6700 SAS6710 L57225 ICM7555 ICM7555 ICM8038CC TK10170 TK10321 HA11223 HA11225 HA12402 HA12402 HA12411 HA12412 HA12411 HA12412 IF13741 MK50375 MM532200 U264 IN THE C	2.75 2.26 9.60 2.03 3.38 2.75 3.20 2.35 1.48 3.65 2.75 2.35 1.48 3.65 2.15 1.22 1.25 1.22 1.20 1.20 1.20 1.20 1.20 1.20 1.20	ICM7217A SP8647	9.50 6.00 7.80 6.00 4.45 8.00 6.00 3.75 3.50 4.05 9.95 7.50 11.00 9.95 8.75 8.75 8.75 1.40 8.75 1.50 1.50 8.75 1.50

L149	1.86	SL1612	1.60	KB4413	1.95	U266	2.43
				KB4436	2.53	LC7137	7.50
U237B	1.28	SL1613	2.06				
U247B	1.28	SL1620	2.17	KB4437	1.75	ICM7216B	19.50
U257B	1.28	SL1621	2.17	KB4445	1.29	ICM7216C	19.95
U267B	1.28	SL1623	2.44	KB4446	2.75	ICM7217A	9.50
LM324	0.45	SL1625	2.17	NE5044	2.26	SP8647	6.00
LM339N	0.66	SL1630	1.62	MC5229	9.60	95H90	7.80
LF347	1.60	SL1640	1.89	SL6270	2.03	HD10551	2.45
LM348	0.90	SL1641	1.89	SL6310	2.03	HA12009	6.00
LF351	0.49	TDA2002	1.25	SL6440	3.38	HD44015	4.45
LF353	0.76	ULN2242	3.05	SL6600	3.75	HD44752	8.00
LM380N	1.00	ULN2283	1.00	SAS6610	1.48	MC145151P	
ZN419CE	1.98	CA3089	1.84	SL6640	2.75	Z80A	3.75
ZN419CE ZN427E/8	6.28	CA3130E	0.80	SL6690	3.20	Z80A P10	3.50
		CA3130T	0.90	SL6700	2.35	Z80A CTC	4.00
NE544	1.80		0.46	SAS6710	1.48	Z80A DMA	
NE555N	0.20	CA3140E					
SL560C	1.98	CA3189E	2.20	LS7225	3.65	Z80A DART	
NE564	4.29	CA3240E	1.27	ICM7555	0.94	Z80A S10/1	
NE567	1.30	MC3357	2.85	ICL8038CC	4.50	Z80A S10/2	
uA741CN	0.20	ULN3859	2.95	TK 10170	1.87	Z80A S10/9	
TBA820M	0.78	LM3900	0.60	TK 10321	2.75	Z8001	65.00
ZNA1034	2.10	LM3909N	0.68	HA11223	2.15	8255	2.58
LM1035	4.50	LM3914N	2.80	HA11225	1.45	6800P	2.90
TDA 1062	1.95	KB4412	1.95	HA12002	1.22	6809	8.75
TDA1083	1.95	KB4417	1.80	HA12402	1.95	6802	3.50
TDA1090	3.05	KB4420B	1.09	HA12411	1.20	68A00P	4.25
HA1197	1.00	KB4423	2.30	HA12412	1.55	68B00P	4.65
MC1350	1.20	KB4424	1.65	LF13741	0.33	2114-L2	1.49
HA1370	1.90	KB4430	2.30	MK50375	3.85	4116-2	1.59
HA1388	2.75	KB4431	1.95	MM53200	3.90	2732	4.00
SL1610	1.60	KB4432	1.95	U264	2.27	2716	3.00
05.070	1.00						

AND THERE'S PLENTY MORE IN THE CATALOGUE 70p inc.

Coils, Filters: Toko, Murata, NTK, Cathodeon.

SFE6.0MA	0.80	CDA10.7MA	0.70	10M15D	14.50
CFSE10.7	0.80	SFE27MA	0.94	LFB4	1.95
SFE10.7MA	0.45	SAF10.7MC-	Z 3.75	LFB6/CFU455H	1.95
CFSB10.7	0.50	MF45510AZ	12118.55	LFB8	1.95
SFE10.7MJ	0.50	MFL45501L	11.95	LFB10	1.95
SFA10.7MF	0.75	10M15A	1.99	LFB12/CFU455	F 1.95
SFE10.7ML	0.70	2-1M15A	3.45	LFH6S/	
SFE10.7MX	0.95	45M15A	5.95	CFW455HT	2.45
CFSH10.7M1	0.50	10M22D	17.20	LFH8S	2.45
CFSH10.7M2	0.50	10M8D	15.50	LFH12S/	
CFSH10.7M3	0.50			CFW455FT	2.45
	TOKO EL	VED VALUE CH	OK ES (E1	2 Values)	

10RB - 1 to 120mH 10RB - .15 to 1.5H

RETAIL SHOP OPENING HOURS

Monday to Thursday 8.30-6.30 Friday 8.30-8.30 Saturday 9.00-5.30 Switched Capacitor Filter: (Access + Barclaycard orders accepted)

NOW IN STOCK MF10 - National's new Dual Price £5.05

ALL PRICES SHOWN EXCLUDE VAT. P&P 60p per order

AMBIT INTERNATIONAL

200 North Service Road, Brentwood, Essex TELEPHONE (STD 0277) 230909 TELEX 995194 AMBIT G POSTCODE CM14 4SG



ambit's nev autumn/winter catalogue





ALL THE 'USUAL' BITS (Rs, Cs, Tr's, ICs etc) + ALL THE TRICKY BITS

at all good newsagents or direct

- TOKO COILS, INDUCTORS, LC FILTERS
- PCM FILTERS, VHF/UHF HELICAL FILTERS
- **UNELCO CAPACITORS**
- PCI INTELLIGENT LCD MODULES
- **TOKO SWITCHES: F SERIES/R7000 SERIES**
- **ALPS POTENTIOMETERS AND** KEYSWITCHES
- TOYO-TSUSHO COAX RELAYS FOR TX/RX
- CRYSTAL FILTERS, CERAMIC FILTERS
- WELLER SOLDERING IRONS
- **COOPER TOOLS**
- **TEST EQUIPMENT**
- **BOOKS, MANUFACTURERS' HANDBOOKS**
- HARDWARE, CASES, PANELWARE, ETC.
- * MODULES, R&EW KITS
- * RF POWER DEVICES

ORDERS SUBMITTED USING STOCKCODES **DESPATCHED WITHIN 8 WORKING HOURS**

* PHONE ORDER SERVICE — (NO MACHINES!)

PLEASE NOTE OUR NEW PHONE SYSTEM AUTOMATICALLY STACKS CALLS IN ORDER OF ARRIVAL SO PLEASE WAIT IF NOT ANSWERED IMMEDIATELY

8 AM - 7 PM MON - SAT 0277 230909

* COMPUTER ORDER SERVICE — 'REWTEL'

 $6~{
m PM}-9~{
m AM}~~300~{
m BAUD/RS232}$ (IT MAY BE 24 HRS BY THE TIME YOU READ THIS) 0277 230959



INTERNATIONAL

200, NORTH SERVICE ROAD BRENTWOOD, ESSEX CM14 4SG Telephone: (0277) 230909 Telex: 995194 AMBIT G

MARCH 1983 Vol 5 No 3

PROJECTS

* THE H.E. EPROM PROGRAMMER)
For 6502-based home computers.	
★ POP AMPS No. 6)
Linear ohmmeter	
* POPAMPS No. 7	3
Low range ohmmeter	
* SIGNAL POWERED LOUDS PEAKER PROTECTOR)
A 'set and forget' circuit	
* OVERVOLTAGE CUT-OUT	3
Crowbar circuit protection device.	

FEATURES

★ FINISHING TOUCHES	12
* COMPONENTS FOR COMPUTING	16
ROMs and EPROMs.	40
★ THE ELECTRONIC REVOLUTION	40
RADIO RULES	55
Propagation and aerials.	
* VOYAGERCARCOMPUTER	62
The review of the kit.	
FAMOUS NAMES	65
Herman Hollerith.	

REGULARS

Monitor													ı											. 6
What's On Next																								
Points of View .																								
Buylines																								
Clever Dick						0						٠				٠		×		۰				37
HE Bookshelf																								
HE Subscriptions																								
Home Computer																								
PCB Service				۰	٠			*,	٠	٠	٠				٠	٠	٠		÷,	٠		is.	٠	70
HE PCB Printout	47					 ٠	-	4			4	٠	4				b				٠			12
Classified Adver	tise	em	lei	u	S		0.	4						10	1,					8				13

Editor: Ron Keeley

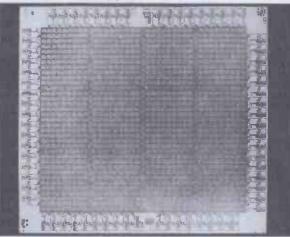
Editorial Assistant: Helen Armstrong Technical Illustrator: Jerry Fowler Advertisement Manager: Jolyn Nice

Divisional Advertisement Manager: Gary Price

Managing Editor: Ron Harris BSc Managing Director: T.J. Connell



FINISHING TOUCHES - page 12



COMPONENTS FOR COMPUTING - page 16 Picture courtesy Ferranti Ltd.



THE ELECTRONIC REVOLUTION - page 40

Hobby Electronics is normally published on the second Friday of the month prior to the cover date.

Hobby Electronics, 145 Charing Cross Road, London WCZH OEE, 01-437 1002. Telex No 8811896. Published by Argus Specialist Publications Ltd.

Design and Organisation by MM Design and Print Ltd, 145 Charing Cross Road, London WCZH OEE, 01-437 1002.

Distributed by S. M. Distribution Ltd, 16/18 Trinity Gardens, London SW9 8DX.

Printed by OB Ltd, Colchester. Covers printed by Alabaster Passmore.

Notice: The contents of this publication including all articles, designs, plans, drawings and programs and all copyright and other intellectual property rights therein belong to Argus Specialist Publications Limited. All rights conferred by the Law of Copyright and other intellectual property rights and by virtue of international copyright conventions are specifically reserved to Argus Specialist Publications Limited and any reproduction requires the prior written consent of the Company. All resonable care is taken in the preparation of the magazine to ensure accuracy, but Argus Specialist Publications Ltd cannot be held responsible legally. ©Copyright 1982 Argus Specialist Publications Ltd. Member of Audit Bureau of Circulation.

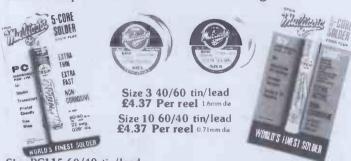


akes soldering ec fast & reliable

Ersin Multicore

Ersin Multicore, solder contains 5 cores of noncorrosive flux, instantly cleaning heavily oxidised surfaces. No extra flux is required.

Comes in handy dispensers and tool box reels in two different alloys 40/60 tin/lead for general purpose electrical soldering and 60/40 tin/lead ideal for small components and fine wire soldering.



Size PC115 60/40 tin/lead £1.38 Handy pack 0 028mm dia

Size 19A 60/40 tin/lead £1.15 Handy pack 1.22mm dia

Multicore Savbit

Multicore Savbit, solder increases the life of your soldering bit by 10 times, for better soldering efficiency and economy. Comes in two handy dispensers and tool box reels.



Size 5 Savbit £1.15 Per pack 1.2mm dia

Size SV130 Savbit £1.73 Per pack 0.048mm dia

Multicore Alu-Sol

Multicore Alu-Sol, solder contains 4 cores of flux, suitable for most metals especially aluminium. Comes in handy dispensers on tool box reels.

> Size AL150 Alu-Sol £2.07 Per pack .048mm dia



Size 4 Alu-Sol £7.82 Per reel 1.6mm dia

All prices inclusive of VAT. Available from most electrical and DIYs stores. If you have difficulty in obtaining any of these products send direct with 50p for postage and packing. For free colour brochure send S.A.E.

Multicore Solder Wick

Multicore Solder Wick, absorbs solder instantly fro tags and printed circuits with the use of a 40 to 50 watt soldering iron.

Quick and easy to use, desolders in seconds.

Size AB10 Solder Wick £1.43 Per pack



Multicore Tip Kleen

Multicore Tip Kleen, soldering iron tip wiping pad. Replaces wet sponges.



Size 2 Tip Kleen £0.92 Per pack

Bib Wire strippers and cutters

Wire strippers and cutters, with precision ground and hardened steel jaws. Adjustable to most wire sizes. With handle locking-catch and easy-gri plastic covered handles.



Bib Audio/Video Products Limited (Solder Division), Kelsey House, Wood Lane End, Hemel Hempstead. Hertfordshire, HP2 4RQ. Telephone: (0442) 61291 Telex: 826437

Fill Min MESISTORS Management Manageme	Annex Anne	340 80244C 1.00 MPSUJS 81 100 80245C 1.30 MPSUJS 51 100 80245C 1.30 MPSUJS 52 120 80245C 1.30 MPSUJS 53 100 80245C 1.30 MPSUJS 53 100 80245C 1.30 MPSUJS 120 80245C 1.30 MPSUJS 120 80245C 1.30 MPSUJS 120 80245C 1.30 MPSUJS 120 MPSUJS 120	4.0 Cncklewood Broadway London NW This is a small list from our vast stocks order by phone quoting Access, Visa or order claims welcome all in stock items, and the stock items of the	### STATE ST

MONITOR

Fourth London Computer Fair - 1983

The Fourth London Computer Fair is to be held from 14 to 16 of April at the Central Hall, Westminster. This year, the computer fair will be part of a larger London Computer Festival, which is being held to bring together all the activities organised by the Association of London Computer Clubs, and events held in London and the South East to mark Information

Technology Year in 1982.

The Computer Fair is the latest of an annual event organised by the Association of London Computer Clubs (ALCC), a group of some fifteen local computer clubs in the London Area. The Fair started out when the North London Hobby Computer Club invited other clubs to join them in organizing the event, and since then it has become yearly more popular, so that now it has become one of the major exhibitions for micro-based systems and projects, attracting both major UK micro companies and the smaller companies in south east England.

This year, as part of the Computer Festival, the Computer Fair is being cosponsored by the ALCC and the GLC (with the actual running being done for the first time by a professional organisation, Goddard, Steadman and Partners).

The main aim of the ALCC and its member clubs is simply to spread knowledge about the use of micros, especially for home users, to put people with computers in touch with each other, and to run seminars, meetings and lectures to teach people what can be done with home computers. They want to establish new clubs, and help information to circulate between groups. Eventually, any kind of group with an interest in hobby computing should be able to join. There is a three-man executive committee, and the chairman and secretary from each member club will form a clubs council. There will be specialist subcommittees to deal with specific aims and projects within the ALCC, so there will be opportunities for people with particular interests to actively do something about them.

Members of associated clubs can attend each other's meetings, and newsletter is circulated to club secretaries. Information is available on Prestel, starting on page 80080, including a newsletter which is updated daily. Remember that Prestel terminals are now available for use in many public libraries. The ALCC also has various discount and bulk purchasing schemes for members.

The main clubs participating are the Croydon Micro Computer Club (01 653 3207 or 764 4043), Harrow Computer Club (01 950 7068), North London Hobby Computer Club (where the whole thing started) (01 607 8349), East London Amateur Computer Club (01 554 3288), North Kent Amateur Computer Club (Biggin Hill 71742), Richmond Computer Club (01 892 1873), South East London Micro Computer Club (01 853 5829), West London Personal Computer Club (01 997 9437), and Worcester Park

Computer Club (01 337 1609), as well as in-house clubs in places like the Post Office HQ, Home Office, etc. All these clubs have regular meetings, monthly or more often, and the North London Hobby Computer Club is run from the Polytechnic of North London, where it holds structured courses on a termly basis, open to members of the public.

The London Computer Festival is being organised by a consortium of computer interests, including the National Computing Centre Micro Systems Centre, and local authority computer centres. For information on the Festival, contact the Secretary to the Consortium, GLC Central Computer Service, Room 431, County Hall, London SE1 (01 633 3348)

For more information about the ALCC, contact the ALCC at North London Hobby Computer Club, Polytechnic of North London, Holloway, London N7 8DB. Tel: (01 607 2789).

Going Up

Many a radio amateur wants to set up a radio mast in the back garden, but, having overcome all obstacles and finally put it up and into operation, finds that he's got the thing the wrong way round, or the mast isn't quite tall enough, or it's prone to blow over - and so on. Allweld Engineering's Altron SP1 Swing Post is a practical way to reduce access problems on radio masts: it is basically a hinged post which can be either latched upright, or swung into a horizontal position at about waist height for adjustments. The swing post will hold a mast made of any piece of aluminium tubing, from 1 3/4 to 2in in diameter and up to 6m (20ft) long, and Allweld also supply 2in tubing up to 5m long at £6.50 a meter, if required.

The swing post is made of galvanised steel and simply sets into concrete, or impacted filling, in a hole in the ground (it could even double as a washing-line post, couldn't it?). The SP1 costs £49.50, inc.

VAT and UK carriage.

For mobile broadcasters, the Altron PM1 portable mast is made in zinc-plated steel tube and is designed to telescope into 1.5m sections for easy carriage. Thus it can be packed into any car and easily set up, with the car as a support, at any location. An adjustable-height bracket clamps to the guttering of most car roofs, while allowing the mast to be rotated. The PM1 extends to 5.5m (18ft) and costs £40.50, VAT and UK carriage inc.

Finally, a universal aerial mounting, for television, CB, amateur radio aerials, etc. The QM1 is a pressure-bar which fits across most window openings or similar from 25 to 42in (or more with an extension) in a vertical or horizontal position. The fixing clamp takes tubes from 1 ½ to 2in, and no drilling or brackets are needed for fixing. For rotatable or long masts, up to 8ft long and 12lb weight, an extra support arm is available which can mount on the QM1 itself, or be set into the wall. We don't have a price for this one, but all orders and enquiries should go to Allweld Engineering, Unit 6, 232 Selsdon Rd., S. Croydon. Tel: 01 681 6734 or 01 680 2995.

Shorts

Camtec Circuits and Systems have produced four new finger heatsink designs for use with SOT32 and TO220 case plastic transistors. The heatsinks, made from high-grade black an'odised aluminium, come with composite drillings to allow a variety of devices to be mounted either flat, or on legs that pass through the PCB. They are also available undrilled or with special drillings if required.

For details and prices contact Camtec Circuits and Systems, 5 York Rd., Bognor Regis, W. Sussex. Tel: (0243) 862911

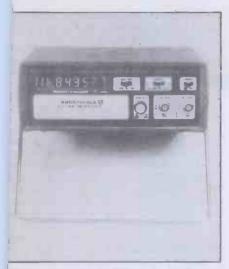
Electronic Hobbies have sent us a description of how to convert their 3½-digit Digital Panel Meter kit for use as a digital thermometer. The kit contians an IC, PCB, liquid crystal display, components and hardware to build a DPM on a single chip, run from a 9V battery. Extra components needed for the conversion have to be obtained in addition to the kit. Other applications mentioned are input attenuator, AC voltage meter, multirange DVMs, current and resistance meters. Details from Caroline Stewart, Electronics Hobbies Ltd., 17 Roxwell Rd?, Chelmsford, Essex CM1 2LY. Tel: (0245) 62149.

Black Star are supplying the Sabtronics 8000 nine-digit frequency meter, a portable, battery or mains operated meter, capable of measuring frequencies bet ween 1Hz and 1GHz with 'impressive accuracy'. Frequencies are covered in three ranges and three gate times are provided.





MONITOR



There are two BNC inputs (10Hz to 100MHz/1MR and 10MHz to 1000MHz/50R) and a sensitivity control. Sensitivity ranges from 20V to 10Hz to 35mV at 1GHz. Maximum resolution is 0.1Hz (on the 10MHz range), 1Hz (on the 10MHz range), all using a ten second gate time.

The 8000 costs £155.00 plus VAT. Specification and information from Black Star Ltd., 9A Crown St., St. Ives, Cambs PE17 4EB. Tel: (0480) 62440.

Stotron have added miniature relays by National to their catalogue, including subminiature DIP relays with single or double pole operation and very low operating power, for 12 or 24V; four pole miniature relays capable of switching 5A at 250VAC, for 24VDC or 220VAC; several kinds of low-profile relays, and various sealed terminals to give higher reliability and to prevent solder contamination.

General enquiries to Stotron Ltd., Haywood Way, Ivyhouse Lane, Hastings, E. Sussex TN35 4PL. Tel: (0424) 442160.

Electronic Hobbies have produced a range of 'Simplex' lightweight soldering irons. These are available for 24 or 48V, and 18 or 23W, and cost £5.00 plus £1.00 p&p, with VAT to be added to the total cost. The irons conform with international CEE11 and BS 3456 safety regulations. A wide range of iron-clad soldering bits is also available.

Order or enquire: Electronic Hobbies Ltd., 171 Broomfield Rd., Chelmsford, Essex CM1 1RY. Tel: (0245) 62149.

Casio, who are already known for pacemaker watches for joggers and runners, have now produced a waterresistant watch (over a distance of 50 meters) for swimmers and people in training for other water sports.

One characteristic of these watches is their ability to bleep at regular, pre-set intervals, to help a runner keep his stride rate steady, important for athletic training. The water-resistant J30 also has a daily alarm, countdown timer alarm and stopwatch feature.

Price is £14.95 (RRP). For further information, contact Casio Electronics Co. Ltd., Unit 6, 1000 North Circular Rd., London NW2 7JD. Tel: 014509131.

A New Hobby Shop

Hobbvists from South London and further afield will be interested to know of a new component and hardware shop opening in SW18, near Southfields and Earlsfield stations. JEE Distribution's shop will be open usual hours plus 10 am to 4 pm on Saturdays, and will be stocking over 4000 electronics items, with the aim of providing a complete equipment source for the hobbyist. A catalogue aimed specifically at hobbyists is available for 25p, and you can write for a complete catalogue and mail-order prices to Roger Buckingham, JEE Distribution Ltd., 43 Strathville Rd., London SW18 4QX. Tel: 018700075 (5 lines).

Telephone Ringer

Inspired by our 'Telephone Repeater' project back in October '81, Tutchings Electronics have sent us information about the new 'Door Bell Repeater' they are producing. This can be set up just about anywhere that a length of wire will reach (Tutchings mention the garage and the garden, but do not say specifically that it is suitable to be mounted out of doors, so you will have to check that) and will sound a bell and flash a green light when the doorbell rings.

This is obviously useful for anyone some distance from their doorbell, or engaged in some noisy pursuit like watching the telly, and the light facility (an optional switch is available to switch off the bell when required) is especially handy when a silent alarm is wanted, or for the hard of hearing. The repeater can be set to sound as many times as you wish for each ring of the doorbell. Apparently, it doesn't work with chimes, but it might be possible to wire it in to some chime systems, so it may be worth asking.

ing.
The repeater can be powered either by PP9 battery or from an AC adaptor (which can be supplied for £3.50). The price of the Door Bell Repeater is £11.50 plus £1.50 p&p, and it is guaranteed for one year. Write to Tutchings Electronics Ltd., Crest House, 3 Grange Rd., Southbourne, Bournemouth BH6 3NY. Tel: (0202) 424858.

Nellie Goes Home

Still on the subject of computers, but going back a bit in time, one of the oldest first generation computers actually to be put to regular commercial use in Britain is being returned to its makers, **STC** (who no longer make computers now), for their archives.

The computer, known as Nellie, is a Stantec Zebra, 'which can be described as a serial digital computer with a 33-bit word length. Operation is based entirely on a magnetic drum rotating at 100 revolutions per second, 32 words per track giving a word cycle time of about 312 microseconds. Although this sounds slow compared with modern computers, the long word length enables a high degree of arithmetical precision to be combined with a multiplicity of switching

operations that could take place in one word time. For precision mathematics, the machine's efficiency is still close to that of the latest equipment available.' For comparison's sake, it takes three kW to heat up Nellie's 600 valves, and 21 fans to make sure they do not overheat. It then takes another four kW to enable her to calculate, when the high-tension circuits are switched on, and she requires a 270sq ft computer room to herself. She has the capacity of a small desk-top micro today.

Nellie has had a fairly impressive history: she was the main computer at Woolwich Polytechnic until the mid-1960s, when STC stopped making computers, which effectively made her obsolete. Later, she was acquired by a gentleman called Mr. MacRae as a backup computer for another Zebra that he was already using in his business - this was long before business computers were the commonplace they now are - and Mr. MacRae's computers were also used by a firm of sail designers, Bruce Banks Sails Ltd. The two computers were used together, each providing a backup for the other, but when the first machine was destroyed by fire in the early 70s, Bruce Banks Sails took over Nellie full-time (such was her reliability that she had never required the backup) and used her for all their research and development work until January 1981, when all her programs were transferred to a modern micro.

By taking a gamble and relying on Nellie at a time when she was obsolete and when there was no outside source of maintenance, Bruce Banks Sails was able to use a computing facility which they would not have been able to afford in any other form, and gain a world lead in the scientific approach to yacht sailmaking, which is today a precise science. Nellie could be said to represent the birthplace of sail technology.

Comparing the dimensions and enormous power of old computers with the tiny size of modern micros which can do the same tasks is a awe-inspiring exercise. Here's hoping that other old machines like Nellie will be preserved in museums and by private owners so that we can look back on them in the future.



MONITOR

Software For Sinclair

Sinclair Research have announced eighteen new software cassettes, mostly adventure games, for the Spectrum and ZX81.

The most expensive tape is The Hobbit, designed for the 48k Spectrum, a fantasy game based closely on the book of the same name, and indeed the game package from Melbourne House publishers includes a copy of said book to give the player hints on what to do next. The game, of course, develops according to the player's decisions, and if he takes too long over them, it will develop without him! The Hobbit has been written to use the full potential of the 48k Spectrum, and has a built-in 500-word 'inglish vocabulary to instruct the computer. Will Bard the Bowman miss this time? Will Smaug the Dragon eat the thirteen dwarves and re-invest his hoard? Here's your chance to find out — it costs £14.95.

There will be a review of The Hobbit game in a future issue of HE.

Also for the Spectrum are four adventure games: Adventure A (Planet of Death) Adventure B (Inca Curse), Adventure C (Ship of Doom) and Adventure D (Espionage Island), all published by Artic at £6.95. Sounds like a normal day's work for Harrison Ford. Then there is Reversi, a modern version of the late nineteenth century board game (also known as Othello) with nine levels of difficulty, from Games Of Skill, price £7.95, and two practical programmes from ICL, the Collectors Pack, which enables collectors to hold a minimum of 600 records of up to nine items on one cassette, and the Club Record Controller, both £9.95.

All these are for the 48k Spectrum, excepting *Reversi*, which is for the 16k version, and Adventure A, which can be played on either the 16 or the 48k model.

For ZX81 users, the four adventure games are available for use with the 16k RAM pack, and are priced £5.95 each. Reversi costs £6.95 and needs 16k. Also for the 16k ZX81 is Thro' the Wall/Scramble, and a tape with two interactive games in machine code, Super Glooper and Frogs, both from Psion/Microgen at £4.95.

For the 1k ZX81 there is a Games Pack with eleven items (£6.00) and a new ZX81 Chess tape (£2.95) — these are both from Artis

both from Artic.

For the experienced ZX81 operator, there is a new ZX Toolkit (Artic, £5.95) which gives nine new functions: renumber, delete, MEM, dump, find, replace, save and append, and remkill.

Prices are all inc. VAT and the tapes are available now from Sinclair Research, Stanhope Rd., Camberley, Surrey, and

from retail stockists.

Oric the Third - and Forth

A 32k version of Oric Products International's Oric I microcomputer will be available from January 1983 — it should be in the shops now. It retails at £139.95 (inc. VAT), making a trio with the 48k

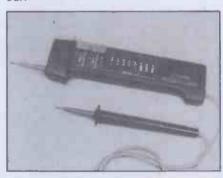
Oric at £169, and the 16k version (£99.95).

All the Orics run on extended BASIC, but for mail order purchasers only there is a free cassette containing FORTH as a second language with the 48k model. This cassette is to be available as an optional extra for other buyers of the 48k and 32k Orics. More information from Oric Products International, Coworth Park, London Rd., Ascot, Berks SL5 7SE. Tel: (0990) 27686.

OK, OK, OK

OK Machine & Tool have now issued their 1983 catalogue with "108 pages of information on tools and equipment for electronics, telecommunications, manufacturing, field services, labs, as well as schools and hobby users...It also features a unique product line of low cost tools and products, especially for educational and home use, and is full of useful technical and product information." Updates will be added every quarter.

Also from OK is a series of wire binding posts by BP which can be connected to a phono plug, banana plug, alligator clip, spade lug or wire, and plastic washers are available for complete insulation from PCB or chassis. For amateurs, these are available in packages of four (one red, one yellow, one green, one black); there are also bulk packages of 100 of any one col-





A hand-held voltage and continuity tester, the **Steinel** Combi-Check, claims to be foolproof and fully protected against any damage to the unit (or the user) from wrong operation. Covering a voltage range of 6 to 660V AC/DC in eight increments, it is shock protected by a high input resistance, and protected against voltage surges.

The Combi-Check can be used for phase-to-ground testing, polarity, continuity in the 0 to 2MR range, and diode testing, as well as AC/DC voltage testing. Its performance and display levels can be

checked on a voltage indicator before or during voltage testing, and it gives visual and audible readouts.

For further news or catalogue, contact OK Machine & Tool (UK) Ltd., Dutton Lane, Eastleight, Hants S05 4AA. Tel: (0703) 610944.

Open And Closed

Open Sesame? It's not quite as simple as that, but if you are fed up with climbing out of your car on wet windy evenings and struggling with the garage keys, you could consider a remote-controlled garage door mechanism. Slave-Dor, long-time specialists in automatic door control, are now handling the US-made Moore Othatic screw-driven remote-controlled

garage door operator.

The newest model, called the Ultra Lift 838, costs £247.00, and is operated by remote control from inside the car. The basis of the opening mechanism is a triplethread 34" hollow aluminium screw and belt-drive mechanism with microprocessor controlled circuit board (easy to replace in case of failure). The 'door open' and 'door closed' limits of the screw, and the pressure needed to stop automatic opening or closing in case of obstruction are adjustable by the owner. The whole mechanism is designed to resist interference by ice, gravel and other driveway hazards, and includes an ingarage light which comes on automatically.

Slave-Dor haven't told us whether the unit is user-installable, or whether the remote is IR or ultrasonic, but they have told us that there is a cheaper version for £181.75, and that they will be introducing a version for domestic gates,

which is user-installable.

For full details, contact Slave-Dor (UK), (Division of Amplite Electrical Ltd.), 1 Maidstone Rd., New Southgate, London N11 2TR. Tel: 01 881 2905.

Going Down

What lies at the bottom of Loch Ness? What lies at the bottom of the generations-old desire to know what lies at the bottom of Loch Ness? Everybody (just for once, we can use this oft-abused cliche with some accuracy) has heard of the Monster — generous time and resources have been spent on tracking it (him? her?). But the Loch Ness Explorers Club are taking an entirely different and down to earth track, by ignoring the palaeontology and getting on with the archaeology.

The Explorers Club are planning to survey the entire floor of Loch Ness, and record — on computer and video and any other appropriate method which is presented — the geography of the loch and any man-made remains which have sunk to the bottom during the loch's millenia-old history as a cross-country waterway (it's part of the Caledonian canal and was at one time the main route across Scotland). They have two sailing boats, video and computer equip-

DNITOR

ment and, far from trying to acquire more heavy-duty gear, want the whole project (which they expect to run for about five years) to be run entirely with the ideas and assistance of hobbyists. In their own words:

"What we are looking for is hobbyists who might fancy designing and building equipment that we can use to further the survey. The hobbyists may either send their built pieces to us and we will try them out and return them with a report of their performance, or better still, they are most welcome to bring them along and try them out themselves on Loch Ness on board our research vessel. This way the hobbyists get a chance to test their ideas and their prototypes under practical conditions. The kind of equipment we need is varied indeed. It ranges from robots, capable of working in 800 feet of water, remote-controlled grabs, TV cameras, water-tight cases, low level lighting systems, sonar (tight beamed), computer recording data methods, position fixing systems . . . the list is endless! Anything that a hobbyist can dream up and wants testing. Time is plentiful, so any modifications that may be needed to someone's idea will be able to be tried out, too. No project is too small, too trivial.

Members of the club will get a quarterly progress report, opportunities to visit the site and use the equipment, and contribute any ideas, even seemingly unlikely

ones, which come to them.

This sounds like a good opportunity for inventors and adventurers, as well as down to earth hobby designers, to try out their ideas in the field.

The address to contact is: The Loch Ness Explorers Club, "John William", Foyers, Inverness-shire, IV1 2YB, Scotland.

Prestel Editing

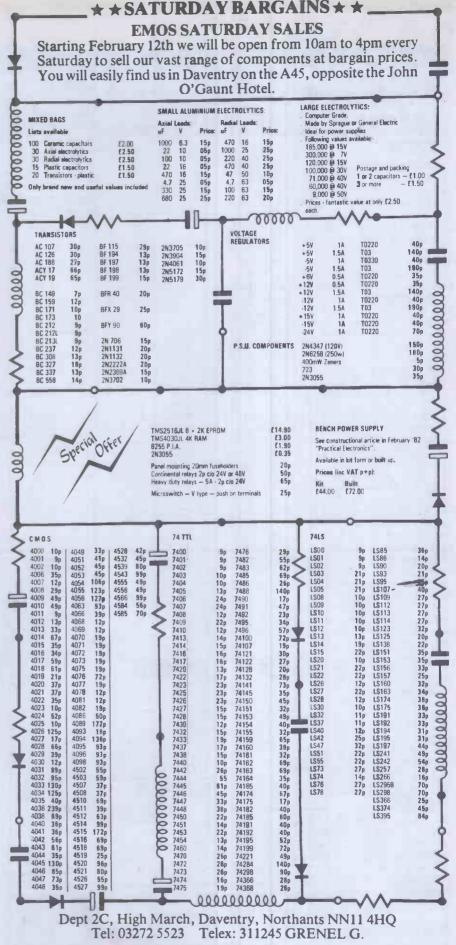
Continuing on the theme of computer clubs: The Association of Computer Clubs (ACC — not to be confused with the ALCC), acting in its role as the national body representing the computer hobbyist, has linked up with Micronet 800 to create Club Spot 800, a new way to involve the ordinary computer enthusiast in Prestel editing.

Club Spot 800 will be on Prestel *8008+, and will contain news and ideas about micros and micro clubs, programs, sales, wants, views etc.

The ACC is holding an editors conference on Saturday 26 February, at the Institute of Grocery Distribution, Grange Lane, Letchmore Heath, Watford, Herts. The nearest station is Watford Junction, and lifts can be arranged from there. Registration is free in advance, or £5.00 on the door, subject to space. There will be an introductory talk on Prestel editing, a hands-on session and questions and discussions.

For information, contact Rupert Steel, ACC National Prestel Committee Secretary, St. John's College, Oxford 0X1 3JP. Tel: (0865) 512811.

HE



Please add 50p per order postage and packing (except where higher is indicated) plus 15% VAT on total. No VAT on overseas orders, postage at cost. Cheques and postal orders made payable to Emos Limited. Send Large S.A.E. for comprehensive catalogue.



₹Rapid ₹Electronics

MAIL ORDERS: Unit 2, Hill Farm Industrial Estate. Boxted, Colchester, Essex CO4 5RD. **TELEPHONE ORDERS:** Colchester (0206) 36412.



BARGLAYCAND +

ACCESS AND BARCLAYCARD WELCOME

►CA3240E 110 LM335Z	25 PLM3909 70	NE565 110 T	L062 60 ZN1034E 200
TRANSPORT	BC51 40 BF33		50 ZTX108 8 2N3055 50
TRANSISTORS	BC547 BFR4 BC548 10 BFR8		30 ZTX109 12 2N3442 120
AC125 35 BC149 9	BC548 10 8FR8 BC549 10 ▶8FR		55 ZTX300 14 ▶ 2N3702 6 37 ZTX301 16 2N3703 9
AC126 25 BC157 8	8C558 10 BF X2		37 ZTX301 16 2N3703 9 35 ZTX302 15 ▶2N3704 6
AC127 25 BC158 10	8CY70 18 BFX8		50 ZTX304 17 2N3705 9
►AC128 20 BC159 8	BCY71 18 BFXE		37 ZTX341 30 2N3706 9
AC176 25 8C160 45	8CY72 18 BEXB		35 ZTX500 15 2N3707 10
AC187 22 BC168C 10	BD115 55 BFX8		37 ZTX501 15 2N3708 10
AC188 22 BC169C 10	BD131 35 BFX8		35 ZTX502 15 2N3709 10
AD142 120 BC170 B	BD132 35 8FY5		37 ZTX503 18 2N3772 170
AD149 80 BC171 10	BD133 50 BFY5		50 ZTX504 25 ▶2N3773 195
AD161 40 BC172 8	BD 135 40 BFY5		75 2N697 20 ▶ 2N3819 18
AD162 40 BC177 18	BD136 30 BFY5		60 2N698 40 2N3820 40
AF124 60 BC178 18	BD137 30 BFY5		85 2N706A 20 2N3823 65
AF126 50 8C179 18	BD138 30 BFY5		05 2N708 20 2N3866 90 25 2N918 35 2N3903 10
AF139 40 BC182 10	▶80139 35 BRY3		
AF186 70 ▶BC182L 8	▶8D140 35 8SX29		25 2N1132 22 2N3904 10 35 2N1613 30 2N3905 6
AF239 75 8C183 10 BC107 10 BC183L 10	BD204 110 BSX29 BD206 110 BSY9		45 2N22184 45 2N3906 10
BC1078 12 BC184 10	BD222 85 BU20		45 2N2219A 25 2N4037 45
▶BC108 9 BC184L 7	BF 180 - 35 BU20		90 2N2221A 25 2N4058 10
BC108B 12 BC212 10	BF 182 35 BU20		90 2N2222A 20 2N4060 10
BC108C 12 BC212L 10	BF184 - 25 MJ298		90 2N2368 28 2N4061 10
▶BC109 9 BC213 10	8F 185 25 MJE3		98 2N2369 16 2N4062 10
BC109C 12 BC213L 10	8F194 12 MJE5		98 2N2484 25 2N5487 36
BC114 18 BC214 10	8F195 12 MJES	1 95 TIP147 1	10 2N2886 45 2N5458 36
BC115 22 ▶BC214L 8	BF196 12 MJE30		60 2N2904 20 2NB459 30
8C117 18 8C237 8	BF197 12 MPF1		55 2N2904A 20 2N5485 36
BC119 35 BC238 14	BF198 10 MPF1		40 2N2905 22 2N5777/ 48
BC137 40 8C308 12	BF199 18 MPSA		45 2N2905A 22 2N6027 30
BC139 40 BC327 14	BF200 30 MPSA		30 2N2906 25 40360 40
BC140 28 BC328 14	▶8F244B;22 MPSA		30 2N2906A 25 40361 \ 50
BC141 30 BC337 14	BF245 30 MPSA		45 2N2907 25 40382 . 50
BC142 25 BC338 14	BF 256B 45 MPSA		75 2N2907A 25 40408 70
BC143 25 BC477 30 BC147 B BC478 30	BF257 32 MPSU BF258 25 MPSU		85 2N2926 9
	7- 1411 00		95 >2N3053 23
BC148 8 BC479 30	BF259 35 MPSU	55 60 ZTX107	8 2N3054 65

MICRO BEST PRICES ANYWHEI	271 253 273 411 611	12 16 P20 16-P3 150	75 205 340 340 70 ns 365 440	Z80A C Z80A C Z80A C Z80A C Z80A C Z80A C Z80A C	210 260 CTC 260 S10 900 DMA 1150 DART 500	81L 148 148 Eps Cor		isve wo	100H 1MH 1.84 2.0N	32M 2 76M 2	236 4.43 275 6.0N 200 7.0N 225 8.0N	1 140 1 150 1 140 M 170 170
CMOS 4000 10 4001 10 4002 12 4006 50 4007 14 4008 36 4009 24 4010 24 4011 10 4012 15 4013 20 4014 4015 40	4016 4017 4018 4019 4020 4021 4022 4023 4024 4025 4026 4027 4028 4029 4030 4031	20 30 45 25 42 40 45 16 33 12 75 20 40 45 14	4034 4036 4039 4040 4041 4042 4043 4044 4046 4047 4048 4049 4050 4051 4052 4053	140 249 280 40 40 38 40 40 40 35 38 21 21 42 48	4054 4055 4059 4060 4063 4066 4067 4068 4069 4070 4071 4072 4073 4075 4076	78 80 430 42 80 22 225 14 13 13 13 13 13 14 45	4081 4082 4085 4086 4089 4093 4094 4095 4098 40106 40109 40163 40173 40175	12 12 48 50 125 18 68 65 290 70 70 40 110 60 100 75	40193 4502 4503 4507 4508 4510 4511 4511 4514 4515 4516 4516 4516 4520 4521 4526 4527	65 60 32 35 110 45 40 40 115 115 55 40 50 130 60 50	4528 4529 4532 4534 4538 4543 4549 4555 4556 4559 4566 4559 4564 4584 4585 4724	45 150 60 400 60 360 215 35 35 390 140 35 60 140
L500 11 L501 11 L502 11 L503 12 L504 12 L505 12 L508 12 L509 12 L510 12 L511 12 L511 12 L512 12 L513 19 L514 30 L515 12	LS20 LS21 LS22 LS26 LS27 LS30 LS32 LS37 LS38 LS40 LS42 LS47 LS48 LS45 LS47 LS48 LS51 LS55 LS73 LS74	12 12 14 12 13 14 15 13 28 35 45 14 14	LS75 LS76 LS76 LS83 LS85 LS86 LS90 LS92 LS93 LS95 LS96 LS107 LS109 LS112 LS113 LS114 LS1122	20 17 17 35 48 16 24 25 24 38 95 40 21 21 21 22 35	LS123 LS125 LS126 LS132 LS138 LS139 LS145 LS147 LS148 LS151 LS153 LS155 LS155 LS155 LS155 LS155	34 24 25 35 26 30 70 150 75 38 38 75 33 36 26 29	LS160 LS161 LS162 LS163 LS164 LS165 LS165 LS177 LS1775 LS1775 LS1790 LS1991 LS1992 LS1993 LS1995 LS1996	35 35 35 40 55 60 45 35 35 36 32 45	LS197 LS221 LS240 LS241 LS242 LS244 LS245 LS247 LS251 LS257 LS258 LS259 LS259 LS279 LS279 LS279 LS283	45 50 60 55 55 55 70 48 28 32 32 55 20 58 30 38	LS353 LS365 LS366 LS366 LS367 LS373 LS374 LS375 LS377 LS378 LS393 LS399 LS399 LS3670	60 28 28 28 29 58 60 43 60 57 45 40 156 78
7400 11 7401 11 7402 11 7403 12 7404 12 7405 14 7406 19 7407 19 7408 13 7410 13 7410 13 7411 15 7412 17	7413 7414 7416 7417 7420 7421 7422 7427 7428 7430 7432 7433 7433 7437 7438 7440	17 23 19 19 19 14 19 19 18 25 13 20 20 23 24 14 30	7444 7446 7447 7448 7450 7451 7453 7454 7472 7473 7474 7475 7476 7480 7482	85 58 36 43 14 14 14 12 22 24 19 26 25 45 65	7483 7485 7486 7489 7490 7491 7492 7493 7494 7495 7496 7497 74100 74107 74109	30 60 19 180 19 34 24 23 33 33 38 86 78 22 24 24	74122 74123 74125 74126 74132 74141 74145 74147 74148 74150 74153 74155 74156 74157	38 38 33 33 30 54 48 75 60 48 38 47 36 36 28 55	74161 74162 74163 74164 74165 74167 74170 74173 74174 74175 74176 74179 74180 74181 74182	46 46 46 46 150 115 58 53 45 35 42 75 38 100 55	74190 74191 74192 74193 74194 74195 74196 74197 74198 74199	40 40 40 40 40 40 40 80 80
CAPACIT	ORS			POTE	NTIOME	TERS		TO	OOLS			

SWITCHES

Submin toggle: SPST 55p. SPDT 60p, DPDT 65p. SPST 59D, SPDT 60D, DPDT 69D, Miniature toggle: SPDT 80D, SPDT centre off 90D, DPDT 90D, Standard toggle: SPST 35D, DPDT 48D, Miniature DPDT slide 12D, Push to make 12D, Push to break 22D. Push to break 22D. Push to break 22D.

Rotary type adjustable stop. 1P12W, 2P6W, 3P4W all 55p each. DIL switches: 4SPST 80p 6 SPST 80p, 8SPST

VERO	
VEROBLOC ◀	350
Size 0,1 matrix:	
2.5 x 1	22
2.5 x 3.75	75
2.5 x 5	85
3.75 x 5	95
VQ board , ,	160
Veropins per 100:	
Single sided	50
Double sided	60
Spot face cutter	105
Pin insertion tool	162
Wiring pen and spool	310
Spare spool 75p Combs	. 6
	$\overline{}$

DIOD	ES		
BY127 QA47	12	▶1N4001 1N4002	3 5
OA90	8	1N4006	7
OA91 OA200	7	1N4007 1N5401	12
OA202 1N914	8	1N5404 1N5406	16 17
▶1N414	8 2	400mWzen	6

20 metre pack single o ing cable ten different		
Speaker cable		10p/m
Standard screened .		16p/m
Twin screened		24p/m
2.5A 3 core mains .		23p/m
10 way rainbow ribbo	n	GEn Im

CABLES

TRANSFORMERS Please add carriage charges to our normal post charges

Ministure mains: 606 V; 909 V, 12012 V all @ 100 mA 100 p each. PCB mounting. Ministure:

506 y; 909 y, 1201 2 V all @ 100 m A 100 p each, PCB mounting, Ministure; 3 V A 0-6, 0-6 @ 0.25 A; 0-9, 0-9 @ 0.15 A; 0-12, 0-12 @ 0.12 A 200 p each, 8 V A 0-6, 0-6 @ 0.5 A; 0-9, 0-9 @ 0.3 A; 0-12, 0.12 @ 0.25 A 270 p each, High quality. Split bobbin construction 6 V A 0-6, 0-6 @ 0.5 A; 0-9, 0-9 @ 0.4 A; 0-12, 0-12 V @ 0.3 A 220 p each, 12 V A 0-6, 0-6 @ 1A; 0-9; 0-9 @ 0.8 A, 0-12, 0-12 @ 0.5 A; 0-15, 0-15 @ 0.4 A 295 0 (plu 40) p carriage], 25 V A 0-6, 0-6 @ 1.5 A; 0-9, 0-9 @ 1.2 A; 0-12, 0-12 @ 1A; 0-15, 0-15 @ 0.8 A 370 each, India SC A processor.

0.8A 330p each (plus 60p carriage) 50VA 0-12, 0-12 @ 2A, 0-15, 0-15 @ 1.5A, 440p each (plus 75p carriage)

HARDWARE

PP3 battery clips
Red or black crocodile clips
Black pointer control knob
Pr Ultrasonic transducers
84 V Electronic buzzer
12 V Electronic buzzer
12 V Electronic buzzer
164mm 64 ohm speaker
164mm 64 ohm speaker
20mm panel fuseholder

BOXES	Aluminium
Plastic with lid + screws 3x2x1" 55 4½x3x1½" 88 7x4x2 160	3x2x1" 70 4x3x1%" 85 4x3x2" 100 6x4x2" 120 6x4x3" 150
	N.C106D 31

SCRs	400V 8A 400V 12A	70 95
BRIDGE RECTIFIERS	2A 200V 2A 400V 6A 100V	40 45 80
1A 50V 20 1A 400V 35	6A 400V 95 VM18 DIL 0. 200V , ,	9 A 50

CONNECTORS

CONNECTORS

DIN Plug Skt Jack Plug Skt
2 pin 9p 9p 2.5mm 10p 10p
3 pln 12p 10p 3.5mm 9p 9p
5 pin 13p 11p Standard16p 20p
Phono 10p 12p Stereo 24p 25p
1mm 12p 13p 4mm 18p 17p
UHF (C8) Connectors;
PL259 Plug 40p, Reducer 14p,
SO 239 square chassis skt 40p,
1EC 3 pin 250 V/6A.
Plug chassis mounting 38p
Socket free hanging . 60p
Socket with 2m lead . 120p 38p 60p 120p

MULTIMETERS

MT-120 4,000 opv
A smart looking 11 range pocket
sized multimeter with an Impressive
spec. Complete with battery, etc.
650p each.
HT-320 20,000 opv.
HT-320 20,000 opv.
Coverload protection. DC volts1000, AC volts – 1000; DC current
0,25A, 4 resistanceranges, Complete
with batterles, leads, etc. 1395p

NEW CATALOGUE * NEW CATALOGUE!!!!!!! Our latest catalogue has just been released containing over 2000 stock lines all at extremely competitive prices backed by Rapid's return of post service. Stocks include Denco coils, tools, Verocases, data sheets etc. etc. Send 45p for your copy now (sent 20 way rainbow ribbon 65p/m free of charge with all orders over £10)

RESISTORS

SOCKETS	Low	
8 pin	prolite 6p	wrag 25o
14 pm	80	350
16 pm .		42p
		52p
20 pin	13p	
22 pin	16p	70p
24 pin	18p	70p
28 pin		q08
40 pin	25p	98p
Soldercon pin	s 60P/100	

Rotary, Carbon track Log or Lin 1K - 2M2. Single 32p. Stereo 85p. Single switched 80p. Slide 60ms travel single Log or Lin 6K - 500 K 63p each. Preset submin, hor, 100 ohms -1M 7p each. Cermet precision multiturn, 0,75W %" 100 ohms to 100K - 88p each.

í	78LQ5	30	79L05	65
¥	781.12	30	79L12	65
ĸ.	78L1营	30	79L15	65
Œ	7805	35	7905	40
ĩ.	7812	35	7912	40
E	7815	35	7915	40
ľ	LM309K	130	LM723	35
ı	LM317K	270	LM338K	475
ı	LM3.17T	120	78H05 5A	
ı	LM323K	350	►EW .	550

ŀ	SOLDERINGIRONS	
ı	Antex CS 17W Sordering Iron	460
ı	2,3 and 4.7mm bits to suit CS 17W iron: 450, element:	65
ı	Antex XS 25W	480
ı	3.3 and 4.7mm bits to suit	65
ı	Solder pump desoldering tool. Spare nozzie for above	
l	10 metres 22swg solder .	100
в		

PCB MATERIALS

Alfac transfer sheets - please s	state
type (e.g. DIL pads etc.) .	45
Dato etch resist pen	100
Fibre glass board 3.75"x8"	80
Ferric chloride 250ml battle.	100

Small trimming tool .		22	
Small pocket screwdriver		16	
Large pocket screwdriver	r .	13	
6 piece precision screwd	lver	set	
in plastic case		170	
Low cost side cutters .		160	
High quality side cutters		650	
Low cost pliers		160	
High quality pliers		650	
Wire strippers		120	
Expo reliant drill .		695	
Expo Titan drill		1025	
Drill stand . ,		1200	
Reduced shank drill bits for			
above 0.8mm, 1mm, 1.4	mm	60	

ОРТО

▶3mm red	7	▶5mm red	7
≥ 3mm gree	n 10	▶5mm gree	n 10
▶3mm vello			
Clips to suit	- 3p		
Rectangular		TIL32	40
i≯redi		TIL78	40
		▶TIL111	60
yellow	17	ORP12	85
		TIL100	90
2N5777			60
Seven segme			0.0
Com cathod		Com anode	
BL704 0.3"			05
FND500	04	FND507	50
	100	0.5"	100
		TIL3120.3	
TIL3220.5	115	TIL3210.5'	1115
LCD: 3% di	git 58	30p. 4 digit 6	20p
			_
		4001/ 0.4	cr

TRIACS		400 V 8A 400 V 16 A	65 95
400 V 4A	50	BR100	25

COMPONENT KITS

An ideal opportunity	for the beginner or the	experienced constructor
to obtain a wide rang	e of components at great	atly reduced prices, %W 5%
Resistor kit. Contain	s 10 of each value from	4.7 ohms to 1M (total
of 650 resistors) .		480
Ceramic Cap, kit, 5 o	if each value - 22p to 0.0	01u (135 caps) 370
Polyester Cap, klt. 5	of each value from 0.01	to 1uF (65 caps) 575
GE Drough		425
	al 300 items): 180o	
		60 69 A nues
		20 OBY Masuels
of 650 resistors). Ceramic Cap, kit, 5 o Polyester Cap, kit, 5 Preset kit, Contains t	of each value - 22p to 0.0 of each value from 0.01 of each value from 100 at 300 items): 180p	01u (135 caps)

he Rapid Guarantee

★ Same day despatch * Competitive prices ★ Top quality components ★ In-depth stocks

ORDERING INFO. All components brand new and full specification. Please add to total order. Please add 50p carriage to all orders under £15 in value. Send cheque/ P.O. or Access/Visa number with order. Our detailed catalogue costs 45p [free with orders over £10]. Callers most welcome. Telephone orders velocome with Access or Visa. Official orders accepted from colleges, Schools, etc. . . Callers most welcome, we are open Monday to Saturday electror/ize

AUTO-ELECTRONIC PRODUCTS

KITS OR READY BUILT

ELECTRONIC IGNITION



YOUR CAR

- AS GOOD AS IT COULD BE ?

 ★ Is it EASY TO START in the cold and the damp? Total Energy
 Discharge will give the most powerful spark and maintain full
 output even with a near flat battery.
- ★ Is it ECONOMICAL or does it "go off" between services as the ignition performance deteriorates? Total Energy Discharge gives much more output and maintains it from service to service.
- ★ Has it PEAK PERFORMANCE or is it flat at high and low revs. where the ignition output is marginal? Total Energy Discharge gives a more powerful spark from idle to the engines max. (even with 8 cylinders).
- ★ Do the PLUGS and POINTS always need changing to bring the engine back to its best. Total Energy Discharge eliminates contact arcing and erosion by removing the heavy electrical load. The timing stays "spot on" and the contact condition doesn't affect the performance either. Larger plug gaps can be used, even wet or badly fouled plugs can be fired with this system.

Is the PERFORMANCE SMOOTH. The more powerful spark of Total Energy Discharge eliminates the 'near misfires' whilst an electronic filter smooths out the effects of contact bounce etc.

Most NEW CARS already have ELECTRONIC IGNITION. Update YOUR CAR with the most powerful system on the market - 3 ½ times more spark power than inductive systems - 3 ½ times the spark energy of ordinary capacitive systems, 3 times the spark duration.

Total Energy Discharge also features:

EASY FITTING, STANDARD/ELECTRONIC CHANGEOVER SWITCH, LED STATIC TIMING LIGHT, LOW RADIO INTERFERENCE, CORRECT SPARK POLARITY and DESIGNED IN RELIABILITY.

IN KIT FORM it provides a top performance system at less than half the price of competing ready built units. The kit includes: pre-drilled fibreglass PCB, pre-wound and varnished ferrite transformer, high quality 2µF discharge capacitor, case, easy to follow instructions, solder and everything needed to build and fit to your car. All you need is a soldering iron and a few basic tools.

FITS ALL NEGATIVE EARTH VEHICLES 6 or 12 volt, with or without ballast.

OPERATES ALL VOLTAGE IMPULSE TACHOMETERS: (Older current impulse types need an adaptor).

STANDARD CAR KIT £15.90
Assembled and Tested £26.70

PLUS P. & P. £1 (U.K.)

TWIN OUTPUT KIT £24-55
For Motor Cycles and Cars with twin ignition systems

Prices include VAT

Assembled and Tested £36.45

PROTECT
YOUR CAR
WITH AN
ELECTRONIZE
ELECTRONIC ALARM



Don't Wait Until Its too Late ~ Fit one NOW!

- ★ 2000 COMBINATIONS provided by an electronic key a minature jack plug containing components which must match each individual alarm system. (Not limited to a few hundred keys or a four bit code).
- ★ 60 SECOND ALARM PERIOD flashes headlights and sounds horn, then resets ready to operate again if needed.
- ★ 10 SECOND ENTRY DELAY allows owner to dis-arm the system, by inserting the key plug into a dashboard mounted socket, before the alarm sounds. (No holes in external bodywork, fiddly code systems or hidden switches). Reclosing the door will not cancel the alarm, before or after it sounds, the key plug must be used.
- ★ INSTANT ALARM OPERATION triggered by accessories or bonnet/boot opening.
- ★ 30 SECOND DELAY when system is armed allows owner to lock doors etc.

- * DISABLES IGNITION SYSTEM when alarm is armed.
- ★ IN KIT FORM it provides a high level of protection at a really low cost. The kit Includes everything needed, the case, fibreglass PCB, CMOS IC's, random selection resistors to set the combination, in fact everything down to the last nut and washer plus easy to follow instructions.

FITS ALL 12 VOLT NEGATIVE EARTH VEHICLES.
SUPPLIED COMPLETE WITH ALL NECESSARY LEADS
AND CONNECTORS PLUS TWO KEY PLUGS

CAR ALARM KIT

£24.95

PLUS P. & P. £1 (U.K.)

ASSEMBLED AND TESTED £ 37.95

Prices include VAT



Access and Visa Welcome. Write or Phone Quoting Number

ELECTRONIZE DESIGN

Dept. E · Magnus Rd · Wilnecote Tamworth · B77 5BY tel: 0827 281000 HOWEVER long you have been building your own electronic projects, the problem of how to house them remains a perennial one. No matter how well the project works, you won't want to show it off to the girlfriend, boyfriend, neighbour, mother-in-law, budgerigar, cat etc. unless it looks good . . . will you!

Over the next couple of pages you'll find all of the information you need to be able to put a project into a box or case and give it the high-quality appearance that it deserves. When you've finished reading this article we think that, even if you have never put a single electronics project into a case before, you will agree that housing a project is just a matter of following a few simple rules.

First things first. What sort of housing are you going to use? There are hundreds of different boxes and cases on the market - some cheap, others not so cheap. You might even make your own if you can, but the problem remains the same, whatever box you decide to put your project in: how do you make it look presentable? After all, you might argue that it doesn't matter what it looks like inside, it's what is outside that people see, so the box itself is important to the final appearance of your project.

Assuming that you have already built up your project on a printed circuit board (PCB) or piece of Veroboard and tested it to make sure it works and does everything it's supposed to, the peripheral components (called panel hardware) such as potentiometers, meters and connection sockets will be joined to the PCB by

short lengths of wire.

Write a list of all these controls sockets, meters etc. - which need to be accessed from outside the case. Other examples of controls are the volume, trebass and balance on a stereo amplifier, while input and output sockets are almost always needed. Now, take a few minutes and try to visualise a layout for the front panel of the project box. Some projects will have an obvious layout for example an amplifier looks 'right' in a case having a long, thin front panel, with all controls in a straight line. Front panels of other projects could take a bit more thought.

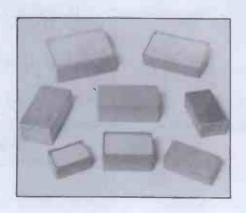
There are two ways of going about this, depending on whether you already have your box or not. If you have a box then the size and shape of the panel is fixed. However, if you haven't got a box you can decide your own front panel size and shape - but then you have the problem of finding a box to suit your requirements. Keep a few catalogues from mail-order companies handy because they will give you a good idea of what boxes you can get (and how much they cost!). Above all, don't rush this stage; take your time, perhaps draw out in pencil on paper a few rough-sketched panel layouts until you've got the one most suitable for your project.

It's worthwhile remembering, while you are designing your front panel, the rule of the 'Five Ps' - Prior Planning Prevents Poor Performance. In other words, a bit of careful thought before you put your project in its box will help stop you making any mistakes. Don't make a move until you are sure you have everything planned! Don't drill a hole, don't even mark the case until you are positive you haven't missed anything out; once you've marked or drilled the case you can't go back and start again - you have ruined the case!

Centres of all holes for all panel hardware should now be marked using a hammer and punch; a punchmark will keep a drill bit in the right place and prevent it from slipping, scratching or scoring the panel. Small holes can be drilled out using a hand-drill and bit, but a power drill fitted with the correct sized bit is better still. Large holes can be a bit trickier. There are two general methods punching, or sawing and filing. Punching gives by far the neatest and cleanest of holes, but you have to have the correct sized punch. If you want a lot of different sized holes you need a good selection of punches, and the problem here is that punches are quite expensive. If you can't afford to buy more than a couple then it's best to buy sizes which you will use most often. For example, a punch which gives a hole to suit potentiometers is a good size to buy because most projects use at least a couple of 'pots'.

Using a punch is simple. Drill a pilot hole in the panel to fit the centre bolt of the punch. Now, following the instructions which will be supplied with it, handtighten the parts of the punch until the





Keith Brindley

With patience, a few sim a home-built project can as "a bou

cutting edge bites onto the panel. Now, using a spanner or Allan key tighten the punch until the hole is cut. It really couldn't be simpler.

The other method of making large holes is a bit more fiddly and takes more care, but is decidedly cheaper. Using a pair of dividers or compasses, mark out



Top left: the professional touch custom metalwork for the HE TV Amp by Newrad Instruments Ltd, assembly and finish by Paul Coster.

Above: A project wired-up for testing. Later it will have to be disassembled for mounting in a case.

Left: A range of simple metal and plastic enclosures.

HING

ple tools and a little skill, be made to look as good ght one".

the exact size of the hole in its correct position. Next, punch-mark and drill a number of holes around the inside of the circumference of the hole. Now, using a padsaw, or junior hacksaw, cut round the marked hole, keeping fractionally to the inside edge of the circumference, going from each small drilled hole to the next.

When you have cut all the way round, the centre will fall out. Then, using a half-round file, carefully file all round the inside edge of the hole until it is the correct size.

Take extreme care when you do any metalwork, because one slip with a drill bit, scriber, file etc. could make a scratch on the panel which you can never remove — the appearance of your project will be ruined.

The Inside Story

When you've made all the necessary holes in the front panel, it's time to think about how you are going to mount the project's circuit board. Plastic pillars are ideal; alternatively simple nuts, bolts and washers can be used to do the job. Whatever method you use, you will need to drill more holes to suit, but in the bottom of the case this time!

Next step on the agenda is to label the front panel so that all controls and switches etc. can be clearly identified. Rubdown transfer lettering is the best for this; there are many different makes of transfer letters but they are basically the same in use. The surface of your project must, first, be perfectly clean and free from grease — the lettering won't stick unless the panel is grease free so spend a bit of time cleaning the case. You can use a piece of rag sparingly damped with methylated spirits or, alternatively, one of

the commercially available kitchen scouring creams. Make sure your hands are clean at this point!

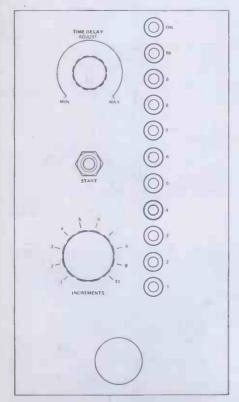
Transfer lettering is bought as a sheet with a quantity of each letter of the alphabet and the numbers '0' to '9' on it. Have a good look at the selection of styles of lettering (called 'faces') you can buy; most manufacturers produce a catalogue for the purpose. Choose a face which you like and which will suit the project. A good tip is to buy a fairly plain face (so the style will suit more than just the one project) and one which is quite small in size (so that you get more letters per sheet!).

Transferring a letter is simply done by laying the sheet ink side down over the panel, making sure the letter you want is exactly over the place you want it. Now, with a soft-leaded pencil or a ball-point pen, slowly rub over the letter so that it sticks to the panel and stays behind when you remove the sheet. There are three useful tips here:

 lightly rule a pencilled line where the tabel is to placed; this way, the word will be 'straight'

 where a label is to be central, above or under a definite point (such as a pot) start labelling with the middle letter; this ensures the word is not lop-sided

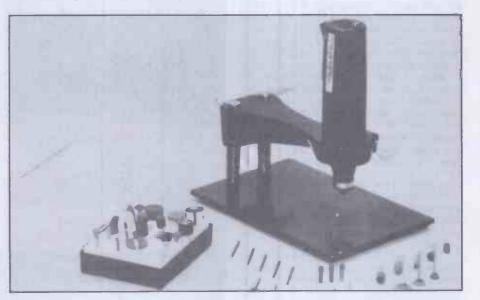
 make sure your spelling is correct; once you've misspelt a word, you'll have to redo it!

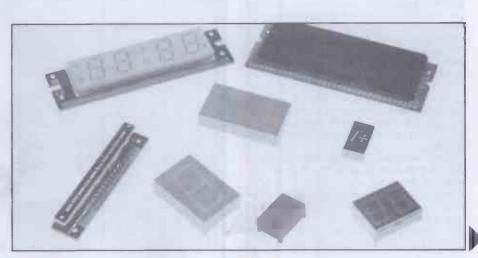


Above: Front panel artwork for the HE Incremental Timer, drawn up from the printed circuit board.

Top right: Even a small bench drill is suitable for drilling PCBs, plastic and light metalwork.

Right: Panel mounted displays require square or rectangular holes, made by drilling, cutting and filing as described in the text.





If you do make any mistakes, ordinary cellophane adhesive tape can be carefully used to remove the offending letters. Lay a piece of adhesive down over the error, rub it down then pull the tape off; the letters underneath the tape will be removed with it. Be careful it doesn't catch any letters you don't want removed!

Spray it Again, Sam?

Transfer letters can be easily scratched and damaged so they have to be protected from mishandling. Clear protective lacquer is available in aerosol form, and this gives a hardwearing finish to your project's front panel, preventing all but



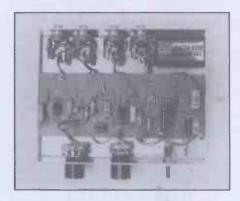
Above: Plastic mounting strips simplify the problem of securing a PCB or Veroboard within a case.

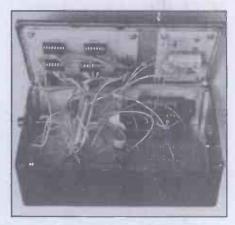
Below: Using rub-down lettering; a soft pencil will do as well as the special burnishing tool!



the fiercest of scratches from damaging the lettering. Most manufacturers of rubdown letters also produce their own forms of aerosol lacquer.

After you've sprayed the front panel, let the lacquer dry thoroughly. There's nothing more irritating than a messy (and irremovable) thumbprint on an otherwise perfect front panel, so allow at least the





Above: A neatly completed Hobby Electronics project and . . . Middle: A not-so-neatly completed project; the 'birds nest' effect could have been avoided by the use of ribbon cable or . . . Below: Cable ties, such as these self-adhering types.

manufacturer's recommended drying time before you touch it!

When the panel is perfectly dry, the time has arrived to put the whole project into the completed case. Unsolder all connecting wires which were on the PCB for testing, and discard them. Now, mount all panel hardware and the PCB in their respective places in the case. At this stage you can put all control knobs onto any pot shafts, too. You may have to shorten the pot shaft to suit — but don't do this with the pot in the case, otherwise you might damage the case; take the pot out and, holding it in a vice, cut the shaft to the correct length using a hacksaw.

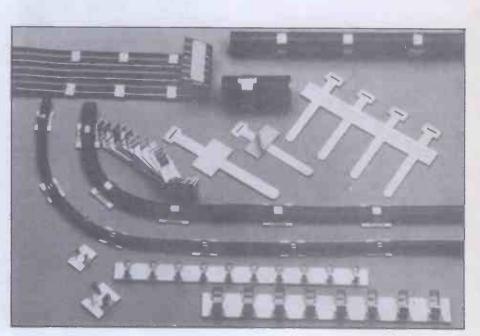
We're at the point now, where we commence final wiring-up of the project. Following the projects's circuit, cut each connecting wire to the correct length; this helps to keep the project looking neat inside. Make each connection in two steps:

- 1. Solder one end of the connecting lead to one point, say the PCB.
- Take the lead around the case to the other point, cut it to length, then solder it.

Make all connecting leads go around the case in the same fashion so that generally they group together. Then, when all connections have been made and you have checked the project, (making sure it still works), tie the group of leads together with a cable tie. Plastic cable-ties, lacingcord or simple string can be used for this job. Forming all connecting leads into such a bunch gives a very neat appearance to the inside of your project, much better than the "bird's nest" appearance you get when a project is wiredup with all connecting leads simply taking the shortest distance between two points. It really is worth the extra few centimetres of wire you might use in forming the group of leads.

Now, the only thing to do is put the lid onto your case and then you can take a step back to admire your fully housed and completed project. Neat, isn't it!

HE



THREE FOR FREE Electronics by Numbers projects No 10, No 11, No 12

EXPERIMENTOR BREADBOARDS

No soldering modular breadboards, simply plug components in and out of letter number identified nickel-silver contact holes. Start small and simply snap-lock boards together to build a breadboard of

All EXP Breadboards have two bus-bars as an integral part of the board, if you need more than 2 buses simply snap on 4 more bus-bars with the aid of an EXP

EXP 325 £2.00 The ideal breadboard for 1 chip circuits. Accepts 8, 14, 16 and up to 22 pin ICs. Has 130 contact points including two 10 point bus-bars.



EXP 350 £3.15 Specially designed a for working with up to 40 pin ICs perfect for 3 & 14 pin ICs Has 270 contact points including two 20 point bus-bars

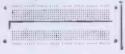


EXP 300 £6.00 The most widely bought bread-board in the UK With 550 contact points two 40 point



bus-bars, the EXP 300 will accept any size IC and up to 6 x 14 pin DIPS. Use this breadboard with Adventures in Microelectronics

EXP 600 £6.30 Most MICROPROCESSOR projects in magazines and educational books are built on the EXP 600. *



EXP 650 £4.25 Has -6" centre spacing so is perfect for MICROPROCESSOR applications



FXP 4B f2 50 Four more bus-bars in "snap-on" unit

Street Party state while street creat (Party state Street

The above prices are exclusive of P&P and 15% VAT

THE GSC 24 HOUR SERVICE **TELEPHONE (0799) 21682**

With your Access, American Express, Barclaycard number and your order will be in the post immediately GLOBAL SPECIALTIES CORPORATION



G.S.C. (UK) Ltd, Dept. 14TT Unit 1, Shire Hill Industrial Estate, Saffron Walden, Essex CB11 3AQ. Tel: Saffron Walden (0799) 21682 Telex: 817477

Available from selected stockists

ELECTRONICS BY NUMBERS

No. 10 SOIL MOISTURE TESTER

No more wilting houseplants with this soil moisture test. Just place the probes into the soil and it will light up to tell you whether the soil is "too wet" or "too dry". You don't even need green fingers.

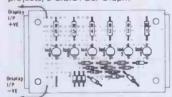
No. 11 DIGITAL ROULETTE

The suspense and excitement of the casino in your own home, Just press the button, the circle of lights go round and there is the sound of the roulette wheel as well both gradually slowing down to reveal the winning number

No. 12 EGG TIMER

How do you like your eggs done, hard or soft, just set the timer and it will sound when the egg is done to your liking. Long battery life because it switches itself off automatically. So get cracking now!

Want to get started on building exciting projects, but don't know how? Now using EXPERIMENTOR BREADBOARDS and following the instructions in our FREE 'Electronics By Numbers' leaflets, ANYBODY can build electronic projects. For example, take one of our earlier projects, a L.E.D. Bar Graph;



You will need; One EXP 300 or EXP 350 breadboard 15 silicon diodes 6 resistors 6 Light Emitting Diodes Just look at the diagram, Select R1, plug it into the lettered and numbered holes on the EXPERIMENTOR BREADBOARD, do the same with all the other components. connect to the battery, and your project's finished. All you have to do is follow the large clear layouts on the 'Electronics by Numbers' leaflets, and ANYBODY can build a perfect working project.

For full detailed instructions and layouts of Projects 10, 11 and 12, simply take the coupon to your nearest GSC stockist, or send direct to us; and you will receive the latest 'ELECTRONICS BY NUMBERS' leaflet

If you have missed projects, 1, 2 and 3, or 4, 5 and 6, or 7, 8 and 9, please tick the appropriate box in the coupon.

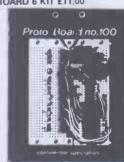
PROTO-BOARDS

The ultimate in breadboards for the minimum of cost, Two easily assembled kits



PB6 Kit, 630 contacts, four 5-way binding posts accepts up to six 14-pin Dips.

PROTO-BOARD 6 KIT £11,00



PB 100 Kit complete with 760 contacts accepts up to ten 14-pin Dips, with two binding posts and sturdy base. Large capacity with Kit economy

PROTO-BOARD 100 KIT £14.25

- IT'S EASY WITH G.S.C. - -

TO RECEIVE YOUR FREE COPY OF PROJECTS 10, 11 and 12 Just clip the coupon For immediate action

Give us your name and full postal address (in block capitals). Enclose cheque, postal order or credit card number and expiry date, indicating in the appropriate box(es) the breadboard(s) you require.

Bus Bars

	DOWIGS! (HE DIESO!	Dual Gisi you io	quire.		Orger	******
	EXPERIMENTOR BREADBOARDS		IC CAPACITY 14 PIN DIP		RICE INC	Oty
	EXP 325	130	1	£	3.16	
	EXP 360	270	3	£	4.83	
L	EXP 300	550	6	£	8.05	
	EXP 800			£	9.48	
	EXP 66 0	270	use with 0.6 pitch Dip s Strip Bus Bar	£	5.75	
	EXP 4B	Four 40 Point Bus Bars		£	3.73	

The GSC 24 hour, 5 day a week service. Telephone (0799) 21682 and give us your Access, American Express or Barclaycard number and your order will be in the post immediately. NAME. ADDRESS

l'enclose cheque/P.O. for E. Debit my Barclaycard. American Express card No. ... Expiry date

PROTO BOARDS If you missed project No's 1 to 9 tick box. 760 £17.53 For Free catalogue tick box

GSC (UK) Ltd., Dept. 14TT Unit 1, Shire Hill Estate, Saffron Walden, Essex CB11 3AQ. Tel: Saffront Walden (0799) 21682. Telex: 817477.

COMPONENTS FOR COMPUTING

Paul Kelly

Like elephants, ROMs never forget (unless you want them to).

Last month we outlined the different types of memory used in microcomputing systems and discussed, in detail, RAMs (Random Access Memory). We continue this month by looking at the other main memory type, ROMs (Read Only Memory). A ROM is in fact a type of random access memory (but rarely referred to as a RAM), in that it consists of a number of memory cells organised as a number of randomly addressable data words, each of one or more bits wide. The most significant difference between a ROM and a RAM is that the data stored in a RAM may be freely altered during normal operation of the device whereas in a ROM, the data is fixed at manufacture or by a programming procedure (depending on the type of device) and is unalterable in-circuit. The property enables ROMs to retain data when no power is applied to the device and is called 'non-volatility'. Such devices are of particular use in microcomputer systems where it is desirable to have the machine's operating software available immediately from powerup, whether it be a BASIC interpreter in a home microcomputer, a Disc Operating System (DOS) of a business machine or an industrial control system.

There are a huge variety of ROMs, in general use, which vary in the technologies of fabrication, in the means of data fixing and, of course, in their capacities and organisations. Most of the devices fall into one of the following broad categories: mask programmed ROMs, bipolar programmable (fusible link) ROMs, UV-Erasable ROMs (EPROM) and electrically alterable ROMs (EEPROM).

In a mask programmed ROM, the stored data is determined by the set of masks used in the manufacture of the device. It is unlikely that these devices will ever be used by hobbyists, as the manufacturer's masking charge, although steadily falling, is of the order of £2,000l Mask programmed ROMs are used widely by high volume manufacturers of microprocessor based equipment (eg microcomputers) where the overall cost per unit (over, say 10,000

devices) is very small.

EPROMS are the most popular ROMs, used almost universally by hobbyists, small volume equipment manufacturers and Research & Development departments. The popularity of these devices lies, firstly, in their field-programmability, and secondly in their ability to be erased (by ultra-violet light) and reprogrammed many times. We will be looking at these devices, in particular, in the final half of this article.

EEPROMS have only recently hit the market and are, at present, too expensive to be in general use though no doubt they will completely replace EPROMS in the long term. EEPROMS vary in type. Generally they are programmed in the same manner as EPROMs but can be erased electrically (rather than by UV),



Pictures courtesy Ferranti Ltd.

some devices one location at a time and others, all locations together.

Bipolar PROMs are almost always programmed by a method of 'blowing' fusible links within the device. The programming process is irreversible a data bit has been programmed (usually from '1' to '0') it cannot be reversed. The basis principle of fusible links is illustrated in Figure 1; when the cell is selected (addressed) by its row drive, it will pull the column output high if the link is intact - if the link is blown the column output remains low. The fuse, which is usually made of nichrome, is blown by momentarily passing a high current through the transmitter and for this, Vcc is often increased to a high voltage (although the particular programming requirements vary widely from one manu-

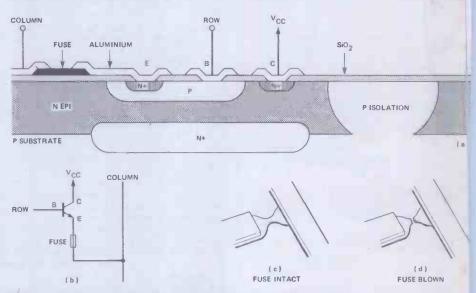


Figure 1. (a) The physical structure of a bi-polar fusible link PROM cell; (b) the circuit of a single cell; (c,d) these drawings, showing the fuse intact and then blown, were made from a pair of photomicrographs of a PROM cell.

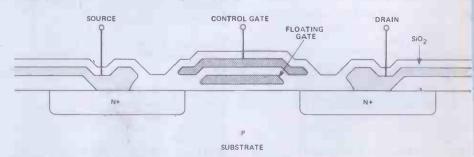


Figure 3. The structure of a UV erasable EPROM memory cell.

Table 1

TYPE	ORGANISATION	TECHNOLOGY	SUPPLY	CURRENT	PINS	COMMENTS
2708	1K × 8	NMOS	+5,+12V	65mA	24	Now obsolete.
2716	2K × 8	NMOS	+5V	100mA	24	Low cost type.
2532	4K × 8	NMOS	+5V	100mA	24	No OE pin.
2732	4K × 8	NMOS	+5V	100mA	24	Uses OE pin.
2764	8K × 8	NMOS	+5V	150mA	28	Pin compatible with 2732; expensive.
2564	8K × 8	NMOS	+5V	150mA	28	Pin compatible with 2532; expensive.

The essential characteristics of the most common EPROM types are tabulated above. As chip densities have increased lowcapacity ICs such as the 2708 have become obsolete. However, the very high density chips remain expensive.

facturer to another). Bipolar PROMS offer an advantage in speed when compared with other PROMs, which are usually MOS (access time of the order of 20nS versus 200nS for MOS). Because this extra speed is not required by the average microcomputer system, and because of the high cost and difficult programming procedures, bipolar PROMs are rarely used for storing software in microcomputers. However they are used in minicomputers and mainframes, within the CPU microprogram control unit (where speed is crucial); a more frequent use is as a substitute for a logic array, as shown in Figure 2. Each of the PROM's outputs is a logical function of the input (address) lines; if any required function is tabulated (as in a truth table) by storing the contents of the table as data in the PROM, it will then function as an equivalent array of combinational logic

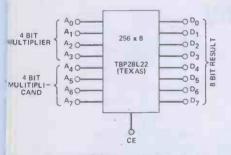


Figure 2. An EPROM can be used as a look-up table; the 8-bit result is stored at an address corresponding to the values of the 4-bit multiplier and multiplicand.

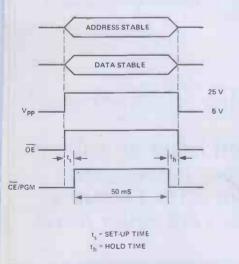


Figure 4. The timing diagram of a single program cycle for the 2716 EPROM.

which might otherwise be used to implement the function. The example given is of a 4-bit multiplier used to give an eight bit product, implemented with one ROM chip - an equivalent circuit with NAND and NOR gates would require many chips!

We return, now, to the subject of EPROMs because, as a hobbyist, this is the type you are most likely to encounter (particularly if you build the programmer presented in this issue). A profile of the 'silicon slice' of one memory cell is shown in Figure 3. Each cell is based on a single MOS transistor, with a 'floating gate' implanted in the silicon dioxide insulator normally placed between the transistor control gate and the drain-source conduction channel. During programming, a high potential applied between drain and control gate causes an injection of electrons into the floating gate across the SiO2 barrier, but when the high potential is removed, a charge remains on the floating gate indefinitely. This charge on the floating gate inhibits the control gate, preventing it from turning on the transistor; thus two logical states exist for the cell, depending on whether the floating gate has been charged or not. The presence of UV light raises the conductivity of the SiO2 sufficiently to permit a gradual leakage of charge from the floating gate. Typically, an EPROM will take 30 minutes to complete erasure using a commercial UV erasing unit. The UV light of sunlight is not strong in the required spectrum (short wavelength UV) and could take several weeks to erase an EPROM. However, erasure boxes can be purchased as cheaply as £40, these days, with tubes running at about £12 each, if you wish to DIY.

In Table 1 we have presented some of the characteristics of most of the popular EPROMS on the market, together with their pin configurations. Most of the devices are in 24-pin DIL packages (except the larger 8kx8) EPROMS, which are 28-pin) and have a glass 'window' at the top of the package to allow UV light to strike the exposed silicon chip. After programming, a paper label or similar must be placed over the window to prevent gradual erasure in sunlight or artificial flrouescent lighting.

We have not gone into the internal architecture of a ROM, as the interconnection of memory cells within the device is basically the same as for RAMs (see last month's installment). Externally, the devices are very similar as well; they have an address bus (the number of lines being determined by the memory capacity), a data bus (which for most devices, being intended for microcomputing applications, is eight bits wide) and a chip select line (CE) which allows many devices to connect onto the data bus (when high, the CE pin disables the data output drivers). Obvously, for a ROM, there is no R/W (Read/Write) line, and in its place a Program Voltage pin is provided.

The earlier EPROM types (eg 2708) were quite complicated to program, in that it was necessary to cycle through all address locations many times so as to avoid localised heating of the chip. Most of the modern EPROMS, though, are fairly standardised and may be programmed a byte at a time; we will consider the 2716 EPROM (probably the most popular, at £2.50 each) in particular. A programming cycle for the 2716 is illustrated by the timing diagram of Figure 4. With the device enabled (CE low) and the programming drive, VPP, at 25V, a stable address and data word are presented to the appropriate pins of the device; the OE (Output Enable) pin is also taken high to avoid conflict with the data 'blanks' already present in the ROM. The data is then programmed by applying a high to the PGM/CE pin for a period of 50mS. It is important to note that a blank EPROM as supplied by the manufacturer has all its bits 'high' and that, during programming, the appropriate bits are forced low; it is not possible to bring a bit back from a low to a high without erasing the entire device. For a 2716, it takes about a minute and a half to program all 2048 locations on an automatic programmer and it takes at least 20 mins to erase the device. This gives the software developer a very fast turn around on modifications he makes during program development.

It is also worth mentioning some details of commercial programmers, although they are priced from 'as little' as £200! Some of the cheaper programmers are simple copiers, and therefore of limited use to software developers (but of considerable use to 'pirates', most noticeably of video games!) For manufacturers, bulk copiers (to program several EPROMS at a time) have become a cheap time-saving device - again not much use to the amateur. The 'intelligent' EPROM programmers, now beginning to flood the market, are becoming just within the reach of the amateur's pocket, and offer all the facilities he could wish. Most of these have video displays (as opposed to the earlier LEDs) and, in conjunction with an integral keyboard, allow data to be entered and manipulated as required before programming. The project presented in this issue, however, is a compromise between what one would

like and what one can afford!

17

COMING SOON TO...



RADIO CONTROLLED GERBIL PROJECT

The April issue of Hobby Electronics features a special project of particular interest to all radio control enthusiasts and connoiseurs of digital devices.

You've seen HEBOT, now meet HOPPY, the Hobby Electronics Radio Controlled Gerbil!

This unique project uses special circuitry to create a remarkable, life-like toy that will provide hours of fun for all the family (with the possible exception of the household cat).

Look for it only in the April issue of Hobby Electronics!

TOOL AND TEST EQUIPMENT FOR THE ELECTRONICS HOBBYIST

Also featured in next month's issue is another great Hobby Electronics survey, this time providing all the information needed to select the most useful items of tools and test equipment for your workshop.

AUTO POWER-DOWN

A simple but ever-so-useful project that can be built into many battery operated projects.

EPROMmer

Our two-part EPROMmer for 6502-based home computers is rounded off next month with full constructional details and a complete listing of the operating program.

Naturally, the April issue of HE will also include our popular regular features such as THE ELECTRONIC REVOLUTION and COMPONENTS FOR COMPUTING, plus your own letters in POINTS OF VIEW; despite all our efforts to restrain him, CLEVER DICK will be here as usual.

Please reserve copies of the February is	sue of
for Name	0,0
Address	



March issue on sale at your newsagent from 11th February. Place your order now!

Although these articles are being prepared for the next issue, circumstances may alter the final content.

7492A		7494 7495A 7495A 7496 7497 74100 74107 74110 74112 74116 74118 74118 74120 74121 74122 74123 74123	11p 11p 12p 12p 12p 12p 12p 12p 12p 12p	74367 74368 74376 74390 74393 74490 74LS SE 74LS00 74LS01 74LS02 74LS03 74LS04 74LS05 74LS05	35p 30p 100p 75p 90p 95p 11p 11p 12p 12p 12p 12p	74LS164 74LS165 74LS166 74LS170 74LS173 74LS174 74LS181 74LS190 74LS191 74LS192 74LS193 74LS194 74LS195 74LS196 74LS197	40p 50p 60p 70p 56p 40p 90p 36p 36p 36p 36p 36p 35p 45p 45p	4023 4024 4025 4026 4027 4028 4029 4030 4031 4033 4034 4035 4036 4037 4039 4040	10p 10p 12p 50p 14p 24p 24p 11p 16p 20p 48p 40p 40p 45p 20p 45p 20p 45p 20p 45p 20p 45p 20p 45p 20p 45p 20p 45p 20p 45p 20p 45p 20p 45p 20p 46p 46p 46p 20p 46p 46p 46p 20p 46p 46p 20p 46p 46p 46p 46p 46p 46p 46p 46p 46p 46	40373 160p 40374 160p LINEAR ICS AD7581 £9 LC7137 270p AN1 03 200p AY1-1313 600 AY1-1313 600 AY1-1313 600 AY1-3810 550p AY3-8910 350p AY3-8910 350p AY3-8910 2625p	LM733 LM741 LM747 LM748 LM1014 LM1801 LM2917 LM3900 LM3909 LM3911 LM3915 LM3915 LM3916 LM3916 LM3916 LM3916	90p 90p 100p 150p 150p 150p 150p 150p 150p 15	MC1310P MC14458 MC14458 MC14956 MC14956 MC14956 MC3409P MC34003 MF100 MK50398 MF100 MK50398 MK5211 NE551 NE566 NE566 NE567 NE566 NE567 NE568 NE567 NE568 NE567 NE568 NE568 NE567 NE571 NE5534A PLIO2A RC4136 RC4151 S5668 SAA1900 SAD1024A SC4136 RC4151 S5668 SAA1900 SAD1024A SC4136 RC4151 S5668 TA7120 TA7204 TA7120 TA7204 TA7301 TA7205 TA7120 TA7204 TA7120 TA7204 TA7120 TA7204 TA7120 TA7204 TA7205 TA7120 TA7204 TA7120 TA7205 TA7120 TA7204 TA7120 TA7204 TA7120 TA7204 TA7120 TA7204 TA7120 TA7205 TA7120 TA7204 TA7205 TA7212 TA7210 TA7204 TA7206 TA7207 TA7204 TA7204 TA7204 TA7204 TA7204 TA7204 TA7204 TA7204 TA7204 TA7205 TA7222 TA7210 TA7204 TA7206 TA7207 TA7204 TA7206 TA7207 TA72002 TA720	800p 450p 450p 450p 450p 450p 450p 450p 4	ZM424E ZM424E ZM426E ZM426E ZM426E ZM426E ZM426E ZM426E ZM426E ZM426E ZM426E ZM626E ZM62E ZM1034E ZM1034E ZM1034 ZM2334 ZM2334 ZM2334 ZM2334 ZM2334 ZM2334 ZM2334 ZM2334 ZM2334 ZM232 ZM23	40p 14s	2N930 2N1132 2N1613 2N1711 2N2102 2N2160 2N2219A 2N2262A 2N2369A 2N22646 2N2905A 2N2907A 2N3053 2N3054 2N3055	18p 24p 30p 25p 70p 296p 25p 25p 25p 25p 25p 25p 25p 35p	BY127 BYX36300 OA47 OA90/91 OA95 DA200 OA202 1N914 1N916 1N4148 1N4001/2 1N4003/4 1N4005/7 1N4006/7	12p 20p 8p 9p 9p 10p 4p 7p 4p 5p 5p 6p 7p	0,125" TiL32	TIL330 4 17750/60 20 DISPLAY 31015F 20 DISPLAY	00p
-------	--	--	---	---	---	---	---	--	---	--	--	---	--	---	--	---	---	---	--	---	--------------	---	---

RUGBY ATOMIC CLOCK

This Z80 micro controlled clock/calender receives coded time data from NPL Rugby. The clock never needs to be reset. The facilities include 8 independent alarms and for each alarm there is a choice of melody or alternatively these can be used for electrical switching. A separate timer allows recording of up to 240 lap times without interrupting the count. Expansion facilities provided.

£120 + £2.00 carr. Complete Kit Ready Built Unit £145 + £5.00 carr Reprint of ETI articles at £1.00 + s.a.e.

AS DESCRIBED IN JUNE/JULY/AUGUST ISSUE

MICROTRAINER

Complete Kit £64.00 + £1.00 p&p 8V 1.8A PSU £7.00 + 70p p&p 1802 Ref. £7.00

IDEAL for HOBBYISTS learn and explore the workings of microprocessors and unravel the mystical field of computers. INVALUABLE for training centres, schools and industries — gives effective insight into micros to engineers, electricians etc not directly involved in the computer field. INEXPENSIVE — a truly low cost teaching aid — in fact a short step towards developing new ideas and systems.



OFFICIAL DEALER

Please phone for availabilit

BBC Model B £399 (incl VAT) Carr £8/unit Model A to Model B upgrade kit £50 Fitting charge £15

Individual upgrades also available. WORD PROCESSOR 'VIEW' 16K ROM £52 **TELETEXT ADAPTOR £195** PRESTEL ADAPTOR £90 2nd PROCESSOR 6502/Z80 £170 ACORN SOFT/BBC SOFT/GAMES PADDLES IN STOCK

FLOPPY DISC INTERFACE inc. 1.0 0.S £95 + £20 installation.

BBC FLOPPY DISC DRIVES

Single drive 5\" 100K £235 + £6 carr.

Dual drive 54" 800K £799 + £8 carr. **BBC COMPATIBLE DRIVES**

These are drives with TEAC FD50 mechanism and are complete with power supply SINGLE: 100K £190: 200K £260: 400K £340 DUAL: 200K £360; 400K £490; 800K £610

MICRO TIMER
The programmable clock/timer is a 6502 based dedicated micro computer with memory and 4 digit 7 segment displays to form an extremely versatile timing device with following features:

- 24 hour 7 day timer
 4 completely independent switch outputs
- 6 digit 7 segment display output to indicate real time turn-off times and reset times
 Individual outputs to day of week, switch and status LEDs
- Data entry through a simple matrix pad

Further details on request £56.00 + £1.00 p & p Complete Kit PSU

Construction details supplied

MAIL ORDERS TO: 17 BURNLEY ROAD, LONDON NW 10 1ED SHOPS AT: 17 BURNLEY ROAD, LONDON NW10 (Tel: 01-452 1500, 01-450 6597. Telex: 922800) 305 EDGWARE ROAD, LONDON W2

PLEASE ADD 40p p&p & 15% VAT

(Export: no VAT, p&p at Cost)

Orders from Government Depts. & Colleges etc. welcome



Detailed Price List on request. Stock items are normally by return of post.



EPROMmer For 6502-Based Computers

lan Hickman

Originally designed to operate in conjunction with a UK101 computer, the HE EPROMmer can be made to work with any computer using the 6502 MPU. Full construction details, including the PCB, component overlay and the operating program listing, will be presented in the April '83 issue of HE.

Part 1: The Circuit and How It Works.

OVER the last few years the cost of PROMs (Programmable ROMs), and particularly UV Erasable Programmable Read Only Memories, has dropped sharply, while single rail 5V types have largely displaced the earlier and less convenient three-rail types. For the budget conscious home constructor, the beauty of EPROMs is that if you get it wrong, the PROM can be 'wiped' and used again, unlike a fusible link PROM, where one "burns one's boats" the first time it is programmed. To erase an EPROM, one simply exposes it to short wavelength Ultra-Violet light from, for example, a 12in 8W uncoated fluorescent tube. The "black light" tubes sold for such purposes as demonstrating the fluorescence of various minerals or rock samples are not suitable for erasing PROMs, as they only emit longer wavelength, less harmful, ultra-violet light. The author purchased an EPROM Eraser replacement tube and found that this works perfectly in a 12V transistor fluorescent ballast which, at other times, is used as a tent light run from the car's cigar lighter socket when camping. The short wavelength UV radiation from the tube will completely erase an EPROM in twenty minutes or less, but on no account look at the tube when lit as the radiation is very bad for the eyes

This EPROM Programmer is designed to program Ultra-Violet Erasable Programmable Read Only Memories, namely 2K by 8 EPROMs such as the 2716 and 2516, and 4K by 8 2732s. The author designed it to work with his Compukit UK101, but it should work

equally well with any 6502-based personal computer. The EPROM Programmer contains a 25V power supply for the programming voltage VPP, but draws the small current that it needs at ±5V from the host computer.

It was decided before the design was commenced that operation should be simple. Thus, the only controls on the EPROM Programmer are two toggle switches; one selects 2716 or 2732 (16K or 32K) operation whilst the other selects Read or Program. Reading, programming and verifying are all carried out under the control of a "user friendly" operating system written in BASIC. The Programmer has been in use for many months now, and has proved extremely useful and completely reliable.

Circuit Design

To cope with 2716 and 2732 EPROMs, the circuit must be able to change the functions of pins 18, 20 and 21 of the PROM socket - all other pin designations for the two devices are identical. Table 1 shows the functions of these three pins for the two different PROMS, and it can be seen that the logic level applied to pin 18 needs to be inverted for the 2732 (relative to the 2716) in the PROGRAM mode, but not in the READ mode. This can be achieved by using an EXOR (Exclusive OR) gate which inverts the signal to pin 18 only when + 25V is applied to pin 20. How this is arranged will shortly become

Figures 1 and 2 show the complete circuit of the HE EPROM Programmer.

Figure 1 shows the circuit board, with a 40 way DIL socket J1. This socket is connected by a 40 way jumper lead to the expansion socket of the host UK101 computer, though the EPROM Programmer does not use all of the signals available. Addresses A8 - 15 are decoded to define the position of the 6821 PIA (Peripheral Interface Adapter) in the UK101's memory map. With the connections shown, this is 32768. Addresses A0 and A1 are also used by the PIA directly, to provide access to Control Register A, Peripheral Register A, Control Register B or Peripheral Register B as appropriate. For those who have not used the 6821 PIA before, Figure 3 shows its internal structure. RSO and RS1 are connected to address lines A0 and A1 of the host computer's address bus and route the PIA's data bus (connected to the UK101's data bus) as shown in Table 2. When RSO,

TABLE 1

			PROGRAM			
EPROM	PIN	READ	START	INHIBIT		
2716	18	0	1	0		
2732		0	0	1		
2716	20	0	1	1		
2732		0	+25V	+25V		
2716	21	+5V	+25V	+25V		
2732		A11	A11	A11		
2716	IC5a	0	0	0		
2732	PIN1	0	1	1		

Two switches are used to change the logic functions according to the programming operation and the type of EPROM, as shown above.

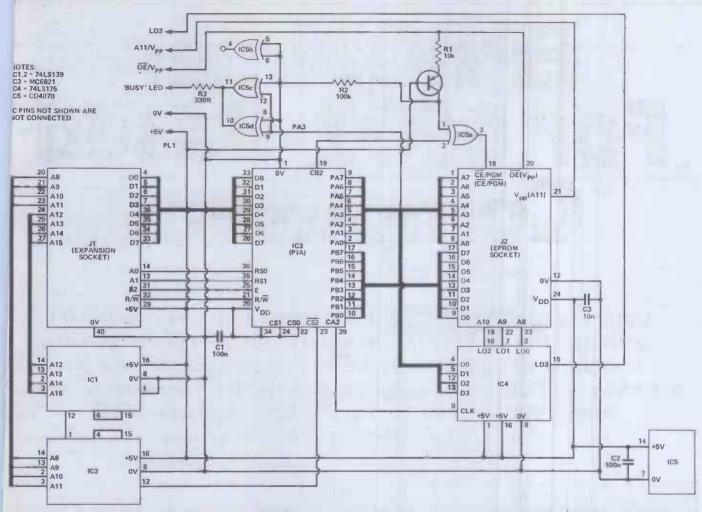


Figure 1. The main circuit board carries the sockets connecting to the host computer (J1) and to the EPROM (J2), the PIA (IC3) and its address decoders (ICs 1 and 2), plus the EPROM address latch (IC4). IC5 and Q1 are concerned with the EPROM pin functions; two spare gates are used to drive the 'Busy' LED.

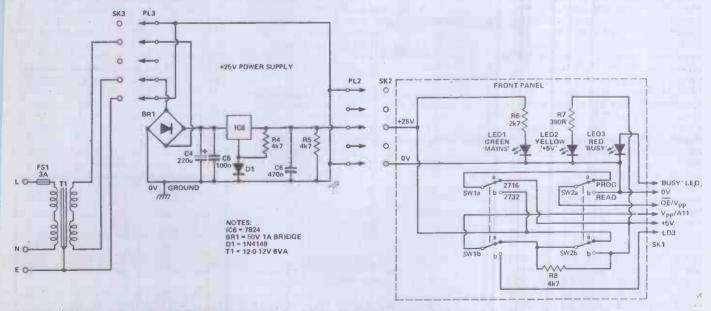


Figure 2. The power supply and pin function logic circuits are designed as separate modules.

RS1 = 1,0 respectively, access is provided to Control Register A. Then, writing a '0' in bit two of the eight bit Control Register A — CRA2 = 0 — provides access to Data Direction Register A (DDRA) if RS0, RS1 = 0,0. For each bit in DDRA which is then set

to a '0', the corresponding bit in Peripheral Interface A (PAO - 7) is set as an input, whilst a '1' sets it as an output. That is, RSO, RS1 = 0,0 accesses DDRA if CRA2 = 0, or Peripheral Interface A if CRA2 = 1. In the latter case, PAO - 7 are all inputs if

DDRA holds zero and are all outputs if DDRA holds 255. (The EPROM Programmer uses all eight lines, PAO – 7, as all inputs or alternatively as all outputs, although under control of DDRA, any mixture of inputs and outputs can be set up).

TABLE 2

RS0	RS1	CRA2	CRB2	LOCATION SELECTED
1	0	X	X	CONTROL REGISTER A
.0	0	0	X	DATA DIRECTION REGISTER A
0	0	1	X	PERIPHERAL DATA REGISTER A
1	1	X	X	CONTROL REGISTER B
0	1	X	0	DATA DIRECTION REGISTER B
0	1	X	1	PERIPHERAL DATA REGISTER B

The 6821 Register selection programming. Control signal RS1 selects either control Register A or B, while RS0 selects either the Data Direction Register or the Peripheral Data Register of the selected side.

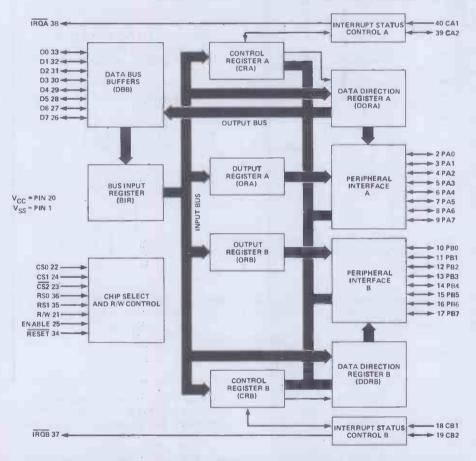


Figure 3. The internal architecture of the 6821 PIA. Not all the functions are used by the EPROMmer circuit!

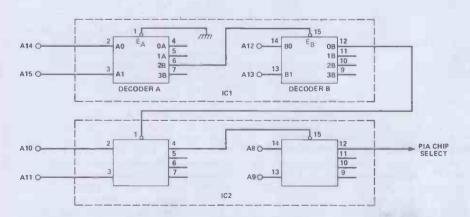


Figure 4. Detail showing the PIA address decoding circuitry. With the connections shown, this places the PIA at 32768, though other addresses can be arranged by selecting the appropriate outputs from each decoder section.

We do not use bits 0, 1, 6 or 7 of CRA, but in addition to bit 2 we also need bits 3, 4 and 5. These control line CA2, and we configure this as an output, which is set to a 0 or a 1 as appropriate by the BASIC operating system, as will be explained later.

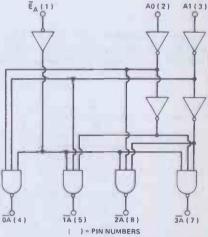
Similar comments apply to the B side of 6821, as shown in Table 2.

The arrangement of the 6821 thus provides access to a total of six registers whilst only occupying four consecutive memory addresses. The present circuit does not take advantage of this economy of address space since for simplicity and economy, partial

Building Blocks

The 74LS139 is a dual 1-of-4
Decoder/Demultiplexer IC containing
two independent decoders. Each
decoder accepts two binary inputs and
produces a single, unique active LOW
output for each combination of inputs,
as shown in the Truth Table. Each
decoder has an active LOW ENable (E)
input which forces all four outputs HIGI
when it is taken HIGH itself.

In the EPROM Programmer, two 74LS139s are used to provide address decoding for the PIA as shown in Figure 4; when the correct address is presented on the host computer's address bus, pin 12 of IC2 goes low, ENabling the PIA.



The circuit of one half of a 74LS139.

1	NPUT	S		OUTP	UTS	
Ē	A ₀	A _{.1}	ō	1	2	3
Н	Х	X	Н	Н	Н	Н
L	L	L	L	Н	Н	Н
L	Н	L	Н	L	Н	Н
L	L	Н	Н	Н	L	Н
Ļ	Н	Н	Ĥ	Н	Н	L

H = HIGH VOLTAGE LEVEL L = LOW VOLTAGE LEVEL

The Truth Table for the decoder; each combination of inputs produces a single unique output.

How It Works

THE HEART of the Programmer circuit is the 6821 Peripheral Interface Adaptor (PIA). This contains two independent sets of DATA registers, PAO-7 and PBO-7, each controlled by separate control Registers CRA and CRB, plus a pair of Data Direction Registers DDRA and DDRB. Register PB is used to store the data to be programmed into the EPROM, while register PA is used to hold the address in the EPROM where the data is to be located. Both sets of information are transmitted via the host computer's Data Bus.

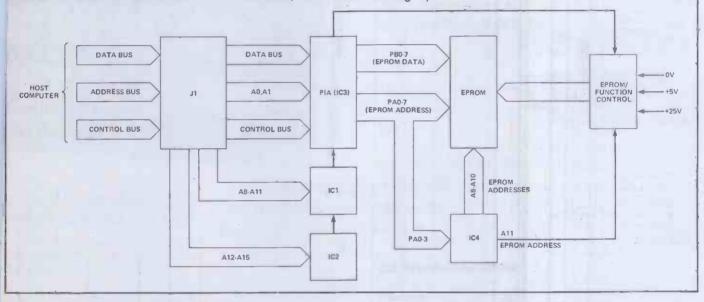
Thus storing a single byte of data requires two separate operations; first the EPROM address is sent to register PA, then the data to be stored in the EPROM at that address is sent to Register PB. These operations are carried out under the control of the

operating software.

However, since only eight address bits are supplied, only 256 bytes of EPROM can be programmed, therefore it is necessary to increment the EPROM address after each block of 256 addresses. Before the low-order address bits are sent to Register PA. four address bits are first loaded into the four-bit latch IC4, and these are presented to the EPROM address bus at the same time as PAO-7 loads the low-order address into the EPROM. That is, programming one byte of data actually required three operations; first, EPROM addresses A8-A11 are latched into IC4; then address bits AO-A7 are presented via PAO-7, then the data is loaded via PBO-7

Since the Programmer is designed to program both 2716 and 2732 EPROMs, which have some slightly different pin functions, the appropriate logic levels are derived from two switches and a small amount of control logic; the switching and logic circuit is described fully in the text and Table 1

Finally, ICs 1 and 2, a pair of 1-of-4 line decoders, are used to ENable the PIA when the appropriate address appears on the host computer's address bus. Address lines A8-A15 are decoded by ICs 1 and 2 while A0 and A1 are applied directly to the PIA (see text and Building Blocks for further details). This system locates the PIA's Control and Data Direction Registers at 32768—32771. However, because address lines A2—A7 are not decoded, the register's addresses also occur at the next four addresses, the four after that and so on.



address decoding is used. Address bits AO and A1 are applied to the 6821 directly and, in conjunction with A8 to A15 decoded by IC1 and IC2, locate the PIA's four registers at 32768-32771. But as address bits A2 to A7 inclusive are not used, the PIA could equally well be addressed at the next four memory locations or the four after that and so on. This is satisfactory in the author's set-up as the 256 addresses following the PIA are unused, but the point must be borne in mind if you wish to relocate the PROM Programmer's PIA address, say to tuck it away in one of the odd spaces near the top of RAM.

Returning then to Figure 1, it can be seen that address lines 0 to 7 of the EPROM are driven by Peripheral Register A, PAO — 7, of the PIA. Do not confuse the EPROM's address lines with the computer's address bus; the EPROM address is written into PAO — 7 via the computer's data bus. The data bus also supplies the data to be stored in the EPROM, and this program data is held in Peripheral Register B, PBO — 7, of the PIA. That would be the end of the story if the EPROM only held 256 bytes, but

in fact it holds 2048 bytes (2716) or 4096 bytes (2732), so the eight address bits held in PAO — 7 must be augmented by three or four more EPROM address lines. These extra address bits are held in four bit latch IC4. The latch inputs D1 - 4 are from the four low order outputs PAO -Peripheral Register A; the appropriate address data is stored in Peripheral Register A and then latched in IC4 by momentarily taking PIA control output CA2 high. This extra operation only represents a tiny overhead as EPROM addresses A8 -10 (or A8 - 11 in the case of the 2732) only need updating once for every 256 lower order addresses.

Having set up the complete EPROM address in latch IC4 and PAO — 7 of the PIA, and with the corresponding data byte to be stored sitting in PBO — 7, PIA control line CB2 is taken high for 50 mS. Provided VPP is at + 25V, this has the effect of "burning" the data into the EPROM at that address. If a 2732 is in course of being programmed, then + 25V will be present at pin 20 of the PROM. This is detected by Q1, which places a '1' on pin 1 of EXOR gate IC5a,

causing it to act as an inverter, as required (see **Table 1**). Under all other conditions (2732 read or verify, 2716 all operations), there will be a 'O' at pin 1 of IC5a and the CB2 signal is therefore not inverted. This looks after pin 18's requirements, and the functions of pins 20 and 21 for the two types of PROM are sorted out by switches SW1 and SW2, again in accordance with **Table 1**.

Two of the spare EXOR gates have an input tied to PA3. Thus during reading, programming or verifying, as successive addresses are set up in Peripheral Register A, red LED1 will blink on and off, showing that it is ''all happening"; PA3 was chosen as giving a suitable blink rate. A green LED driven from the +25V supply indicates that the mains supply to the EPROM Programmer is on, whilst a yellow LED powered from +5V indicates that the Programmer is indeed receiving this supply from the host computer. The 25V supply is actually more like 24V7 nominal, using as it does a 7824 regulator with the common leg propped up on a small signal silicon diode D2.

Sinclair ZX Spec

16K or 48K RAM...
full-size movingkey keyboard...
colour and sound...
high-resolution
graphics...

From only £125!

First, there was the world-beating Sinclair ZX80. The first personal computer for under £100.

Then, the ZX81. With up to 16K RAM available, and the ZX Printer. Giving more power and more flexibility. Together, they've sold over 500,000 so far, to make Sinclair world leaders in personal computing. And the ZX81 remains the ideal low-cost introduction to computing.

Now there's the ZX Spectrum! With up to 48K of RAM. A full-size moving-key keyboard. Vivid colour and sound. High-resolution graphics. And a low price that's unrivalled.

Professional powerpersonal computer price!

The ZX Spectrum incorporates all the proven features of the ZX81. But its new 16K BASIC ROM dramatically increases your computing power.

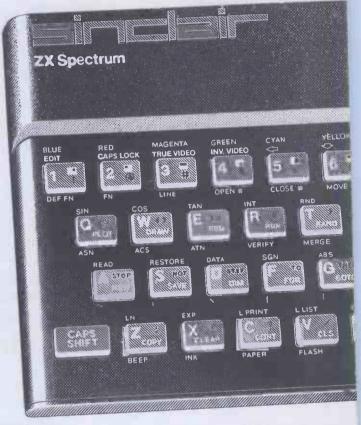
You have access to a range of 8 colours for foreground, background and border, together with a sound generator and high-resolution graphics.

You have the facility to support separate data files.

You have a choice of storage capacities (governed by the amount of RAM). 16K of RAM (which you can uprate later to 48K of RAM) or a massive 48K of RAM.

Yet the price of the Spectrum 16K is an amazing £125! Even the popular 48K version costs only £175!

You may decide to begin with the 16K version. If so, you can still return it later for an upgrade. The cost? Around £60.



Ready to use today, easy to expand tomorrow

Your ZX Spectrum comes with a mains adaptor and all the necessary leads to connect to most cassette recorders and TVs (colour or black and white).

Employing Sinclair BASIC (now used in over 500,000 computers worldwide) the ZX Spectrum comes complete with two manuals which together represent a detailed course in BASIC programming. Whether you're a beginner or a competent programmer, you'll find them both of immense help. Depending on your computer experience, you'll quickly be moving into the colourful world of ZX Spectrum professional-level computing.

There's no need to stop there. The ZX Printer – available now – is fully compatible with the ZX Spectrum. And later this year there will be Microdrives for massive amounts of extra on-line storage, plus an RS232/network interface board.



Key features of the Sinclair ZX Spectrum

- Full colour 8 colours each for foreground, background and bore plus flashing and brightness-inter control.
- Sound BEEP command with variable pitch and duration.
- Massive RAM-16K or 48K.
- Full-size moving-key keyboard a keys at normal typewriter pitch, wi repeat facility on each key.
- High-resolution 256 dots horizontally x 192 vertically, each individually addressable for true hi resolution graphics.
- ASCII character set with upper- a lower-case characters.
- Teletext-compatible user softwar can generate 40 characters per lin or other settings.
- High speed LOAD & SAVE-16K in 1 seconds via cassette, with VERIFY MERGE for programs and separate data files.
- Sinclair 16K extended BASIC incorporating unique 'one-touch' keyword entry, syntax check, and report codes.

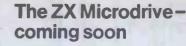


The ZX Printeravailable now

Designed exclusively for use with the Sinclair ZX range of computers, the printer offers ZX Spectrum owners the full ASCII character set—including lower-case characters and high-resolution graphics.

A special feature is COPY which prints out exactly what is on the whole TV screen without the need for further instructions. Printing speed is 50 characters per second, with 32 characters per line and 9 lines per vertical inch.

The ZX Printer connects to the rear of your ZX Spectrum. A roll of paper (65ft long and 4in wide) is supplied, along with full instructions. Further supplies of paper are available in packs of five rolls.



The new Microdrives, designed especially for the ZX Spectrum, are set to change the face of personal computing by providing mass on-line storage.

Each Microdrive can hold up to 100K bytes using a single interchangeable

storage medium.

The transfer rate is 16K bytes per second, with an average access time of 3.5 seconds. And you'll be able to connect up to 8 Microdrives to your Spectrum via the ZX Expansion Module.

A remarkable breakthrough at a remarkable price. The Microdrives will be available in the early part of 1983 for around £50.





How to order your ZX Spectrum

BY PHONE-Access, Barclaycard or Trustcard holders can call 01-200 0200 for personal attention 24 hours a day, every day. BY FREEPOST-use the no-stamp needed coupon below. You can pay by cheque, postal order, Access,

FREEPOST-no stamp needed.

Barclaycard or Trustcard.

EITHER WAY-please allow up to 28 days for delivery. And there's a 14-day money-back option, of course. We want you to be satisfied beyond doubt – and we have no doubt that you will be.

Export prices on application.

To: Sinclair Research, FREEPOST, Camberley, Surrey, GUI5 3BR. Order Qtv **Item Price** Total Code £ £ Sinclair ZX Spectrum - 16K RAM version 100 125.00 Sinclair ZX Spectrum - 48K RAM version 101 175.00 Sinclair ZX Printer 27 59.95 Printer paper (pack of 5 rolls) 16 11.95 Postage and packing: orders under £100 28 2.95 4.95 orders over £100 29 Total £ Please tick if you require a VAT receipt *I enclose a cheque/postal order payable to Sinclair Research Ltd for £ *Please charge to my Access/Barclaycard/Trustcard account no. *Please delete/complete as applicable Signature **PLEASE PRINT** Name: Mr/Mrs/Miss Address

Prices apply to UK only.

ipectrum software on ettes—available now

⇒ Spectrum software library is g every day. Subjects include , education, and business/ nold management. Flight tion... Chess... Planetoids... ... Inventions... VU-CALC... VU-3D Record Controller... there is hing for everyone. And they all full use of the Spectrum's colour, , and graphics capabilities. You'll e a detailed catalogue with your um.

Expansion Module

is module incorporates the three ons of Microdrive controller, local etwork, and RS232 interface. Lect it to your Spectrum and you can ollup to eight Microdrives, unicate with other computers, and wide range of printers. Lee potential is enormous, and the e will be available in the early part 3 for around £30.



air Research Ltd, Stanhope Road, perley, Surrey GU15 3PS. camberley (0276) 685311.

POINTS OF WIEW

Feel like sounding off? Then write to the Editor stating your Point Of View!

Gordon Channer Again!

Now, replies to a reader's query, from other readers:

Dear Sir,
With regard to Gordon Channer's letter
(HE January '83) may I suggest he
contacts Black Star Ltd., who advertise
in ETI (they appear in Monitor and in our
suppliers' surveys from time to time, too
— Ed.). They stock a range of Crotech
oscilloscopes, two of which may be
operated from a 10V to 15V DC supply.
I hope this information will be of use.
J.M. Oakley,
Ormskirk,
Lancs.

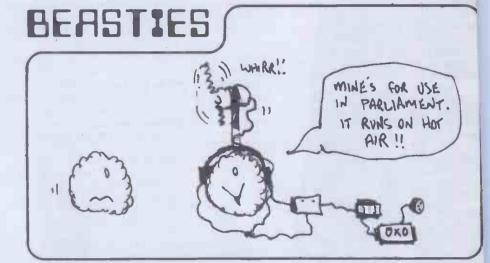
Thanks, J.M. — you've furthered the cause of hydro-electronics. (Anybody who doesn't understand that hasn't read their January HE properly — shame on you.)

Dear Sir (or Madam), In answer to Gordon Channer's letter in HE January '82 about a 12VDC oscilloscope, the instrument he is looking for is obviously the superb instrument that was offered by ETI in their May '82 issue and the following couple of issues. C. Williams, Willenhall, West Midlands.

This letter continued with various facetious comments concerning Clever Dick, Steven Spielberg, binders and the dotted lines on our survey sheet . . all of which are being referred to the proper authorities, who will doubtless be round with rubber truncheons one evening quite soon. As for the query about whether ETI is actually extra-terrestrial, we can't reply to that one as we can't understand a word their editorial team says. Sorry!

Generating Some Curiosity

Dear Sir,
I have just read the 'Wireless Goes To
War' article in HE January '83 and
found it very interesting. Can I suggest
that John Biggins writes about the
wartime development of radio during
World War Two, which should also
make interesting reading.



The caption for Fig. 3 on page 56 states that the purpose of the 'fan (propellor)' is not known; I think the purpose is quite obvious. It is an air driven generator to provide power for the aeroplane's radio, to save the weight of battery power packs. What do other readers think?

C.M. Daw,

Flitwick,

Beds.

It's easy when you know how! We had one or two readers contact us about this propellor, and they all agree with you. Now, when will our modern electronics companies think of something similar for personal stereos? I'm sure we'd all be willing to walk a bit faster to avoid the frustration of batteries conking out in the middle of a loud bit!

Flash It Again, Please

Dear Sir,
Last year I built the circuit you published using two 555 timers and LEDs to make the 'Twinkling Star' tree decoration, and it worked perfectly. However, when I made the 'Christmas Tree Lights Flasher', neither of the 555 timers would work the relay specified. When put back into the 'Star' circuit they both functioned perfectly. Both circuits were powered by new PP3 batteries, which pulled the relay in when directly connected.

Could you offer any explanation for this, or should I boost the output of the 555 with a small transistor in order to power the relay?
Robin R. Davies, Horley, Surrey.

Uh oh. Deeply involved as you are in building this circuit, your description of it must seem to you all-embracing. Unfortunately, to us, with our miles of files and lengthy editorial history, it sounds pretty much like any of a dozen other circuits.

As a matter of general policy, please can you try to name the month and year of the Hobby you were working from when writing about circuits? If you send an SAE, you will get a personal reply; if you don't, you will eventually appear in POV; but if we can't work out what you're talking about, you may never get a reply which makes any sense! So please, gentle readers — name, rank and serial number when you're reporting projects for misconduct.

Ear Errata

Dear Sir,

May I point out what I think are a number of errors concerning the project 'Big Ear' in HE December '82.

1) Reference page 80 (Circuit Diagram): The volume control RV1 has the bottom end connected to OV. This would place a dead short across C5 and R6

2) Reference page 81 (Component Layout): R2 is shown as going to Pin 2 of the IC1 (TLO82). Circuit Diagram shows R2 going to Pin 3.

3) In the description of the Circuit (page 81) it is stated that "The input from the mic is fed to the non-inverting -ve input of IC1a", but the Circuit Diagram shows the input from mic to the +ve input of IC1a.

4) The article states that "The junction of the two resistors is bypassed to OV by C3", but the Circuit Diagram shows the bypass capacitor to be C5 at the junction of R3/R6.

A. Lord, Southport, Merseyside.

Dear Sir,

An electronics engineer has informed me that at least one error is present in the Circuit Diagram of the directional microphone published in HE December '82

I would be grateful if you would send me a correct circuit diagram should the statement be true. I have already purchased the components and am keen to complete the project. P.E. Philpotts.

P.E. Philpotts, Brentwood, Essex.

Well, notwithstanding what we say about feedback sometimes taking months to come through, where the errors are less subtle they come back to us pretty fast! Here are the errata from our own correction card:

a) Page 80, Fig 2: Junction of R6, C5 and RV4 should not go to OV.

b) Page 81, Fig 3: R2 should go to pin 3 of IC1, not pin 2.

c) Page 81, Text: Input from mic is to

non-inverting (+ ve) input.
d) Page 81, Text: Junction R2,
R3/R6 is bypassed to ground by C5, no

R3/R6 is bypassed to ground by C5, not C3.

A Bit Off The Beat

Dear Sir,
I have constructed the circuit board and components for the Metronome project in HE November '81. The accented beat is very unreliable. After a few seconds the 4017 IC breaks down and the accented beat is at random intervals. I have tried two fresh ICs, but the same fault develops after a couple of minutes. I have tried various voltages, and breakdown seems to occur soon after 7V. I am quite convinced that it is not a

circuit fault.

Is it possible that there is an inate problem with the 4017 when the reset pin is connected to one of its output pins? I once used the 4017 as a divide-by-five counter, but eventually had to resort to other means because of its poor reliability. In any event my niece who was so looking forward to having the metronome is very disappointed.

C.A. Bearfield,

Sale, Cheshire.

Unfortunately, there was more than one error in this project, so we can't correct it in a few words. Anyone who thinks or knows, that there is an error in a project they are building, send us an SAE. Mark your own envelope 'project errata' and we'll forward a correction sheet as a matter of priority. The only snag can be that some project problems are subtle and may not come to light for months after a project is published, so anyone writing for corrections too soon after publication may not find what they're looking for. It's safest to do what Mr. Bearfield has done: test out all the possibilities to see if it's a construction or a component fault, and then contact Hobby.

Faults in projects seem to be inevitable because Hobby projects are effectively production designs — they're being made up in multiple copies by different people with components from different sources in different places. Designs for commercial production can have months of strenuous testing under all sorts of conditions before they're released for cloning — if we did that,

your Hobby would shoot up to about £3.00 a copy. So we rely on careful testing and — er — proofreading, and feedback from designers and readers, and cheer loudly when we get a design for publication that has been tested in the field for a year or two — not, alas, all that common, but nice if we can get it

Heat But No Light

Dear Sir.

Some months ago you published an article on solar cells which I found very interesting. We are interested in using these solar panels to provide lighting in some of the bush missions and outstations. You mentioned one particular type of panel which appeared suitable. We would be very grateful if you could send us the name and address of the manufacturers and/or suppliers. We would also like to have an idea of the cost.

When we get your magazine (which is unfortunately very seldom) we find it very interesting and instructive. Keep up the good work.
Martin O'Neil,
Mansa,
Zambia,
Central Africa.

We have to admit that, unliminger old England, you have no shortage of sun out there. The cells, unfortunately, might prove a problem. The cells we featured were at the time listed in the RS Components catalogue, but on checking, they no longer appear to be available. Can any reader or supplier help? If so, contact us at POV. Meanwhile, somebody had better get HE onto the Bush Telegraph double quick and make sure Mr. O'Neill gets our reply!

Seeking The Light

Dear Sir,

I am a student at East Ham College of Technology, studying my final year in a TEC Diploma Electrical Engineering course.

The class has been asked to carry out a full year project. I have therefore decided to make and research on the Light Dimmer featured in HE October '80.

Can you therefore please be kind enough to send me some information based on this project. Ilyas Syed, Forest Gate, London E7.

I'm afraid we don't keep files of extra information on our projects — what we have is what we publish in the magazine. Of course, back issues are always obtainable through our backnumbers service (details in most Hobby issues — not this one, alas. Check out February or April. Cost is £1.25 per issue or article). Also, there are in London some very good libraries that

have stocks of technical magazines going back many years which you can look at for reference, even if you don't live in the same local area. Try asking your local library for advice.

Microlog Mistake

Dear Sir,
HE Microlog (December '82).
Thank you for this excellent project
which I am in the process of building. I
think this is a good introduction into the
world of analogue computing. With
reference to Fig. 6, there appears to be
a misprint. The top part of the
secondary of T1 is taken straight to
regulator IC3, instead of into the top
part of BR1. Thanks for this great
magazine and please keep up the good
work.
H. Meidner,
Kensal Rise,
London NW10.

Yes, we caught that one, unfortunately, just too late to stop it from getting into print, but the correction was published in January's Hobby as part of Monitor, with the corrected diagram on page 72. Thank you for contacting us anyway—it might have been something no-one else had yet spotted. Just to recap, the top of T1 should go to the top of the diode bridge BR1, but not to IC1.

Might As Well Stay Home . . .

I read with interest both the letter from Mr. Gordon Channer (POV HE January '83) and the article 'Light and Power', both of which dealt with DC/AC inverters. I had already drafted out a letter to you on the same subject, now disposed of. I was going to state, and I do now, that I'm sure there are many people like myself who garage their car some distance from their home and would welcome such an inverter to enable them to use an electric drill, etc. That would mean something with a power capability of around 4-5000 watts. Perhaps your engineers can come up with something in the near future.

The other point I would like to raise, again for your engineers. What I would like to see is a project on a digital scoring device, like two seven segment displays that would retain their respective figures until they are updated, but only using one key-pad that could be switched (by a two-way switch) from one to the other. This could be used for many games like darts, cards, dominoes, etc.

A. W. Guy,
Forest Gate,
London E7.

As stated in the article on supplies, power in excess of around 200 watts is very difficult to realise, so it's unlikely that a more powerful supply will appear as a Hobby project, regrettably.

However, as for the scoring systems: we have something in mind, so watch this space!

27

Make us your No. 1 SUPPLIER OF KITS and COMPONENTS for H.E. Projects. We supply carefully selected sets of parts to enable you to contruct H.E. projects. Kits include ALL the electronics and hardware needed. Printed circuit boards (fully etched, drilled and roller tinned) or Veroboard are, of course, included as specified in the original article, we even include nuts, screws and I.C. sockets. PRICES INCLUDE CASES unless otherwise stated. BATTERIES ARE NOT INCLUDED. COMPONENT SHEET INCLUDED. If you do not have the issue of H.E. which includes the project — you will need to order the instruction reprint at an extra 45p each.

Reprints available separately 45p each + p. & p. 40p. PHASE FOUR Dec 82 £18.71
STEREO NOISE GATE Dec 82 £15.35
TAPE/SLIDE SYNCHRONIZER Dec 82 E21.73
BIG EAR Dec 82 less pipe parts £6.21
MICROAMMETER ADAPTOR Dec 82

E4.98

ODOMETER Nov. 82 £14.98

DIANA V.C.O. Nov 82 £4.89

CB SQUELCH UNIT Oct 82 £9.19

'JUNIOR' SLOT CAR CONTROLLER
Sept 82 £5.60 less case.

ZX INTERFACE BOARD Sept 82 inc

edge con £11.33. T.V.I. FILTER July 82 £5.33 AUTO WAH June 82 £18.98 inc case or .28 less case.
TO GREENHOUSE SPRINKLER

AUTO GREENHOUSE SPRINKLER
June 82 £15.38 less pump and power
supply (12V 2A).
TELEPHONE TIMER June 82 £33.42 less

power supply (suitable type below).
POWER SUPPLY DESIGN 12V 500mA
June 82 £9.98
ECHO REVERB UNIT May 82. Less case

£33.98. Economy case W83 £3.76 extra DIGITAL THERMOMETER May 82 excluding case + bezel £16.90
AUDIO SIGNAL GENERATOR May 82

CABLE TRACKER May 82 £9.98
DIGITAL CAPACITANCE METER Apr 82 £21.37 82 £21.37 SIGNAL TRACER Apr 82 £3.86 BIKE ALARM Apr 82 £11.74 DIGITAL DICE Mar 82 £7.29 BICYCLE SIREN Mar 82 £10.89 MOISELESS FUZZBOX Feb 82 £10.45
MASTHEAD AMPLIFIER Feb 82 £14.74
DRUM SYNTHESIZER Dec 81; Full kit

E21.37
GUITAR HEADPHONE AMPLIFIER Dec 81 £3.72 IN CAR CASSETTE POWER SUPPLY Dec 81 £4.77 SCRATCH FILTER Nov 81 Mono £5.82

Stereo £8.98 LED VU METER Nov 81 less case £4.87 SIMPLE STYLUS ORGAN Nov 81 less case £4.98

METRONOME Nov 81 £12.71 TELEPHONE BELL REPEATER Oct 81 £13.67

Med linking wire extra 14p metre
COMBINATION LOCK Oct 81 less solenoid £18.65

BABY ALARM Oct 81 £8.70, Fig 8 linking wire 7p metre 'DIANA' METAL LOCATOR Sept 81 E34.50 REACTION TESTER GAME Sept 81 £12.81 VARIABLE BENCH POWER SUPPLY Aug 81 £26.98

ULTRASOUND BURGLAR ALARM
July 81 £19.98

ELECTRONIC DOOR BUZZER July 81 ELECTRONIC METRONOME July 81 CONTINUITY CHECKER June 81 £5.71 **ENVELOPE GENERATOR June** AUDIO MIXER June 81 £5.33
PUBLIC ADDRESS AMPLIFIER March
81 £19.48. Extras - horn speakers £6.83
each, PA MIC £4.40 FUZZBOX March 81 £10.98
WINDSCREEN WIPER CONTROLLER
March 81 £8.20
STEAM LOCO WHISTLE March 81 PHOTOGRAPHIC TIMER March 81 £3.50 HEARTBEAT MONITOR Feb 81 £24.98 TWO-TONE TRAIN HORN Feb 81 £5.60

less case medium wave radio Feb 81 £8.20 BENCH AMP Jan 81 £10.80 NICAD CHARGER Jan 81 £8.20 CHUFFER Jan 81, less case £7.53 BATTERY CHARGE MONITOR Dec 82

MEMORY BANK — MINI SYNTH-ESISER Nov & Dede 80 £29.98 TRANSISTOR TESTER Nov 81 £6.54 inc GUITAR PRE-AMP Nov 80 £6.65

Case (diecast) extra £2.29
INTRUDER ALARM Oct 80 £20.98
TOUCH SWITCH Sept 80 £2.75 less case

GUITAR PHASER Sept 80 £16.28 SOUND OPERATED FLASH TRIGGER July 80 no skt £5.33 FOG HORN June 80 £6.64 SPEED CONTROLLER FUR HIG APRIL 80 £17.55 (less case) DIGITAL FREQUENCY METER April 80

GUITAR TUNER Nov 79 £12.82 CAR ALARM Feb 79 £12.91

MORE PROJECT KITS – SIMILAR STYLE TO H.E. INSTRUCTIONS INCLUDED (SEPARATELY 45p EACH) PLEASE QUOTE REF. NO. WHEN ORDERING

B1 PEST CONTROL 'Ultrasonic cat scarer' £7.85
B2 COMPONENT TESTER £8.88
B4 GUITAR NOTE EXPANDER £17.98
B5 CAMERA OR FLASH GUN
TRIGGER Infra red system £12.51
B6 SIMPLE INFRA RED REMOTE
CONTROL £17.20
B7 0.12V POWER SUPPLY £17.98
B9 SOUND TO LIGHT — single channel £8.42

B10 THREE CHANNEL SOUND TO LIGHT E21.44

B11 IN SITU TRANSISTOR TESTER

B12 WEIRD SOUND EFFECTS GENERATOR £5.98 B13 AUDIBLE VISUAL METRONOME

B14 ELECTRONIC DICE 55.71 B16 MINI EGG TIMER £4.34

B18 LED JEWELLERY — Cross brooch £2.77 Star brooch £9.91 Spiral brooch £7.98

MORE KITS AND COMPONENTS IN OUR LISTS

FREE PRICE LIST
Price list included with
orders or send sae (9 × 4)
CONTAINS LOTS MORE KITS, PCBs & COMPONENTS

1982 ELECTRONICS CATALOGUE

Illustrations, product descriptions, circuits all included. Up-to-date price list enclosed. All products are stock lines for fast delivery. Sends 80p in stamps or add 80p to order

MORE H.E. PLUS E.E. and E.T.I. PROJECT.
KITS IN THE PRICE LIST

MAGENTA gives you FAST DELIVERY OF QUALITY COMPONENTS & KITS. All products are stock lines and are new & full specification. We give personal service & quality products to all our customers—HAVE YOU TRIED US?

MAGENTA ELECTRONICS LTD

HV34. 135 HUNTER ST., BURTON-ON-TRENT, STAFFS.
DE11-25T, 0233 66435, MON-FRI 9-5. MAIL ORDER ONLY
ADD 450 PEP TO ALL ORDERS PRICES INC VAT

ACCESS and BARCLAYCARD (VISA) ORDERS ACCEPTED BY PHONE OR SAE ALL ENQUIRIES.

Prices inc. VAT
OFFICIAL ORDERS WELCOME OVERSÉAS. Payment must be in sterling IRISH REPUBLIC and BFPO: UK PRICES. EUROPE: UK PRICES plus 10%. ELSEWHERE: write for quote.

ANTEX X5 SOLDERING IRON 25W SOLDERING IRON STAND . £1.98 SPARE BITS. Small standard, large, 65p each. For X5 + X25
 SOLDER. Handy size.
 .99p

 SOLDER CARTON
 £1.84

 DESOLDER BRAID
 .69p
 . 99p69р HEAT SINK TWEEZERS..... 29p DESOLDER PUMP£6.48 HOW TO SOLDER LEAFLET 12p LOW COST CUTTERS £1.69 LOW COST LONG NOSE PLIERS £1.68 WIRE STRIPPERS & CUTTERS . . £2.69

PRECISION PETITE 12V PCB Driff.... Drill Stand....... Grinding Stone... Grinding Wheel. Saw Blade. Brass Wire Brush..... 50p VERO SPOT FACE CUTTER . . £1.49 MULTIMETER TYPE 2 (20,000 opv) with transistor tester. Very good CROCODILE CLIP TEST LEAD SE

10 leads with 20 clips . **MULTIMETER TYPE 2 -**YN360 TR. £14.75

. 99p

ED 11 colours 49p £1.14 £2.40 £2.98 SCREWDRIVER SET. £1.98
POCKET TOOL SET £3.98
DENTISTS INSPECTION MIRROR £2.85 JEWELLERS EYEGLASS £1.50 PLASTIC TWEEZERS
PAIR OF PROBES WITH LEADS 69p . 77o



20,000 opv. Includes transistor tester. AC + DC volts. DC current. 4 very useful resistance ranges. We've used it and we like it.

MIN. BUZZERS, 6V. 50p. 9V. £1-10.

	SPEAKERS, Miniature, 8 ohm	87p
MONO HEADPHONES £2.96		
TELEPHONE PICK-UP COIL 720	MONO HEADPHONES £	2.96

ES. UP COIL	89p 65p .£2.96	MAGEN STEREC	TIC EAR	PIECE	
ER STRIPS £1.20 per 5		PP3 CLIPS PP9 CLIPS			PANEL METERS 50uA: 100uA: 1mA,
	S DEC BR	EADBOARD		£3.98 £6.98	1A, 25V. 100uA-0- 100uA; 5A. AU £4.98 each. State

24 strips 50 holes 36 strips 37 holes 36 strips 50 holes Terminal pins 0.

VEROBOARD 0.1" COPE

BOOKS

SEMICONDUCTOR DATA BOOK LECTRONIC PROJECTS FOR HOME SECURITY ELECT. PROJECTS IN PHOTOGRAPHY £3.35 £5.35 £1.95 110 ELECT. ALARM PROJECTS 55.38
MODEL RAILWAY PROJECTS 61.98
BASIC ELECTRONICS. Theory & practice BEGINNERS GUIDE TO BUILDING ELECT.
PROJECTS £1.50

ADVENTURES WITH MICROELECTRONICS

Similar to 'Electronics' below. Uses I.C.s. Includes dice, electronic organ, doorbell, reaction timer, radio, etc. Based on Bim-board 1 bread board. Adventures with Microelectronics... £2.55

Component pack £29.64 less

ADVENTURES WITH ELECTRONICS

by Tom Duncan

An easy to follow book suitable for all ages. Ideal for beginners. No soldering, uses an S-Dec breadboard. Gives clear instructions with lots of pictures. 16 projects—including three radios, siren, metronome, organ, intercom, timer, etc. Helps you learn about electronic components and how circuits work. Component pack includes an S-Dec breadboard and all the components for the

Adventures with Electronics £2.40. Component pack £18.98 less battery.



	£3.06
JUNIOR HACKSAW	85p
SPARE BLADES	
ABRAFRAME HACKSAW	cuts in all
directions)	87р
SPARE BLADES	36p for 2
VEROBLOC BREADBOAR	
QUICKTEST (quick connect	
	£6.99

HELPING HANDS JIG £6.30

Heavy base. Six ball and socket joints allow infinite variation of clips through 360°. Has 2%" diameter (25×) magnifier attached, used and recommended by our staff.



BACKNUMBERS



February 1980

Passion Meter, Win Indicator, Short Circuit Special, Kit Review Special, Into Electronics Construction Part 1.

May 1980

MiniClocks, 5080 Preamp, Model Railway Track Cleaner, 5080 Loudspeakers, Loudspeaker Crossover Design, Radio Controlled Model Survey.

lune 1980

Microbe Radio Control System, Egg Timer, Two Watt Amplifier, Fog Horn, Short Circuits, LEDs and LED Displays.

July 1980

Sound-Operated Flash Trigger, 18 + 18 Car Stereo Booster, Hazard Flasher, Electronics in Photography, Electronic Espionage, Piezo Electricity.

August 1980

EquiTone Car Equaliser, Pass-The-Loop Game, Gaztec Gas Detector, OP-Amp Checker, In-Car Entertainment Survey, Introducing Microprocessors. September 1980

MicroMixer, Reaction Tester, Guitar Phaser, Development Timer, Teletext Explained, Into Digital Electronics Part 1.

October 1980

Kitchen Timer, Tug 'o' War Game, Light Dimmer, Freezer Alarm, Intruder Alarm, Temperature-Controlled Soldering Iron.

January 1981

Car Rev-Counter, Bench Amplifier, Sound-Into-Light Converter, Chuffer, Electronic Games reviewed.

February 1981

Heartbeat Monitor, High-Impedance Voltmeter, Medium Wave Radio, Two-Tone Train Horn, Audio Signal Generator.

March 1981

Public Address Amplifier, Windscreen Wiper Controller, Bicycle Speedometer, Photographic Timer, Microcassettes. **April 1981**

Pre-Amplifier Part 1, Super Siren, Guitar Tremolo, Russian Roulette Game, Doorbell Monitor, Anatomy of a Space Shuttle.

May 1981

Electronic Organ, Voice-Operated Switch, Infra-Red Controller, Pre-Amplifier Part 2, Audio Millivoltmeter.

June 1981

Power Amplifier Part 1, Continuity Checker, Envelope Generator, Early Radio, Gadgets Games and Kits Supplement.

July 1981

Burglar Alarm, Doorbuzzer, Treble Booster, Electronic Aids for the Disabled, Power Amplifier Part 2.

August 1981

Electronic Ignition, Thermometer, Electronic Organ (final part), RPM Meter, Bench Power Supply, Radio Control Survey, Into Electronic Components Part 1.



All of the 1980 issues, except January and April, are still available together with the remaining issues from 1981.

All backnumbers cost £1.25 each. For those of you who only want copies of articles, we do offer a photocopying service. Each copy costs £1.25 and information as to its title and publication date should be given. Ordering backnumbers and photocopies could hardly be easier, just fill in the coupon, cut it out and send it to:

Hobby Electronics, 145 Charing Cross Road, London WC2H 0EE

Please remember to mark your envelope with the service you require,

BACKNUMBERS or PHOTOCOPIES,

otherwise our mailroom won't like you.

HOBBY ELECTRONICS BACKNUMBER ORDER FORM Please send me the following items:	HOBBY ELECTRONICS PHOTOCOPY ORDER FORM Please send me the following items:
NAME	NAME
ADDRESS	ADDRESS
<u> </u>	
·	Photocopies ofin the
Back issues	issue at £1.25 each
l enclose £	l enclose £

Pop Amps owen

Simple circuits based on operational amiplifiers

No 6: Linear Ohmmeter

BOTH of this month's Pop Amp circuits are concerned with the measurement of resistance. Like the previous circuits in this series, they are low-cost add-ons which give an inexpensive multimeter those extra facilities normally found only on the high grade models. You need only add a simple voltmeter or a multimeter switched to a DC voltage range.

Most multimeters include a circuit for measuring resistance; Usually it is powered by a cell hidden inside the case of the meter. This is wired in series with the coil of the meter and one of a set of standard resistors which can be switched into the circuit according to the range required (Figure 1). There are four snags to this arrangement: one is that the accuracy of the reading depends on the cell delivering the correct voltage. If it is not fresh, the reading is wrong. The second is that this circuit inevitably produces a non-linear reading. You will notice that the multimeter has a special scale for resistances; this is a non-linear scale with the lower gradations widely spaced and the higher values crowded toward the left-hand end. This highlights a third disadvantage which is that the scale reads from right to left, instead of the direction to which we are all more accustomed. Finally, there is the serious limitation that the amount of current flowing through a resistor of several megohms is usually far too small to be measured precisely with the kind of microammeter found in the average multimeter. Consequently, resistance in excess of about 1M ohms can not be measured with precision, if at all.

This circuit provides a linear reading, using the ordinary scale of a 10V voltmeter, and reads from left-to-right. Its accuracy is not affected by battery condition until the batteries are really worn out, and it gives equally precise readings on all ranges, up to 9M ohms.

Operating Amps

The op-amp is wired as a inverting amplifier, with the resistance which is to be measured (Rx, in Figure 2) as the feed-back resistor. The op-amp used in the prototype is a 7611 CMOS amplifier; the output of this device can swing fully between +9V and -9V, giving the maximum range of readings on one range setting.

The way the op-amp works as an inverting amplifier is explained for the benefit of readers who have missed earlier circuits in this series. The first point to note is that the amplifier has a balanced power supply of +9V and -9V, provided by the two batteries. The two inputs to the amplifier have extremely high impedance — 10¹²ohms (one teraohm) — and for all practical purposes we can consider that no current can flow into these terminals.

The amplifier detects the potential of each input, and when they are equal, the output of the amplifier is OV. If the potential at the non-inverting input (positive) is greater than that at the inverting input (negative), the output

swings to a positive voltage; if the positive input is less than that of the negative input, it swings negative. In this circuit, the positive input is wired directly to the OV line and all input voltages to the negative input are positive. Consequently the potential at the negative input is either equal to or greater than that of the positive input, so the outputs are OV or less. This is why the meter is connected with its negative terminal to the output of the amplifier and its positive terminal to the OV line; the output voltages are actually negative, but we read them as positive.

The positive input to the inverting input comes from a reference voltage source, which will be described in a moment. A current flows toward the input through a resistance, called the input resistance, RIN. In practice, this may be any one of a number of different resistances, each made up from a fixed resistor in series with a variable resistor, which can be switched into circuit. This allows changing the range of measurement. Because of the high input impedance referred to above, however, virtually no current can enter the inverting input, so the current flows along unchanged, through the test resistor, Rx to the output of the amplifier. Since this has swung to a negative voltage (for a positive input), the current flows into the amplifier's output.

RIN and Rx are in series and the same current flows through each, so they act as a potential divider. Think of it as a seesaw which turns around a point at a distance from its middle (Figure 3). The high end is at VIN (a positive voltage), and the low end is at VOUT (a negative

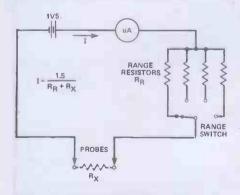


Figure 1. The resistance measuring circuit of a typical multimeter.

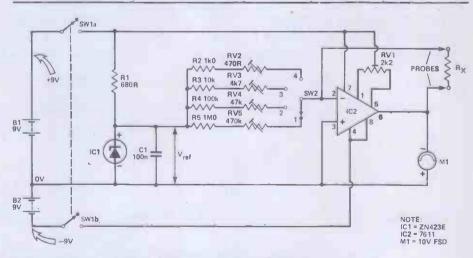


Figure 2. Figure 2. Circuit diagram of the Linear Ohmeter.

voltage), and somewhere between positive and negative there must be OV. The amplifier adjusts Vout until this OV point is located exactly at the negative input, then both inputs are at OV and the circuit becomes stable. In this condition, the voltage drop across RIN is VREF, so the current through RIN is I = VREF/RIN. Also the voltage across RX is VOUT, so I = VOUT/RX, and the same current, I, is flowing through both resistors, so VREF/RIN = VOUT/RX. We already know VREF and RIN, and we can measure VOUT on the meter, so we can easily calculate RX.

VREF is provided by a band gap reference IC (ICI) which acts in a way similar to a reverse-biased Zener diode but with much greater precision; the voltage across this is typically 1V26. If RIN is exactly 1V26R and the voltage across it is exactly 1V26, the current flowing through it is 1mA, and if Rx is exactly 9kR, it requires a voltage of 9V to make 1mA flow through it. In other words, with a 9kR resistor as the test resistor, Vout swings to -9V, and remains there — the meter reads 9V.

If Rx is 8kR, then VouT swings to —8V; the current through Rx is 1mA, as before, and the voltage at the negative input is OV as before. Now the 'see-saw' is tilted less steeply, with its long arm only 8 times longer than the short one, and the meter reads 8V. The same happens for all

other resistances up to 9kR; the meter reading in volts equals the resistance of Rx. in kilohms.

If we make RIN equal to 12k6, I's reduced to 100uA, so to obtain full-scale deflection of 9V, Rx must be 90k. Then the meter reading in volts equals the resistance of Rx in tens of kilohms. Table 4 shows the details of the four ranges which this circuit provides.

To obtain a 900R range we would need to make RIN equal to 126 ohms, and the current would be 10mA. The IC is not able to hold VREF steady when the current is as large as this. If you would like a lower range, make RIN 252 ohms, giving a full-scale reading equivalent to 1k8; take the scale reading, divide it by five and call it kilohms.

The only other part of the circuit which needs comment is the zero adjustment. The inputs of the amplifier behave as if there is a very small voltage difference between them, even if there is not, and when amplified, this small difference would appear as a significantly large reading on the meter. We compensate for this by setting RV1, as explained later.

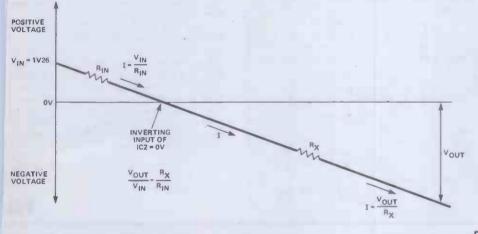


Figure 3. The voltage see-saw around an op-amp.

PROBES S = STRIP CUT BENEATH THE BOARD 00000000000 0 0 G 0 **(** 20 (+) SW ON SW2 (REAR VIEW) Œ 82 9V \odot

Figure 4. Component layout of the circuit board; note that the track cuts are shown viewed from the component side.

Construction

A board of the size recommended has room for four sets of fixed and preset resistors but you can leave out some of

Parts List

- 5	I di to Elot
	RESISTORS
	(All ¼ watt 5% carbon) R1
	R2
ı	R3
1	R4
	POTENTIOMETERS
١	(All horizontal sub-miniature presets) RV1
ı	RV2470R
ı	RV3
1	RV5 470k
ĺ	CAPACITORS
ĺ	C1100n
	SEMICONDUCTORS
ı	IC1ZN423
1	band-gap reference
ı	CMOS op-amp
	MISCELLANEOUS
ĺ	SW1 DPDT toggle or slide
	SW2 rotary
	single pole six-way
	0.1" stripboard, 72 × 46mm (18 strips × 28 holes); 8-pin DIL socket; 9 × 1mm
	terminal pins; 2 × crocodile clips; case
	(optional); wire, solder etc. Calibration resistors — see Buylines
	BUYLINES page 34

		Table 1		
Rin	R2-5	RV2-5	CURRENT	FULL SCALE
1k26	1kR	470R	1mA	9kR
12k6	10k	4k7	100uA	90k
126k	100k	47k	10uA	900k
1M26	1M	470k	1uA	9MR

Table 1 shows the input resistance, the values of the input resistors and potentiometers which make up RIN, the reference current I, and the full scale resistance reading for each range of the Linear Ohmeter.

BEASTIES EVERY TIME I USE THE ALARM ON MY DIGHTAL WATCH THIS YOU'LL BELIEVE A NUT IN THE CAPE APPEARS!! BALL OF FUZZ.CAN 26E! 26E!!

these if you do not want all the ranges listed in Table 1. If you are unable to obtain a 2k2 preset for RV1, use a 4k7 preset instead.

Wire up the whole circuit before testing it; it can readily be powered by two PP3 batteries though you can use other types, or a mains power pack, if you prefer. Switch on the power and first check that ICI is working; the voltage across C1 should be close to 1V26.

To make the offset null (set zero) adjustment, temporarily connect pins 2 and 3 of IC2 together, using a lead with crocodile clips, and adjust RV1 until the needle of the meter rests at OV, This operation requires patience, since the needle tends to swing violently to either side of zero, but it can be achieved with a little care. Then remove the connection between pins 2 and 3.

You will need a standard resistor to test each range; a 1 % tolerance resistor is best. Choose a value which is near the upper end of the scale you are calibrating, attach the probe clips and select the range on SW2. Adjust the corresponding preset until the meter reading shows the value of the standard resistor; all other readings on that range will now be correct. When all the ranges have been calibrated, the circuit is ready for use.

HE

For a detailed booklet on remote control — send us 30p and S.A.E. (6" \times 9") today.

HOME LIGHTING KITS

se kits contain all necessary components and full ructions & are designed to replace & standard wall ich and control up to 300w. of lighting. TDR300K Remote Control £14.30
Dimmer
MK6 Transmitter for above £ 4.20 Touchdimmer £ 7.00 TD300K

TDE/K Extension kit for 2-way switching for TD300K £ 2.00 LD300K Rotary Controlled



DVM/ULTRA SENSITIVE THERMOMETER KIT



Price £15.50

3-NOTE DOOR CHIME

Based on the SAB0600 IC the kit is supplied with all components, including loudspeaker, printed circuit board, a pre-drilled box (95 x 71 x 35mm) and full instructions. Requires only a PP3 9V battery and push-switch to complete. AN IDEAL PROJECT FOR BEGINNERS. Order as XK102

XK113 MW BADIO KIT

Based on ZN414 IC, kit includes PCB, wound aerial and crystal earplece and all components to make a sensitive miniature radio. Size: 5.5 \times 2.7 \times 2cms. Regulres PP3 9V battery. IDEAL FOR BEGINNERS. £5.00

COMPONENT PACKS

PACK 1 650 Resistors 47 ohm to 10 Mohm - 10 per

PACK 1 650 Resistors 47 ohm to 10 Mohm — 10 per value £4,00

PACK 2 40 × 16V Electrolytic Capacitors 10μF to 1000μF — 5 per value £3.25

PACK 3 60 Polyester Capacitors 0.01 to 1μF/250V — 5 per value £5.25

PACK 4 45 Sub-miniature Presets 100 ohm to 1 Mohm — 5 per value £2.90

PACK 5 30 Low Profile IC Sockets 8, 14 and 16 — pin — 10 of each £2.40

PACK 6 25 Red LEDs (5mm dia,) £1.25

MINI KITS

MK1 TEMPERATURE
CONTROLLEVTHERMOSTAT
Uses LM331 IC to sense temperature (80°C max.) and triac to switch leater. 180°C max. 180°C m

LCD 31/2 DIGIT MULTIMETER

It renges including DC voltage (200 mv-1000 v) and AC voltage, DC current (200 mA-10 A) and resistence (0-2 M) + NPN & PNP transistor gain and diode check. Input Impedance 10M. Size 155x88x31 mm. Requires PP3 9 battery. Test leads included

ELECTRONIC LOCK KIT XK101

This KIT contains a purpose designed lock IC, 10-way keyboard, PCBs and all lock IC, 10-way keyboard, PCBs and all components to construct a Digital Lock, requiring a 4-key sequence to open and providing over 5000 different combinations. The open sequence may be easily changed by means of a prewired plug. Size: 7 x 6 x 3 cms. Supply: 5V to 15V d.c. at 40uA. Output: 750mA max. Hundreds of uses for doors and garages, car anti-theft device, electronic equipment, etc. Will drive most relays direct. Full instructions supplied. tions supplied. ONLY £10.50

Electric lock mechanisms for use with latch locks and above kit £13.50

Have you got our FREE ORANGE CATALOGUE yet? NO?! Send S.A.E. 6" + 9" TODAY!!

It's packed with details of all our KITS plus large range of SEMICONDUCTORS including CMOS, LS-TTL, linear, microprocessors and memories, full range of LEDs, capacitors, resistors, hardware, relays, switches etc.

We also stock VERO and Antex products as well

as books from Texas Instruments, Babani and Elektor ALL AT VERY COMPETITIVE PRICES.

ORDERING IS EVEN EASIER — JUST RING THE NUMBER YOU CAN'T FORGET FOR PRICES YOU CAN'T RESIST.

5-6-7 8-9<u>-10</u>

and give us your Access or Barclaycard No or write enclosing cheque or postal order. Official orders accepted from schools, etc. hdd 55p postage & packing +15% VAT to total Overseas Customers; Add £2,50 (Europe), £8.00 (elsewhere) for p&p Send & A.E. for further STOCK DETAULS. Goods by return subject to availability.

Answering service evngs & weekends

DISCO LIGHTING KITS

Dt 1000K
This value-for-money kit features a bi-directional sequence and frequency of direction change, being variable by means of potentiometers and incorporates all master dimming control



DLZ100K DIZ100K
A lower cost version of the above, featuring undirectional channel sequence with speed variable by means of a pre-set pot. Outputs switched only at mains zero crossing points to reduce radio interference to a minimum.

Optional opto Input DLA1 owing audio ("beat") -light response.

Only £8.00

This 3 channel sound to light kit features zero voltage switching, automatic level control & built in mic. No connections to speaker or amp required. No knobs to adjust – simply connect to mains supply & lamps (1Kw/Channel) Only £11.95

ST SERVICE TOP QUALITY LOW LOW PRICES No circuit is complete without a call to-

ELECTRONICS

11 Boston Road London W7 3SJ



TEL: 01-567 8910 ORDERS
01-579 9794 ENQUIRIES
01-579 2842 TECHNICAL AFTER 3PM

OPEN 1 Sem to Spm (Mon to Fri) EXCLUDE VAT

HE

ALL

PRICES

MINI-MULTI TESTER Deluxe pocket size precision moving coil instrument, Jewelled bearings - 2000 o.p.w.mirrored scale.

11 Instant range measures:

DC volts 10, 50, 250, 1000.

AC volts 10, 50, 250, 1000.

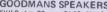
DC amps 0 – 100 mA.

Continuity and resistance 0 - 1 meg ohms in two ranges, Complete with test procs and instruction book showing how to measure capacity and inductance as well, Unbelievable value at only £6.75 + 60p post and insurance.

end insurance.
FREE Amps range kit to enable
you to read DC current from 0 10 amps, directly on the 0 - 10
scale, it's free if you purchase
quickly, but if you already own a
Mini-Tester and would like one,
send £2.50.

SUPER HI-FI SPEAKER CABINETS

Made for an expensive HI-FI outfit Made for an expensive HI-FI outfit—will suit any decor, Resonance free, Cut-outs for 6½" woofer and 2½" tweeter. The front material is Dacran. The completed unit is most pleasing, Supplied in pairs, price £6.90 per pair (this is probably less than the original cost of one cabinet) carriage £3.00 the pair.





VENNEH TIME SWITCH

Mains operated with 20 amp switch, one on and one off per 24 hrs. repeats daily automatically correcting for the lengthening or shortening day. An expensive time switch but you can have it for only £2.95. These are without case, but we can supply a plastic base £1.75 or metal case £2.95. Also available is adaptor kit to convert this into a normal 24 hr, time switch but with the added advantage of up to 12 on/offs per 24 hrs. This makes an ideal controller for the immersion heater. Price of adaptor kit is £2.30.

THERMOSTAT ASSORTMENT

THERMOSTAT ASSORTMENT

10 different thermostats. 7 bi-metal types and 3 liquid types,
There are the current stats which will open the switch to protect
devices against overload, short circuits, etc., or when fitted say
in front of the element of a blow heater, the heat would trip
the stat if the blower fuses; appliance stess, one for high temperatures, others adjustable over a range of remperatures which
could include 0 – 100°C. There is also a thermostatic pod which
can be immersed, an oven stat, a calibrated boiler stat, finally an
ice stat which, fitted to our waterproof heater element, up in the
loft could protect your pipes from freezing. Separately, these
thermostats could cost around £15,00 -- however, you can have
the parcel for £2.50.

50 THINGS YOU CAN MAKE

Things you can make include Multi range meter, Low ohms tester, A.C. amps meter, Alarm clock, Soldering Iron minder, Two way telephone, Memory jogger, Live line tester, Continuity checker, etc., etc., and you will still have hundreds of parts for future projects. Our 10 Kg parcel contains not less than 1,000 Items - panel meters, timers, thermal trips, relays, switches, motors, drills, taps, and dies, tools, thermostats, colls, condensers, resistors, neons, earphone/microphones, nicad charger, power unit, multi-turn pots and data on the 50 projects.

YOURS FOR ONLY £11.50 plus £3.00 post.

EXTRACTOR FANS

Plannair extractor £6.50. Post £1.25.



ROTARY WAFER SWITCHES

Two wafer type, 59p each, as follows
2 pole 12 way
6 pole 2 way
8 pole 3 way 4 pole 6 way 12 pole 2 way

3 wafer types, 99p each 9 pole 4 way 6 pole 6 way 18p 2 way

EXTRA POWERFUL 12v MOTOR

Made to work battery lawnmower, this probably develops up to ¼ h.p., so it could be used to power a go-kert or to drive a compressor, etc. etc. £6.90 + £1.50 post.
(This is easily reversible with our reversing switch - Price £1.15).

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



POPULAR PROVEN PROJECTS

MULTI-CHANNEL or ROBOT CONTROLLER This is two kits. The 8 channel transmitter kit and the 8 channel receiver kit. Each kit comes with diagrams and notes, but no circuit boards, the component leyout being left to you.

ws how to drive, reverse and steer tw motors. With spare channels to perform other functions. Price £9.50 for both kits.

3 CHANNEL SOUND TO LIGHT KIT



Complete kit of parts for a three channel sound to light unit controlling over 2000 watts of lighting. Use this at home if you wish but it is plenty rugged enough for disco work. The unit is housed in an attractive two-tone metal case and has controls for each channel, and a master on/off. The audio input and output are by X" sockets and three panel mounting fuse holders provide thyristor protection. A four-pin plug and socket facilitate ease of connecting lamps. Special price is £14,95 in kit form or £25.00 assembled and tested. Case & metal Chassis No. Fully punched and prepared.

WHY BE COLD - Build a tangential blower heater.

TANGENTIAL BLOW HEATER

2.5 Kw quiet, efficient instant heating from 230/240 volt mains, Kit consists of blo strated, 2,5 Kw



ntrol switch and data all for £4.95, post £1,50,

CAR STARTER AND CHARGER KIT

In an emergency you can start car off mains or bring your battery up to full charge in a couple of hours. The kit comprises: 250 watt mains transformer, 40 amp bridge rectifier, start/charge switch and full instructions. You can assemble this in the evening, box it up or leave it on the shelf in the garage, whichever sults you best. Price £12.50 + £3.00 post.

TRANSMITTER SURVEILLANCE

Tiny, easily hidden but which will enable conversation to be picked up with FM radio. Can be made in a matchbox — all electronic parts and circuit. £2.30.(not licenceable in the U.K.).

RADIO MIKE

Ideal for discos and garden parties, allows complete freedom of movement. Play through FM radio or tuner amp, £6.90 complete kit, (not licenceable in the U.K.)

FM RECEIVER

Made up and working, complete with scale and pointer needs only headphones, ideal for use with our surveillance transmitter or radio mike. £5.85. or kit of parts £3.95.

3 - 30v VARIABLE VOLTAGE POWER UNIT

With 1 amp DC output, for use on the bench, students, inventors, service engineers, etc. Automatic short circuit and overload protection. In case with a volt meter on the front panel. Complete kit £13.80.

INTERRUPTED BEAM

This kit enables you to make a switch that will trigger when a steady beam of infra red or ordinary light is broken. Main components — relay, photo transistor, registors and capacitors, etc. Circuit diagram but no case. Price 22:30.

IONISER KIT

Refresh your home, office, shop, work room, etc. with a negative ION generator. Makes you feel better and work harder — complete mains operated kit, case included. £11,95 plus £2.00 post.

RADIO STETHOSCOPE

Easy to fault find — start at the aerial and work towards the speaker — when signal stops you have found the fault. Complete kit £4.95.

INVISIBLE AND SILENT SENTINEL

Ultra-sonic beam when broken could warn you of visitor—transmitter & receiver, To operate light or bell. £9.50. - two kits

BURGLAR ALARM

Complete kit includes 6" extrenel alarm bell, mains power unit, control box with keyswitch, 10 window/door switches, 100 yards of wire. With instructions. £29.50,

12v MOTOR BY SMITHS

Made for use in can, these are a wound and they become more powerful as load increases. Size 3 %" long by 3" dia. These have a good length of %" spindle — price £3.5.5. Ditto, but double ended £4.25.

Ditto, but permanent magnet, £3.75. WATERPROOF HEATING WIRE

60 ohms per yard, this is a heating element wound on a fibre glass coil and then covered with p.v.c. Dozens of uses — around water pipes, under grow boxes in gloves and socks. 23p a metre.

J. BULL (Electrical) Ltd. (Dept. HE), 34—36 AMERICA LANE, HAYWARDS HEATH, SUSSEX RH16 30U 30 YEARS

MAIL ORDER TERMS: Cash, P.O. or chaque with order. Orders unde £10 add 60p service charge. Monthly account orders accepted from schools and public companies. Access & 8/card orders accepted day or night. Haywards Heath (0444) 46563. Bulk orders: write for quote. Delivery by return. Shop open 9.00 — 5.30, mon to Fri, not Seturday.

SCHOOLS-LABS-STORES-WORKSHOPS-FACTORIES-

Your chance to re-stock at less than cost prices!!!

LIGHTING & POWER CARLES

FIGHTING & LOWEL	ICADELO		
Copper clad, PVC sheathed.	Made by Volex to BSS		
1.5mm single	per 100 metres	£2.00	
1.5mm flat twim	per 100 metres	£3.50	
1,5mm flat 3 core & E	per 100 metres	£5.50	
4mm single	per 100 metres		
6mm flat 3 core	per 100 metres	£27.50	
16mm flat twin & E	per 100 metres	£47.50	
Telephone and multiway cables, Reliance as used by GPO.			
15 core	per 200 metres	£60.00	
10 core	per 200 metres	£40.00	
THE DALOGT ATO SHIE AT CHILTOHEC			
THERMOSTATS & HEAT SWITCHES			
Thermostat: 3 level contact type			

Thermostat: 3 level contact type . 10 amp appliance type thermostat. Spindle adjust . Contact type with changeover, 10 amp switches, 0 - 100°C Wall mounting, metal case, c/o contacts low voltage .

TIMERS & CLOCKSWITCHES				
Time and Set Switches, Smiths, Glass fronted :	25 amp,	230v	£2.30	
24 Hour time switch, 100 amp Smiths and clo	ckwork			
reserve. Ex-Electricity Company			£5.50	
Cooker clock switch. Smiths 12 hour			£1.00	
Clockwoek operated switches:				
15 amp, 230v. On time up to:				
10 minutes £1.37 120 minutes			£1.37	
30 minutes £1.37 360 min	utes .			
OMRON mini-timer, ref, STP NH			£3.50	

£2 30

.20 .25 .15

20

.30 .65

.50 .50 .10

.50

BLEEPERS - SIRENS - BELLS - BUZZERS	
Siren/Hooter - Delta 6 or 12v DC or 24v AC	
Open type buzzer, ex GPO, 10 - 20V	
Underdome bell, 4v - 9v	
COUNTERS	

Oddit Counter. Mains operated. Not resettable Ditto, But even numbers only 6 digit counter. 48v OC, 115v AC, Resettable

SWITCHES - ROCKER, TOGGLE, ETC.				
Rocker switches: white push into hole 1" x 7/16", All rated				
10 amp, AC 250 volt. on/off			.12	
changeover centre off			.15	
on/off with neon	-		.30	
push to make spring return			.20	
. push to break spring return			.20	
			.20	
13 amp rocker switch, Car Fastener (DoT)				
			.30	
Interlocking switch: blow heater, 3 rockers, 10 amp				

13 amp rocker switch. Car Fastener (DoT)
Pistol Grip Switch: with lock-on as in electric drills
Interlocking switch: blow heater, 3 rockers, 10 amp
Micro switches, V3 types, 10 amp c/a contacts
mains button operated:
15 amp c/a contacts
10 amp off/on
15 amp off/on Lever operated add .
Lever with roller operation add
Miniature types: Burgess V4T6 c/o
Two mounted with roller operator
Glass reed switches: 60 watt 10p. 40 watt 5p.
flat multi stackable 60 watt
Operating coils for reed switch multi voltage 3, 8, 9, or 12
Ceramic magnets Multard
Mini Magnet . Lever operated add

MISCELL ANEOUS ITEMS

Neon Mains indicators. Standard	.15
Extra small ,	.25
Bench isolation mains in 230/240v output, 250 Watts	£4.50
Mains input. Porcelain removable fuse	.20
Light operated switch 12 volt. Encapsulated	
Insulating board, srbp etc. Approx 10 tons, Sheet size 4'x 4'	
or larger, Various thicknesses, price per lb	.50
Dieto Tufnol price per lh	£2 00

Ditto, Turnol, price per lb. Aerosol can ICI Fluon flubricant Varicap P.B. TV tuner Battery holder takes 6 U2 batteries, snap connector Car Battery clips, as for charger, 4 and —, per pair MAINS TRANSFORMERS

35 volt 2 amp . 38 volt 2½ amp . 26 volt 10 amp . 50 volt 2 amp . 12 · 0 · 12, 2 amp 12 · 0 · 12, 1 amp 100W auto 115v o £2.00 £2.50 £4.00 £2.00 6 volt 1 amp 6.3 volt 2 amp50 £1.00 12 volt ½ amp 12 volt 4 amp 12 volt 1 amp 8.5 - 0 - 8.5 1 amp £2.00 £1.00 £1.00 18 volt 1 amp

20 AOUT IN BUILD	E1.50	
MOTORS - MAINS 8	BATTERY	
3 - 6 volt bettery motor, ver	ry small	.15
3 - 12 volt bettery motor, v	ery low current	.20
Mains motor with gear box	. 5 rev minute ,	£2.25
	80 rev per minute	€3.00
	110 rev minute	€2.00
	200 rev minute	£1.50
Mains motor, double ended	fan motor	£1.20
Ditto single ended i	an motor	£1.00
Fan blade for above .		.50
Mains motor, double ended	, very powerful 11/2" stack	£1.50
Mains instrument motors	J ray 24 hours	£1.50
with gear box:	1 rev 1 hour	£1.50
3	16 rev minute	£1.50
	4 rev minute	£1.50
	2 rev minute	£1.50

Motor clockwork, set up to 1 hour with ringer Motor, clockwork set up to 1 hour with ringer Malis motor X h.p. 1425 revs, ex-computer Vent opening motor with end stop switches 12 volt motors, Smiths, single ended X" spindle 12 volt motors, Smiths, double ended X" spindle 12 volt motors, P magnet type, single ended 1% h.p. motor 3450 rpm 100 volt, 50 Hz. New .75 £4.25 £12.50 £1.50 £2.00 £1.75

SPECIAL TERMS. For items in this column. Order no less than 10 of any item. Then add VAT at 15%, and 20% for carriage in the case of transformers and electric motors. All other items in this column are free post & packing.

Pop Amps

We do not usually give sources of supply for the components used in these simple projects because they are generally easily available! This month though, there are several that are a little hard to get hold of. These are: the ZN423 precision voltage reference, the 7611 CMOS op-amp (used in the Linear Ohmeter, Pop Amps No.6) and the 334Z programmable current source used in the Low Range Ohmeter (Pop Amps No.7).

The calibration resistors for the Linear Ohmeter should ideally be 0.4 watt 1% tolerance metal film types, for best accuracy, and these are not stocked by every supplier either. The values required are 8k2, 82k, 820k and 8M2, though lower values in each range would do at a pinch. Fortunately, though, almost all of these components are stocked by Rapid Electronics.

Loudspeaker Protector

The difficult items in this project are the 1N5349B 12V/5W Zener diode and the TIP31C transistor; note that a TIP31A will not do, here! Also, the 12V PCB mounting relay and the 2k2 2.5W resistor may be somewhat hard to

locate; a 5W resistor will do instead. You may find all these at your local supplier or in your favourite catalogue but if not, try Watford Electronics or MS Components, who stock all the hard to find items. MS Components are at

Zephyr House, Waring Street, West Norwood, London SE279LH, 'phone 01-670 4466.

Since the Protector circuits are designed to fit into the loudspeaker cabinets, cases are not required and the cost should be in the region of £6.00. excluding the price of the PCB.

CHECK LIST

RESISTORS

(All 1/4 watt 5% unless noted) x 47R; 1 x 2k2, 2.5W or greater; x 47k; 2 x 100k; 3 x 470k; 1 x 220k; 1 2M2; 1 x 10M. **POTENTIOMETERS**

x 20k miniature carbon trimpot. CAPACITORS

1 x 1000u 25V axial electrolytic; 2 x 220n polyester. SEMICONDUCTORS

1 x CD4050; 1 x TIP31C; 1 x 1N5349B; 4 x 1N4004; 4 x 1N914, 1N4148 etc. MISCELLANEOUS 1 x 12VDC PCB relay; PCB, wire, solder

Overvoltage Cut-Out

Once again, there are a couple of hard to get items; the 2N3904 transistor. which is however stocked by Electro-Value, and the 2N6403 SCR, which appears to be available only from Ambit. However, Greenweld stock a suitable substitute for the SCR (the C126M, rated at 12A and 400V PIV) and also the last awkward item, the OR47 5 watt resistor; thus they are a convienient source for all the components used in this project.

The cost of this project excluding the PCB should be about £3.50; a suitable two-part aluminium case can be had for around £1.00.

CHECK LIST

RESISTORS

(All ¼ watt 5% carbon unless noted) 1 x 2k2; 2 x 22k; 1 x 5k6; 1 x 2M2; 1 x 330R; 1 x 330R; 1 x 0R47 5W 10%. CAPACITORS

x 10u 25V axial electrolytic. SEMICONDUCTORS

1 x 2N3904; 1 x CA3140; 1 x 2N6403 or C126M; 1 x BZY88C6V8; MISCELLANEOUS

Chassis mounting 20mm fuse holder; 20mm quickblow fuse, current rating as required; input and output terminal; optional case (as above); mounting fixings, PCB, wire, solder etc.

ELECTRONIC COMPONENTS AND TEST EQUIPMENT 35, HIGH BRIDGE, NEWCASTLE UPON TYNE NE1 1EW TEL: 0632 326729

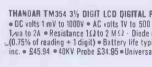


SAFGAN OSCILLOSCOPES— 5 mV/div sensitivity. Choice of Bandwidth 10, MHz, 15 MHz, 20 MHz. 18/div-100n S/div. Calibrated timebase. Solid trigger with bright line auto, normal and TV. XY facility. Z modulation. Calibration output. Bright and clear display. Portability.

■ Model DT410-10 MHz £205.85.

Model DT415-15 MHz £217.35.

■ Model DT420 20 MHz £228.85. Send S.A.E. FOR FULL spec.





KD55C LCD DIGITAL MULTIMETER

■ 31 digit ← Auto zero ← Auto polarity ← Full overload protection ● 10 MegΩ input impedance ● Over range and low battery indication ● DC volts 200 mV-700 V 5 ranges ● AC volts 200 mV-700 V 5 ranges ● DC current 200 μa 10 A 6 ranges ● AC current 200 μa 10 A 6 ranges ● Resistance 200 Ω-200 MegΩ ● Complete with battery, test leads, spare fuse and carrying case f33 95

THANDAR SC110 SINGLE TRACE LOW POWDER 2 HANDAR SCHO SINGLE TRACE LOW POWDER 2"

DSCILLOSCOPE • Bandwidth DC to 10 Mhz • Sensitivity: 10mV/
div to 50 V/div. • Sweep speeds: 0.1,u secs / div to 0.5 secs/div.

Power requirements 4-10 V DC 4 "C" cells: Size & weight

255 x 150 x 40mm: 800gms £171.35 a truly portable and superb
instrument • Carrying case £8.86 • AC Adaptor £5.88 • Nicad Batt.
pack £8.83 • x1 probe £9.78 • x10 probe £11.50 Complete range of
Thandar instruments available from stock S.A.E. for CAT. & prices.











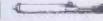


G.S.C. SOLDERLESS BREADBOARDS • Accepts all components with

SABTRONICS LCD MULTIMETER MODEL 2033. • DC volts 100 uV-1000V Accuracy ± -5% • AC volts 100, vV-1000 V Accuracy ± 11/4 • DC current 10, uA-2A Accuracy ± 1% • AC current 10, uA-2A Accuracy ± 1% • Resistance 1Ω-20 MΩ Accuracy ± 1% • \$42.27. • Please send 30p for full Sabtronic catalogue and price list

TMK 500 MULTIMETER • 30 kopv. • AC volts 2.5 10 25 100 250 500 1000V • DC volts 0.25 1 2.5 10 25 10 25 100 250 000 • DC current 50,ua 5MA 50MA 12 amp • Resistance 0-6K 60K, 60 meg. • Decibels • 20 to + 56 d/b • Buzzer continuity test • Size 160×110 ×65 • Batteries and leads inc. £26.95

YN360 TR MULTIMETER • AC volts 10 50 250 1000 • DC volts 0.1, 0.5, 2.5, 10v 150v 250v, 1000v. • DC current 50,ua 2.5 MA, 25MA, 250 MA • Resistance 0-2K 20K 2M Ω , 20 M Ω , • Translator check • DB: -10db -+ 22db £16.95



DESOLDERING TOOL 65.45.



SCHOOLS, COLLEGES, UNIVERSITIES SUPPLIED. PHONE OR SEND YOUR ACCESS OR BARCLAYCARD NUMBER. PRICES INCLUDE VAT. PLEASE ADD 75p POSTAGE TO ORDERS UNDER \$10.00



mail order products for electronic projects

SPECIAL INTRODUCTORY KIT OFFERS

To enable the price conscious enthusiast to be a

PROFESSIONA

Hobbyboard Systems are derivatives from well proven, high quality PCB manufacturing techniques – they produce quality products for technical projects – why settle for less?

PRINTED CIRCUIT TRANSFER & ETCH (KIT HB/1)

A complete kit which includes simple Foil Pattern transfer system, rub down transfers, copper clad PCB and all processing materials and requirements including explicit instructions. (Up to 10 circuits/kit)

Normal Price £15.00

SPECIAL OFFER PRICE £12.00 INCL. VAT

PRINTED CIRCUIT PHOTO RESIST PRINT & ETCH (KIT HB/2)

A complete kit which enables you to make top quality PCB's the professional way, includes full set of artwork aids, photo resist PCB and all process materials and requirements. (Up to 10 circuits/kit)

Normal Price £24.00

SPECIAL OFFER PRICE £16.00 INCL. VAT

DAYLIGHT PHOTOGRAPHIC SYSTEM (KIT HB/3)

Now you can make your own Photopositives and Negatives to professional standards – NO DARKROOM – complete kit with Pos. & Neg. film and all

Normal Price £19.50

SPECIAL OFFER PRICE £13.00 INCL. VAT

PHOTO LABEL & PANEL SYSTEM (KIT HB/4)

Now make professional labels & panels for your project cases – finish the job properly – complete kit includes artwork transfers and materials to print fully laminated Plastic Panels in 5 colours. (Up to 20 labels/kit)

Normal Price £22.50

KITS HB/2, /3, /4 REQUIRE UV EXPOSURE

SPECIAL OFFER PRICE £15.00 INCL. VAT

BUILD YOUR OWN UV UNIT (HB/UV1)

UV Lamp, Holder & Shade supplied with full assembly instructions to build a unit which will give superb results normally only obtained from very high cost systems - FAST EXPOSURES - FINE LINE REPRODUCTION

Normal Price £27.00

SPECIAL OFFER PRICE £18.00 INCL. VAT

Hobbyboard UV ARTBOX (HB/UV2)

A fully built, self-contained artwork table and UV exposure unit – TWO for the price of ONE – EXPOSURE AREA 9" \times 6" – EXCELLENT VALUE

Normal Price £65.00

SPECIAL OFFER PRICE £49.00 INCL. VAT

Even greater savings if you order kits HB2, HB/3 and HB/4 with your new exposure unit KIT HB/5 FULL PHOTO KIT - £60.00 INCL. VAT KIT HB/6 FULL PHOTO KIT - £90.00 INCL. VAT

ORDER FORM (Cheques or Postal Orders only please for Special Offers)

Please send me the following as quickly as possible DESCRIPTION PriceCat. TOTAL KITHB/1-PCBTRANSFER&ETCHKIT-£12.00-£16.00-KITHB/2-PCBPHOTORESISTKIT-KITHB/3-DAYLIGHTPHOTOKIT-C13.00-KITHB/4-PHOTOLABEL/PANELKIT-£15.00-KITHB/5-FULL UV/1 PHOTOKIT-260.00-KITHB/6-FULLUV/2PHOTOKIT-590.00-HB/UV1-DIYUVEXPOSUREUNIT-£18.00 -£49.00-HB/UV2-HobbyboardUV ARTBOX-TOTAL Name P&P 03:0 3

> Cheque/PO£ Please Send further details



KELAN (Hobbyboard)

North Works, Hookstone Park, Harrogate, North Yorkshire. **常 0423-883672**

A division of Kelan Engineering Ltd.

HE/383





7 HUGHENDEN ROAD, HASTINGS. SUSSEX, TN34 3TG Telephone: HASTINGS (0424) 436004

ELECTRONIC KITS

Post & Packing 50b, for KS kits, 75p for UK kits, £1.00 for Cabinets, Send 20p S.A.E. for catalogue of our extensive range of kits & Cabinets. Trade, Educational & Export enquiries



KS 100 Mini VHF St 88-108 MHZ 9V D.C.



S 200 Mini F.M. transmitter 88-108 MHZ 9V D.C. (Not Ilcenceable in U.K.) £7.37 inc. V.A.T.



UK 108
Miniature F.M. transmitter,
Not licenceable in U.K.
£9,46 inc. V.A.T.



KS 370
2 Tone Siren, output 10W at 4 ohm, 6W at 8 ohm, 100 DBM
65.27 Inc VAT



UK 875 pacitive Discharge Electronic Ignitio



UK 150 Amplifier Output Voltmeters (Mono & Stereo) £9.46 inc VAT



UK 114/U 20W Integrated Circuit Amplifier, reg 32V D.C. power £8.42 inc VAT



UK 232 Antenna tenna Amplifier AM/FM £5.27 Inc VAT



UK 602/U MW-LW Radio Receiver £7.37 inc VAT



KS 272 6 Chan High Power VI 300W per chan £15.79 inc VAT VU Unit



UK 11/W Electronic Siren (read assembled) 12V DC £10.52 Inc VAT



KS 142 LED VU Display 0.3V-1.3V, 6-12V D.C. £9.12 Inc VAT





UK 568 600MHZ Prescaler £28.42 inc VAT



operated sound to light, 300W per channel, 240V A.C. £11.58 inc. V.A.T.





KS 260 3 channel chase light, 1KW per channel, 240V A.C. £10.52 inc. V.A.T.



KS250 12V-0.5A stabilized power supply £7.37 inc. V.A.T.



KS 490 Nicad battery charger, 10-20 45-150 mA, 15V D.C. max 240V A.C. £8.42 inc, V.A.T.



Digital tuning indicator £37.88 inc. V.A.T.



KS 420 Digital D.C. voltmeter, 999MV-999V, 0.5V D.C. £17.89 Inc. V.A.T,



300 Westminster chimes, (Big Ben) £9,48 inc. V.A.T.

Instrument Cabirro. W 82mm, L 145m £5.27 inc VAT



UK 562 Transistor and diode tester £14.73 Inc. V.A.T.



KS 165 Dusk Switch 9V D.C. Itches 240V-5A | £12.63 inc VAT



3005-70 Instrument Cebinet, H 68mm, W 263mm, D 216mm £11.58 inc VAT All aluminium



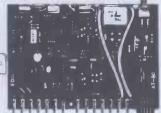
3003-00 Heat Sink Box, H 78m 72mm, L 143mm £5.00 inc VAT

Address

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

NOW AVAILABLE IN KIT FORM





SX1000

Inductive Discharge

Extended coil energy storage circuit

Contact breaker driven
Three position changeover switch

Over 65 components to assemble Patented clip-to-coil fitting Fits all 12v neg. earth vehicles

AT-80 **Electronic Car Security System**

- Arms doors, boot, bonnet and has security loop to protect

VOYAGER Car Drive Computer

 A most sophisticated accessory.
 Utilises a single chip mask ● A most sophisticated accessory. ● Utilises a single chip mask programmed microprocessor incorporating a unique programme designed by EDA Sparkrite Ltd. ● Affords 12 functions centred on Fuel, Speed, Distance and Time. ● Visual and Audible alarms, warning of Excess Speed, Frost/Ice, Lights-left-on. ● Facility to operate LOG and TRIP functions independently or synchronously. ● Large 10mm high 400ft-L fluorescent display with auto intensity. ● Unique speed and fuel transducers giving a programmed accuracy of + or −1%. ● Large LOG & TRIP memories. 2,000 miles. 180 gallons. 100 hours. ● Full Imperial and Metric calibrations. ● Over 300 components to assemble. A real challenge for the electronics enthusiast!





TX1002 **Electronic Ignition Electronic Ignition**

- Contactless or contact triggered
 Extended coil energy storage circuit
 Inductive Discharge
 Three position changeover switch
 Distributor triggerhead adaptors included Die cast weatherproof case Clip-to-coil or remote mounting facility Fits majority of 4 8 6 cyl. 12V. neg. earth vehicles Over 145 components to assemble.



TX2002

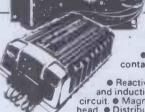
Electronic Ignition





- The brandleading system on the market today
- Unique Reactive Discharge Combined Inductive and
- Capacitive Discharge Contact breaker driven
- Three position changeover switch Over 130 components to assemble

- Patented clip-to-coil fitting Fits all 12v neg. earth vehicles



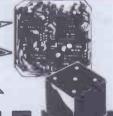
● The ultimate system ● Switchable contactless. Three position switch with Auxiliary back-up inductive circuit.

Reactive Discharge. Combined capacitive

- Reactive Discharge. Combined capacitive and inductive.
 Extended coil energy storage circuit.
 Magnetic contactless distributor triggerhead.
 Distributor triggerhead adaptors included.
 Can also be triggered by existing contact breakers.
 Die cast waterproof case with clip-to-coil fitting
 Fits majority of 4 and 6 cylinder 12v neg. earth vehicles.
 Over 150 components to assemble

All SPARKRITE products and designs are fully covered by one or more World Patents

FREE" MAGIDICE KIT WITH ALL ORDERS OVER £45.00



MAGIDICE **Electronic Dice**

- Not an auto item but great fun for the family
 Total random selection
 Triggered by waving of hand over dice
 Bleeps and flashes during a 4 second tumble sequence
 Throw displayed for 10 seconds
 Auto display of 1 ast throw 1 second in 5
 Muting and Off switch on base
 Hours of continuous use from PP7 battery
 Over 100 components to assemble

SPARKRITE 82 Bath Street, Walsall, West Midlands, WS1 3DE England.

Tel: (0922) 614791 Allow 28 days for deliver

		SELF ASSEMBLY KIT
	SX 1000	£12.95
	SX 2000	£19.95
	TX 1002	£22.95
	TX 2002	£32.95
	AT 80 .	£32.95
	VOYAGER	£64.95
į	MAGIDICE	f9.95

PRICES INC. VAT. POSTAGE & PACKING

NAME ADDRESS _ I ENCLOSE CHEQUE(S)/POSTAL ORDERS FOR KIT REF. CHEQUE NO.



BRANDLY ADING BRITISHELECT PO

CUT OUT THE COUPON NOW!

Still half full of Christmas Spirit, CD attempts to answer another motley selection of reader's letters.

Christmas comes but once a year . . . fortunately. Letters like this next one arrive more frequently, though.

Dear CD.

I am writing to ask you this question: what are the units of conductance?

If you cannot answer the question then I think that a binder would compensate me, don't you? Yours hoping that you don't answer, A. Sutton, Rishton,

Lancs. PS I'm trusting you not to consult a dictionary, nor to ask anybody else. Don't cheat!

Who needs a dictionary? The unit of conductance, as you seem to know already, is the 'mho'; that is, the inverse of resistance which is measured in 'ohms'. Get it? Good.

The author of the next letter receives the CD Bright Idea award . . . a very large raspberry.

Dear Clever Dick, I think HE is fantastic, brilliant, clever etc. BUT your printers are chronic. Here is a solution (how about a binder?): rebuild all your projects after the designs have been mangled by the printer, ie build them from the finished article. M. Cummings, Chepstow, Gwent.

Well . . . yes. It sounds like a good idea, in theory. Unfortunately, it just can't be.

First, though, any errors which occur in HE are certainly not the fault of our printers. We manage them ourselves, thank you very much! Second, the editor takes every precaution to catch errors in circuits or projects before the issue is sent to the printers. Last, your suggestion is impractical for the simple reason that it is far, far too late to correct errors which are found only after tens of thousands of copies of the magazine have been printed!

And if there was an award for Dumb Letter of the Month, this next one would win hands down . .

Dear Clever Dick. I was wondering if you could tell me whether or not it would be safe to wire a single-wired intercom, that is mains operated, through the earth of the mains

Could you also please tell me where I could buy an Eagle LT700 transformer and the ZN414 silicon chip?

S. Williams, Keighley, West Yorks. PS Is it true that the OC71 transistor is going out in place of the AC128?

Is this man winding me up?

On the basis of the information supplied, I can only reply - No! Better to be safe than sorry, you see. (I'm tempted to say "yes" but I do hate to lose readers!).

For the transformer, why don't you try Eagle International? Their address is: Precision Centre, Heather Park Drive, Wembley HAO 1SU. The telephone number is 01 902 8832. The ZN414 is widely available from most of the compenent suppliers advertising in Hobby Electronics. . . TK Electronics, for example.

As usual, the subject of my precious binders arises once more. Anybody would think I had thousands to spare!

Dear Clever Dick, Would you mind telling me who I could send off to, and how much I would pay if I actually want to (wait for it . . .) BUY a HE binder!? It's all very well you sitting there with your pile of binders, carelessly discarding them in the direction of grovelling electronics enthusiasts when the whim takes you; how about telling us unfortunate and wretched beings how we can obtain these priceless gems to keep our equally priceless HEs in without grovelling to some anonymous "wit"

Incidentally, I've been buying HE regularly since February 1979 and I desperately need some binders - how about sending me one immediately (and free) so I don't have to bother to write off again? P. Spring,

Bath, Avon.

PS Notice the lack of scrounging, squirming, crawling, truckling, scraping and fawning (and any other nasty words of such like meaning) in this letter.

Of one thing I can assure you: my binders are never discarded "carelessly", or on a whim!

Astute readers may have noticed in last month's issue, that I have actually agreed (under considerable pressure, it must be said) to award one of my blue and gold masterpieces free of charge to any reader clever enough to fill out a subscription form for Hobby Electronics.

And now for something a little more exotic, to borrow a phrase.

Clever Dick Sir.

I am a guitar player in a rock group and would like to build a radio transmitter/receiver for use with my

instrument, as I and many other quitarists are tied to our equipment by leads, cables etc.

Commercially I fear, those units are very expensive (hundreds of pounds) and I would be very pleased if you have any ideas or could put me in touch with anyone who has plans for such a project.

Finally, would I have to apply for a licence, as the range would only need to be approximately 100 ft? E.C. Mountford, Stone, Staffs.

I felt this question required an expert answer, so I contacted Mr. Steve Stow of Martellow Sound Ltd., manufacturers of the popular 'Rello' range of radio mics.

First, a licence is required to operate any such system and will only be issued for Home Office approved equipment. This means it is most unlikely that you will ever see a radio mic system project.

Second, it is virtually impossible to design a guitar transmitter/receiver system at a reasonable price, that will satisfy all guitarists. Any inexpensive system must incorporate a limiter. making it unrealistic for those players who use a wide dynamic range (a system that did not use limiting would cost over £1000!).

However, Martello will shortly be releasing a new narrow-band system designed primarily for speech transmission. It will be shown at the annual APRS event in June '83 and will retail for approximately £299 plus VAT. Martello Sound will be able to supply individual modules at a slightly lower price to anyone who wishes to experiment. See you at the APRS?

I'm continually amazed by the poetic nature of some of my fans. Not so much by their poetry, though.

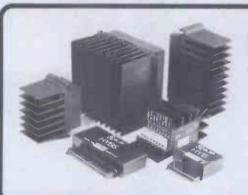
Dedicated to Seedy.

Being a nice sort of fellow I'm sure you will oblige, Now that I've forty issues Down in a scruffy old drawer, Eventually they're going to get torn, Rendering them pretty messed up.

But you have just the cure, If only you'll read from the top, Next to the left hand side Downwards towards the bottom, Ending then starting again; Read carefully and you will see the perfect cure for me!

The Poet, C/O S.A. Lilleyman, Sale, Cheshire.

I hate to be seen to encourage any more of this appalling stuff, but it is the cleverest letter of the month - not that that's saying very much. You win. The Binder is presently being despatched.



P Modular **Amplifiers** the third generation

Due to continous improvements in components and design ILP now launch the largest and most advanced generation of modules ever.



WE'RE INSTRUMENTAL IN MAKING A LOT **OF POWER**

In keeping with ILP's tradition of entirely self-contained modules featuring, integral heatsinks, no external components and only 5 connections required, the range has been optimized for efficiency, flexibility, reliability, easy usage, outstanding performance, value for money.

With over 10 years experience in audio amplifier technology ILP are recognised as world leaders.



ВІ	P	٥L	A	R	М	0	D	U	L	E	S

Module Number	Output Power Watts rms	Load Impedance	T.H.D. Typ at 1KHz	I.M.D. 60Hz/ 7KHz 4:1	Supply Voltage Typ	Size	WT	Price inc. VAT
0.730	15	4-8	0,015%	<0.006%	± 18	76 x 68 x 40	240	£8.40
HY60	30	4-8	0.015%	< 0.006%	± 25	76 x 68 x 40	240	£9.55
11745060	30 + 30	4-8	0.015%	< 0.006%	± 25	120 x 78 x 40	420	£18,69
HY124	60	1	0.01%	< 0.006%	± 26	120 x 78 x 40	410	£20.75
HY128	60	8	0.01%	< 0.006%	± 35	120 x 78 x 40	410	£20.75
HY244	120	4	0.01%	< 0.006%	± 35	120 x 78 x 50	520	£25.47
HY248	120	8	0.01%	< 0.006%	± 50	120 x 78 x 50	520	£25.47
HY364	180	1	0.01%	< 0.006%	±.45	120 x 78 x 100	1030	£38.41
HY368	180	В	0.01%	<0.006%		120 x 78 x 100	1030	£38.41

Protection: Full load line, Slew Rate: 15v/ps, Risetime: 5ps. S/N ratio: 100db, Frequency response [-3d8] 15Mz = 50KMz. Input sensitivity: 500mV rms. Input Impedance: 100K Ω_{\odot} Damping factor: 100Hz >400.

PRE-AMP SYSTEMS

Module Number	Module	Functions	Current Required	Price inc. VAT
HY6	Mono pre amp	Mic/Mag. Cartridge/Tuner/Tape/ Aux + Vol/Bass/Treble	10mA	£7,60
HY66	Stereo pre amp	Mic/Mag, Cartridge/Tuner/Tape/ Aux + Vol/Bass/Treble/Balance	20mA	£14,32
HY73	Guitar pre amp	Two Guitar (Bass Lead) and Mic + separate Volume Bass Treble + Mix	20mA	£15.36
HY78	Stereo pre amp	As HY66 less tone controls	20mA	£14.20

Most pre-amp modules can be driven by the PSU driving the main power amp. A separate PSU 30 is available purely for pre-amp modules if required for £5.47 (inc. VAT). Pre-amp and mixing modules in 18 different variations. Please send for details.

Mounting Boards
For ease of construction we recommend the 86 for modules HY6—HY13 £1.05 (inc. VAT) and the 866 for modules HY66—HY78 £1.29 (inc. VAT).

POWER SUPPLY UNITS (Incorporating our own toroidal transforme

Price inc. VAT PSU 21X PSU 41X PSU 41X PSU 42X PSU 42X 1 x HY128 PSU 42X 1 x HY128 PSU 51X 2 x HY128, 1 x HY244 £11.93 £13.83 £15.90

Model Number	For Use With	Price inc. VAT
PSU 52X	2 x HY124	£17.07
PSU 53X	2 x MOS128	£17,86
PSU 54X	1 x HY248	£17.86
PSU 55X	1 x MOS248	£19.52
PSU 71X	2 x HY244	£21,75

Module Number	Output Power Watts rms	Load Impedance		RTION I,M,D. 60Hz/ 7KHz 4:1	Supply Voltage Typ	Size	WT gms	Price inc. VAT
MO5 128	60	4-8	<0.005%	<0.006%	± 45	120 x 78 x 40	420	£30.4
MOS 248	120	4-8	< 0.005%	< 0.006%	± 55	120 x 78 x 80	850	£39.8
MOS 364	180	4	< 0.005%	< 0.006%	± 55	120 x 78 x 100	1025	€45.5

Protection: Able to cope with complex loads without the need for very special protection circuitry (fuses will suffice). Slew rate: 20v/ps. Rise time: 3ps. S/N ratio: 100db Frequency response t-38ls: 15Hz -100kHz. Input sensitivity: 500mV rms Input impedance: 100K Ω . Damping factor: 100Hz > 400,

'NEW to ILP' In Car Entertainments

C15

Mono Power Booster Amplifier to increase the output of your existing car radio or cassette player to a nominal 15 watts rms.

Very easy to use.

Robust construction.

£9.14 (inc. VAT)

Mounts anywhere in car.

Automatic switch on.

Output power maximum 22w peak into 4.0. Frequency response (~3d8) 15Hz to 30KHz, T.H.D. 0.1% at 10w 1KHz S/N ratio (DIN AUDIO) 806B, Load Impedance 3.0. Input Sensitivity and impedance (selectable) 700mV rms into 15KΩ 3V rms into 8.0.

Size 95 x 48 x 50mm, Weight 256 gms

C1515

Stereo version of C15.

£17.19 (inc. VAT)

Size 95 x 40 x 80, Weight 410 grns.

For Use With Price inc 2 x H Y 248 1 x H Y 364 1 x H Y 368 2 x M O S 248, 1 x M O S 368

Please note: X in part no. indicates primary voltage. Please insert "O" in place of X for 110V, "1" in place of X for 220V, and "2" in place of X for 240V

WITH A LOT OF HELP FROM DILL P ELECTRONICS LTD

PROFESSIONAL HI-FI THAT EVERY ENTHUSIAST CAN HANDLE...

Unicase

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

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

Because of ILP's modular approach, "open plan" construction is used and final assembly of the unit parts forms a compact aesthetic unit. By this method construction can be achieved in under two hours with little experience of electronic wiring and mechanical assembly.

Hi Fi Separates

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

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

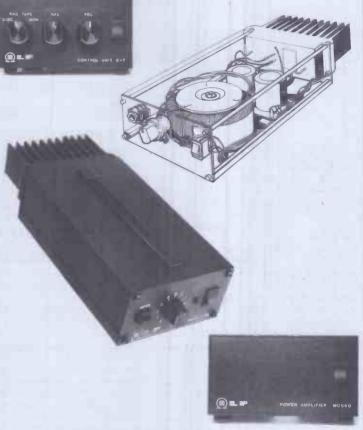
Power Slaves

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

UNICASES

					Price inc.
HIFI Sep	arates				VAT
UC1	Preamp				£29,95
UP1X	30 + 30W/4-8A	Bipolar	Stereo	HiFi	£54.95
UP2X	60W/4Ω	Bipolar	Mono	HiFi	£54.95
UP3X	60W/8 A	Bipolar	Mono	HiFi	£54.95
UP4X	120W/4A	Bipolar	Mono	HiFi	£74.95
UP5X	120W/8 Ω	'Bipolar	Mono	HIFI	£74.95
UP6X	60W/4-8Ω	MOS	Mono	HiFi	£64.95
UP7X	120W/4-8Ω	MOS	Mono	HiFi	£84.95
Power SI	aves				
US1X	60W/4Ω	Bipolar	Power	Slave	£59.95
US2X	120W/4 Ω	Bipolar	Power	Slave	£79.95
US3X	60W/4-8Ω	MOS	Power	Slave	£69.96
US4X	120W/4-8	MOS	Power	Slave	£89.95

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



TO ORDER USING OUR FREEPOST FACILITY

Fill in the coupon as shown, or write details on a separate sheet of paper, quoting the name and date of this journal. By sending your order to our address as shown at the bottom of the page opposite, with FREEPOST clearly shown on the envelope, you need not stamp it. We pay postage for you. Cheques and money orders must be crossed and made payable to I.L.P. Electronics Ltd. if sending cash, it must be by registered post. To pay C.O.D. please add £1 to TOTAL value of order.

PAYMENT MAY BE MADE BY ACCESS OR BARCLAYCARD IF REQUIRED

	REQUIRED	
	Post to Post to ELECTRONICS LTD	: ILP Electronics Ltd, Freepost 6, Graham Bell House, Roper Close. Canterbury, CT2 7EP, Kent, England. Telephone: (0227) 54778. Technical: (0227) 64723. Telex: 965780.
	Please send me the following	
	Total purchase price	
	l enclose Cheque Postal Orders	Int. Money Order
	Please debit my Access/Barclaycard No.	
П	Name	
a	Address	
1	Signature	

THE ELECTRONIC REVOLUTION:

PICTURES FROM AFAR

John Biggins

A GREAT DEAL of the trouble with television in its early days stemmed from the fact that it came so close upon the heels of radio broadcasting. The first publicservice wireless broadcasts took place in the USA late in 1920. Within ten years, the first regular mechanical-scan TV transmissions were being made and at the end of 1936, still a month short of the BBC's fourteenth birthday, the world witnessed the start of the first television service using the all-electronic system which is the direct ancestor of TV as we know it today. All in all, an astonishingly short time-scale when you consider how long it had taken public electricity supply, for instance, to get established in the mid-19th Century.

An amazingly rapid development perhaps, but it was also a remarkably difficult one when you compare it with the birth of sound broadcasting in the years immediately after the Great War. The trouble with television was quite simply that the idea existed long before anyone had much idea of how to put it into practice. With wireless broadcasting it had been the other way around, of course: the basic technology - radio telephony had lain there virtually unnoticed for nearly two decades before the idea had dawned, some time in 1919, that there was enjoyment to be had (and perhaps money to be made) from using it to talk to a mass audience. But, once the idea of sound broadcasting was firmly established, about 1923, people naturally began to wonder why you couldn't broadcast pictures as well.

The problem was that in the early 1920s, no more than a tiny handful of visionaries around the world had even the remotest idea of how this was going to be put into practice. In fact, most of the Informed Opinion in the electronics world thought that if the transmission of moving pictures could be achieved at all (which was far from certain) it would take at least half a century to do it. The next fifteen years were to prove the doubters dramatically wrong, but only at the cost of one near-disastrous false start, great expense, and a legacy of bitterness and illeling which was to plague television for years to come.

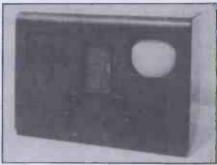
Early Days

The possibility of transmitting pictures electrically over long distances had been

The idea of transmitting pictures electrically over long distances had been around since the middle of the 19th Century, but it took nearly 100 years to develop the technology.

examined half-heartedly since the 1850s, when French experimenters had managed to pass a few slow, fuzzy reproductions of still pictures along telegraph wires. The idea never really caught on but it remains one of the curiosities of technological history that in the end, a reasonably fast and reliable system for telegraphing press photographs came into use in the early 1930s, only a couple of years before the start of the first high-definition TV service. In fact it was rather as if the steam engine had been invented only a few years before the aeroplanel

The idea of pictures-from-afar was given a major boost in 1873 with the discovery of selenium and its photoelectric properties. After a few years' research, though, this line of enquiry appeared to lead to nothing, as it was realised that the new substance was too slow in responding to light variations for it to be much use in transmitting a moving picture. In 1888 the German experimenter Nipkow achieved a major breakthrough (though it was scarcely recognised as such at the time) by cracking the problem of image dissection - how to break a picture down into separate elements capable of being transmitted over a single wire as a succession of electrical pulses. His solution was the Nipkow disc: a spinning disc with a series of holes spiralling inwards from the edge, so that as each successive hole passed between the subject and a photo-electric cell, the light reflected through the hole onto the cell would give an electrical analogue of the light/shade



(British Crown Copyright, Science Museum, London.)

pattern on that part of the subject which the hole had just scanned. With this process reversed at the receiving end, a crude picture could be built up, with the number of lines corresponding to the number of holes in the disc. Although well ahead of its time — it had to wait for the invention of the valve as an effective current amplifier — this device was to form the basis of the first attempts at a working TV system.

Mechanical scanning, then, was the obvious starting-point when researchers began to think seriously about television but it took a long time for them to begin thinking about it at all! Prior to the First World War, a few scientists had toyed with the idea as part of their researches into something else. Boris Rosing in Russia and A.A. Campbell-Swinton in Britain, for example, whose early work on cathode ray tubes had given them an inkling at least that they might one day be used in television systems, if only at the receiverend. It is only in looking back on it, though, that we can see the beginnings of television, and in later years Campbell-Swinton used to become very annoyed when journalists described him as the 'Father of Television'. The Great War did nothing for TV, since its military value was far from clear. In fact, it set research back by a good few years when the Russian Revolution broke up Rosing's team of scientists at St. Petersburg. Then, when the War ended, attention was focussed for several years on the business of setting up sound-broadcasting in America and Europe. But a's life returned to normal a few pre-War experimenters got working again.

John Logie Baird in Britain and C.F. Jenkins in the USA were pursuing the task of marrying the Nipkow scanning system to the valve-based radio transmitter, while an obscure Russian immigrant called V.K. Zworykin, an old pupil of Rosing's, was beavering away in the Westinghouse research laboratories in Pittsburg, developing the all-electronic iconoscope scanning system which was eventually to drive all before it.

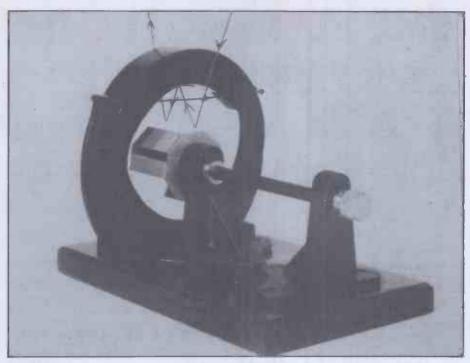
Flying Spots

At the beginning of 1924 though, when Baird gave the first demonstrations of his TV system in London, it looked very much as if mechanical scanning systems would be the basis of all future work on televi-

sion broadcasting. Baird's television camera in these demonstrations was really little more than an up-dating of Nipkow's apparatus. The main innovation was that the subject was scanned by a spot of light shone onto it through a Nipkow disc by a lamp mounted on the camera. The light reflected back - only a tiny percentage of that given out by the lamp - was focussed onto the photoelectric cell by lenses fitted over the successive holes in a second Nipkow disc, synchronised to spin with the first. The current given out by the cell modulated a medium-wave radio signal. The receiver, for its part, was a disarmingly simple contraption consisting of a neon light whose output was varied by the signal from the transmitter. It shone through another motor-driven Nipkow disc, synchronised with the camera, onto the back of a ground-glass screen. Given luck with synchronising the spin of the camera and receiver discs, the result was a postcardsized picture made up of twenty-five curved, vertical strips of yellowish light and greyish shade in which those with a good imagination might discern the smudgy, distorted semblance of a human face or some similar-sized object.

It was this rather unpromising system which Baird and his motley, quarrelsome crew of financial backers set out to perfect and sell to the British public during the years 1924-30. Before they could do so, however, they first had to win over the GPO and the BBC to the idea of a television service: the former so that it would grant the Baird Company a sizeable slice of the already-crowded MW band for experiments and the latter so that it would relax its statutory monopoly of broadcasting, lend a transmitter and eventually (it was hoped) take the new invention aboard as the BBC Television Service. Contrary to later legends, the Post Office and the BBC seem in fact to have been interested in the idea of television, and tolerably helpful despite the difficulty of negotiating with Baird (who was an outstandingly poor businessman) and his financial partners (some of whom were more than a little shady).

Demonstrations for the benefit of the GPO's engineers and then the BBC, in the autumn of 1928, seem to have given far from outstanding results even for an experimental system, and while the general verdict was that television was an idea



A Mihaly mirror-drum scanner, in use around 1929; the arrows show the path of the light.

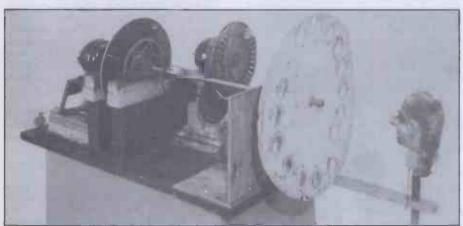
(Photo. Science Museum, London.)

well worth developing, the GPO thought that it would need to have a lot of work done on it before they could inconvenience radio users by giving it part of the medium-wave band for trial broadcasts. Baird's associates were furious and immediately began a press campaign, accusing the Post Office and "the BBC bureaucrats" of trying to strangle the new invention at birth. This lead to the Postmaster-General twisting the BBC's arm until it agreed to lend the Baird Company a transmitter at Brookman's Park in North London, for six months of the experiment, problems with the transmitter led to a typically British compromise whereby the vision and the sound were broadcast on alternate days! Once the service was working properly however, the BBC (who were producing the programmes) were quite adventurous about what they broadcast. In May 1930 they put out the world's first television play, Pirandello's "The Man With A Flower In His Mouth", undetered by the fact that the entire cast had to act seated around a

four foot-wide table. In June 1931 the Derby was televised in the first outside broadcast, the Nipkow disc being replaced on this occasion by a rotating drum of mirrors, each angled slightly from the next. In the autumn of 1932 the BBC formed a television committee and agreed with the Baird Company to provide two programmes per week until the spring of 1934

Unfortunately public interest in the new service was minimal, however much of a stir TV demonstrations might cause on the stands at the Radiolympia exhibitions. Baird manufactured "televisors", at 25 guineas a time, to be on sale for the opening the experimental broadcasts but few of these were ever sold. Only thirty were known to exist when the broadcasts began in September 1929 and eighteen months later, only about 10,000 were in operation. True, most of these were home-built from kits of parts, since the receiver was simple enough for most radio amateurs to make for themselves. But as a public service, mechanical-scan TV failed to catch on, despite the fact that the Brookman's Park transmitter gave theoretical coverage over a large part of southern England. This was partly due to the fact, no doubt, that sound-broadcasting was only just becoming accepted as a regular public service. The main reason, certainly, was that the picture was simply not good enough.

Studio productions were very limited because the most the camera could take in was one or two people in head-and-shoulders close-up. Any larger scene or outside broadcast had to make use of the clumsy intermediate film process, which involved shooting it first with a conventional cine camera, developing the film and running it through a scanner a minute or so later. Those appearing in the studio had to be thickly painted with a coating of flat white and dead black make-up, so as



John Logie Baird's 1925 experimental TV camera.
(British Crown Copyright, Science Museum, London.)



One of Baird's Televisors; the serial number on the bottom left corner of the cabinet reads "1936-647".

(British Crown Copyright, Science Museum, London.)

to get the maximum constrast from facial, features. Then, sitting in the tiny blackedout studio being scanned by a brilliant, flickering light was unpleasant for most people, and it was even said to trigger epileptic fits in some. Nor were the results particularly impressive when they arrived in the living-room: the screen was about 3in by 7in, the picture swayed up and down the whole time, it smeared and it often lost sync and dissolved into a rushing smudge of light and shade. Even when the picture was received at its best, viewers said that it compared unfavourably with the early cine-films. All in all it was something people might watch out of interest but scarcely something they would pay to watch for pleasure!

The End of the Beginning

Baird tinkered with the system for three years in an effort to achieve acceptable definition and screen-size, but the mechanics and the electrics were both against him. A larger screen meant a larger scanning disc; a larger scanning disc had to spin faster and this inevitably led to loss of synchronisation and smearing of the picture, as the photo-electric cell found itself unable to keep up with the changing light values. In any case, better definition would have meant taking up an even larger slice of the MW band. Baird was a formidably stubborn man and his backers tended to blame the BBC for not trying hard enough to make mechanical TV work. But there were other opinions to be considered: wireless-users were complaining about interference from the TV transmissions and, in the USA and Germany, RCA and Deutsche Rundfunk (using the Mihaly-Traub system) were preparing to abandon their own TV experiments at the end of 1932 as a waste of time and money. Early in 1933, then, the BBC announced to the Baird Company that it would end the broadcasts from Brookman's Park in September 1935.

While all this was going on, Zworykin had been at work in the United States, first for Westinghouse and later for the Westinghouse associate RCA. He had taken out a patent on his iconoscope TV camera as early as 1923, but it was not until 1931 that he and his growing research team had developed it to a point where its picture could be compared with mechanical-scan television. The principle of the iconoscope was that an electron beam was fired obliquely at a metalmosaic plate, being electromagnetically deflected in the process to scan back and forth across the plate from top to bottom. The camera lens focussed the image onto the plate and as the electron beam traversed, it created a succession of tiny electron discharges corresponding to the light and shade of the image; these were amplified to modulate a VHF signal. Secondary emission of electrons was a serious problem, at first, and the haloes which it caused around the brighter parts of the picture were so persistent that at one point, late in 1932, RCA was preparing to give up its experiments with allelectronic TV and go back to mechanical scanning. But the problem was gradually overcome during the early months of 1933 to the extent that by mid-year Baird who had once confidently said that "there is no hope for television by means of cathode ray tubes" — was sufficiently alarmed to begin his own experiments with electronic TV, borrowing the American inventor Philo T. Farnsworth's image-dissector tube (a primitive cathode-ray device) for the purpose.

Part of Baird's alarm was caused, no doubt, by the talks which were in progress between the BBC and RCA's British sister-company, EMI, following a very promising demonstration of electronic-



This exotic piece of glassware is an EMITRON camera tube, dating from 1935.

(Lent to the Science Museum by Electrical & Musical Industries Ltd.)

scan TV in April 1933. The BBC was determined to try the new system in an experimental public service, but the newspapers were beating the patriotic drum about American competition with the all-British Baird system. Baird's supporters, like the journalist Sydney Moseley, had always believed that the BBC was operating a vendetta against the Company, and they had sufficient in-fluence in Parliament and Fleet Street for the Postmaster-General to be wary of doing anything which might lead to accusations that the Government had killed off Baird's Television by favouring foreigners. The result was that, however much the BBC might be impressed by the superiority of the EMI system over Baird's, it had to allow some sort of comparison when the Corporation's television service began broadcasts on 2 November 1936.

"String and Sticky Tape"

The arrangement was that each company's system would be used in alternate weeks: the EMI 405-line, 50-scan per second transmissions going out from the Alexandra Palace in North London and the Baird 240-line, 25-scan broadcasts from Crystal Palace on the other side of town. In the event, though, it was hardly much of a competition. The Baird pictures, put out by a hastily-assembled jumble of mirror-drums, image-dissectors and intermediate filming, were so patently inferior to those from the EMI cameras that it hardly needed the bad luck of the Crystal Palace fire to bring about the Baird system's demise after only three months, in February 1937. From then on, electronic scanning was to rule the world's television systems, with only minor changes like the introduction of orthicon cameras in the late 1940s and the European switch to 625 lines in the mid-1960s.

The technical argument was over, but television took many years to live down the collapse of mechanical scanning and the bitter quarrels which followed. Development was slow during the years 1936-39, both in Britain and in the USA. In fact, by the time the Alexandra Palace transmitter was closed down abruptly at the end of a Mickey Mouse film on the morning of 1st September 1939 (it was feared that the Luftwaffe would use it as a navigation beacon), the number of sets in

use had barely reached 20,000. Transmissions went out for a mere twenty hours per week and they could only be picked up within a radius of about 25 miles from Alexandra Palace. True, sets had got markedly cheaper over the three from around 95 guineas to 21 guineas for some of the most basic and they had also become models noticeably less bulky, as improvements were made to the large iron-cored transformers needed to provide the 2,5000 volt anode potential. But 21 guineas was still 3-4 weeks' wages for a skilled workman in 1939 and, in any case, people were extremely reluctant to invest such a large sum in a set which might well end up as a useless relic like the 1930 televisors, if the BBC decided to abandon TV at some future date. Television excited little public interest in the last years of peace, either here or in the States, where NBC began regular broadcasts only in February 1939.

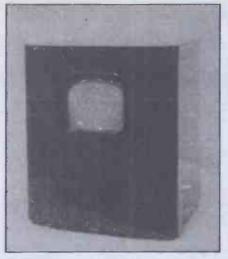
Radio was still the dominant medium and TV was regarded as a faintly crankish and unreliable experiment for years, even after it became a regular service. Indeed, there have been some historians in recent years who have said that much of the British Government's interest in television around 1936 arose from the fact that the Air Ministry needed a cover-story to explain the mass production of cathode ray tubes for use in the chain of top-secret radar stations which it was building along the South Coast!



Not a prototype Dalek, but an early EMI TV camera.

(British Crown Copyright, Science Museum, London.)

The War put paid to television services the world over. The USA's embryonic TV network was closed down by order from Washington early in 1942, to free tube-manufacturing capacity for the Navy and, by the end of 1943, the German experimental transmitters had been bombed out of existence — though for some mysterious reason the Wehrmacht was



A pre-war (1938) EKCO TV receiver; the size of the screen can be judged against the operating knobs!

(British Crown Copyright, Science Museum, London.)

tinkering with transmissions from the Eiffel Tower right up to the liberation of Paris in 1944. The story of television begins once more on 7th June 1946, the day before the Victory Parade, when the BBC resumed television broadcasts from the Alexandra Palace. TV was back on the air, but it was there only as a rather threadbare version of the pre-War service. The number of sets in use had actually gone down as a result of the Blitz, and new manufacture was a very fitful affair as the electronics industry readjusted to peace. A few skilled enthusiasts managed to build their own sets from surplus radar equipment, but for most people a TV set was an undreamed-of luxury item; the climate of Austerity Britain was not at all favourable to expensive new services like television. It was not until 1949 that the BBC got its second TV transmitter, at Sutton Coldfield, and during 1950 set manufacture stopped altogether because of the Korean War. The actor's unions and the theatre managers were hostile while BBC radio broadcasting was reluctant to share its immense wartime prestige with this upstart newcomer.

Towards the Future

In spite of all these difficulties, television was busy preparing itself for its great take-off in the mid-1950s. The production teams were rapidly learning their new trade in the dingy, cluttered studios of the Ally Pally and the realisation slowly dawned, even on the BBC management, that television was a completely separate medium from radio: a process of education which was greatly helped by a disastrous attempt to put on Tommy Handley's ''ITMA'' programme as a simultaneous TV and radio broadcast. Scriptwriters began to cater exclusively for television and the first "personalities" began to emerge at the beginning of the 1950s: people like Gilbert Harding and MacDonald Hobley and Philip Harben. Sets were still expensive, though, and worse than that - the populace at large still regarded TV as a slightly suspect plaything for the rich. It needed some major event to force TV in to the public consciousness.

That event came with the Coronation in June, 1953. Unlike the earlier Coronation in 1938, the BBC was allowed to televise the whole ceremony, including the scene inside Westminster Abbey. Large numbers of sets were hired for the occasion by people who would normally no more have thought of acquiring a TV set than a Rolls Royce. In the event, the whole proceeding turned out to be such an impressive spectacle that few of the sets went back to the showrooms afterwards. The number of licences had risen to two and a half million by the end of the year and, from then on, the television era had really arrived, both in Britain and in the United States where the three major networks CBS, NBC and ABC were soon able to parcel out the national TV audience among themselves much as they had shared out wireless broadcasting in the 1930s.



A Bush model TV22 9" television set from 1950; millions of viewers watched the 1953 Coronation on sets such as this.

(Photo, Science Museum, London.)

Technical improvements were few after 1950. The size and weight of sets were reduced still further as transformers were made more compact and scanning angles were increased to allow a wider screen for a given length of tube, eventually doing away with the early solution of mounting the tube vertically and placing an angled enlarging mirror over the top of it. At the studio end, the orthicon camera replaced the iconoscope and the zoom lens replaced the earlier four-lens turret, which made it necessary to cut from one camera to the other while changing focus. Video recording arrived in 1956, live satellite relay in 1962 and colour TV at the end of the 1960s. With these developments television came to cover the whole Earth and the last stimuli to the imagination were removed. TV's direct influence on the world has been small in comparison with radio's. But the era of cable, satellite, home video and high-definition digital TV can only confirm it in its undisputed position as the world's most popular pastime.

BI-PAK BARGAINS

SX19 SX20

SX24

100

100

20



5T21 SCREWDRIVER SET 6 precision screwdrivers in hinged plastic

case. Sizes: - 0.8, 1.4, 2, 2.4, 2.9 and 3.8mm €1.75

5T31 NUT DRIVER SET 5 precision nut drivers in hinged plastic case.

With turning rod. Sizes: -3, 3.5, 4, 4.5 and 5mm. **£1.75**

5T41 TOOL SET

precision instruments in hinged plastic case Crosspoint (Phillips) screwdrivers: -H 0 and H 1 Hex key wrenches: 1.5. 2 and 2.5mm £1.75

5T51 WRENCH SET

5 precision wrenches In hinged plastic case Sizes: - 4 4 5 5 5 5 and 6mm. £1.75

BUY ALL FOUR SETS: 5T21-5T51 and get HEX KEY SET FREE

SIREN ALARM MODULE

any 12 volt supply into 4 or 8 ohm speaker.

Ideal for car burglar alarm, freezer break

down and other security purposes. BP124 5 watt 12v max — Siren Alarm Module

£3.85

Order No

BP124

ican Police type screamer powered from

HEX KEY SET ON RING. Sizes: 1.5, 2, 2.5, 3, 4, 5, 5.5 and 6mm.

Made of hardened steel. HY/1 €1.25

RESISTOR BARGAINS"

Pak No.	Ots."	Description	rice
SX10	400	Mixed "All Type" Resistors	£1
SX11	400	Pre-formed %-1/2 watt Carbon	1
		Resistors	£1
SX12	200	4 watt Carbon Resistors	£1
SX13	200	% watt Carbon Resistors	13
SX14	150	1/2 watt Resistors 22 ohm-	
		2m2 Mixed	£1
SX15	100	I and 2 watt Resistors 22	
		ohm-2m2 Muxed	£1

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

25 pieces of Audio Plugs, Sockets and Con-nectors to include DIN 180°-240° Inline 36 Pin, Speakers, Phono, Jack Stereo and Mono etc Valued at well over ₤3 normal Order No. SX25.

Our Price 1.50 per pak. Guaranteed to save you money

The Third and Fourth Hand...

... you always need but have never got "until now This helpful unit with Rod mounted horizontally on Heavy Base, Crocodile clips attached to rod ends. Six ball & socket joints give infinite variation and positions through 360° also available attached to Rod a 21/2 diam magnifier giving 2.5 x magnification. Helping hand unit available with or without magnifier. Our Price with magnifier as illustrated ORDER NO. T402 £5.50

Without magnifier ORDER NO. T400 £4.75

SXA9

6 Black Heatsink will lit TO-3 and TO-220. Ready drilled. Half price

1 Power finned Heatsink, This heatsink gives the greatest possible heat dissipation in the smallest space owing to its unique staggered fin design, pre drilled. TO-3 Size 45mm squarex 20mm high, 40p

"CAPABLE

CAPACITOR PAKS"

metal foil

BARGAINS

20 x Large .2" RED LEO 20 small .125 Red LED's 10 Rectangular Green LED's .2 30 Assorted Zener Diodes 250mw-2 watt mixed voltages. all coded. New.

Knobs-winged with pointer %" Standard screw. Fit size 29 # 20mm.

12 Neons and Filament Lamps. Low

voltage and mains — various types and colours — some panel mounting

*Quantities approximate, count by weight,

4 Black Instrument

20 Assorted Stider Knobs

Black/Chrome, etc

Description
Capacitors Mixed Types
Ceramic Capacitors Miniature
Mixed

Mixed Ceramics 1pf-56pl

Electrolytics, all sorts Quality Electrolytics 50-1000 mf

Tantalum Beads, mixed

Mixed Ceramics 68pf-0,5mf Assorted Polyester/Polystyrene Capacitors Mixed C280 type capacitors

TO-66 size. 35mm x 30mm x 12mm. I Heat Efficiency Power Finned Heatsink 90mm x 80mm x 35mm High, Drilled to take up to 4 x TO-3 devices £1.50 each

SINGLE SIDED FIBREGLASS BOARD

0-2 Megohms. Acc: 1%
BI-PAK VERY LOWEST POSS PRICE

£35.00 each

BRAND NEW LCD

RF 188m

May indication

Input impedance

Zero adjust

Sampling time

Power Supply

Consumption

DC Voltage 0-200mV.

0-2-20-200-1000V. Acc: 0.8% AC Voltage 0-200-1000V.

Acc. 1.2% OC Current 0-200uA.

Resistance 0-2-20-200K ohms.

0-2 Megohms. Acc: 1%

0-2-20-200mA 0-10 A. Acc: 1.2%

RANGES

Price £1

61

£1

El

£1

E1 E1

£1

£1

£1

DISPLAY MULTITESTER.

polarity *Single-handed, pushbutton operation *Over range indication *12.5mm

-inch) large LCO readout *Diode check

*Fust circuit protection *Test leads, battery and instructions included.

Polarity indication Negative only.

1999 or - 1999

without + sign

Automatic 250 milliseconds

- 5°C to 50°C

155 x 88 x 31mm

20mW

10 Megohms

Positive readings appear

1 x PP3 or equivalent 9V

è

LCD 10 MEGOHM INPUT IMPEDANCE *3½ digit *16 ranges plus hFE test facility for PNP and NPN transistors *Auto zero, auto

Size 9 x 2%" Sq. Ins. 100 100 156 11 x 3" 13 x 3" DOUBLE SIDED FIBREGLASS

BOARD 14 x 4" 110 62.00

SILICON POWER TRANSISTORS **— 703**

> NPN like 2N3055 -- but not full spec NPN line 2N3033 100 watts 50V min. 10 for £1.50 — Very Good Value 100s of uses — no duds 100s of uses -Order No. SX90



Kit comprises OROER NO. SX80

1 High Quality 40 watt General Purpose Lightweight Soldering Iron 240v mains inc

1 Quality Desoldering pump. High Suction with automatic ejection. Knurled. anti-corrosive casing and tellon nozzle.

metres of De-soldering braid on plastic dispenser

2 yds (1.83m) Resin Cored Solder on Card. 1 Heat Shunt tool tweezer Type. Total Retail Value over £12.00 OUR SPECIAL KIT PRICE CR. 95

BI-PAK PCB ETCHANT AND DRILL KIT

Complete PCB Kit comprises

1 Expo Mini Orill 10,000RPM 12v DC Incl 3 illets & 1 x 1mm Twist bit.

1 Sheet PCB Transfers, 210mm x 150mm

1 1/2 Ib pack FERRIC CHLORIDE crystals. 3 sheets copper clad board

2 sheets Fibreglass copper clad board full instructions for making your own PCB.

OUR BI-PAK SPECIAL KIT PRICE £9.75

PROGRAMMABLE UNIJUNCTION TRANSISTOR
"PUT" case T0106 plastic MEU22 Similar to
21\text{0027} /6028 PNPN Silicon
Price: 1-9 10-49 50-99 100+ Normal Re
Each: 20p 18p 15p 13p Price £0.33

SX33A 6 Small (min (SDST/SPDTToggle SU.35 et Switches 240v 5amp \$\)
SX35A 6 Rocker Switches 250v 2A \$\)
SX26A 12 Assorted Jack & Phono plugs suckets and adaptors, 2.5m, 3.5mm and standard sizes \$\)
SX71 50 BC108 "Fallouts" Manutacturers out of spec on volts or gain You test.
SX72 A mixed bundle of Copper clad Board Fibre glass and paper. Single and double sided. A fantastic bargain \$\)

REGULATED' VARIABLE STABILISED

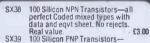
POWER SUPPLY

riable from 2-30 volts and 0.2 Amps lift includes:-1 - VPS30 Module, 1 - 25 volt 2 amp transformer, 1 - 0-50v 2" Panel Meter, 1 - 0-2 amp 2" Panel Meter. 1 - 470 ohm wirewound potentiometer, 1 - 4K7 ohm included VPS30 KIT F70

TECASBOTY

The Electronic Components and Semiconductor Bargain of the Year. A host of Electronic components including potentiometers — rotary and slider, presets — horizontal and vertical. Resistors of mixed values 220 hms to 2M2 — 1/8 to 2 Watt. A comprehensive range of capacitors including electrolytic and polyester types plus disc ceramics etcetera. Audio plugs and sockets of various types plus switches, fuses, heatsinks, wire, nuts/bolts, gromets, cable clips and tyes, knobs and P.C. Board. Then add to that 100 Semiconductors to include transistors, diodes, SCR's oplo's, all of which are current everyday usable devices. In all a Fantastic Parcel. No rubbish all identifiable and valued in current catalogues at well er £25.00. Our Fight Against Inflation

- Beat the Budget JUST £6.50. Down with Depression



all perfect. Coded mixed types with data and eqvt. sheet. No rejects. Fantastic value. £3.00

2M3055 The best known Power Transistors in the World — 2M3055 NPN 115w.
Our 81-PAK Special Offer Price;
10 off 50 off 100 off £3.50 £16.00

80312 COMPLIMENTARY PNP POWER TRANSISTORS: TO 2N3055. Equivalent MJ2955 — B0312 — T03 SPECIAL PRICE 60.70 each



MORE BARGAINS!

SX51 60 metres PVC covered Hookvire single and stranded. Mixed £1 25 Assorted TTL Gates 7400 Series. 7401-7460. 10 Assorted flip Flops and MSI £1 £1 20 Assorted Slider Potentiometers 40 Assorted Pre-Sets Hor/Vert £1 5162 ٤1 10 Reed Switches — glass type 3 Micro Switches — with lever

SEND YOU WITH S TO DEPT HES BY PAK FO BOX & WARE HERT'S SHOP AT 3 BALDOCK ST., WARE, HERTS TERMS, CASH WITH ORDER, SAME DAY DESPAICH, ACCESS BARCLAYCARD ALSO ACCEPTED TEL (1920) 3182. GIRO 388 7000 ADD 15° VAT AND 75p PER ORDER POSTAGE AND PACKING

Total Postage add /bp ser Total orde

and your reder ment faster. Grands normally sent Zort

BI-PAK BARGAIN

TRIACS - PLASTIC

4 AMP - 400v - T0202 - TAG 1360 50 OFF £17.50 10 OFF

40p £3.75 £17.50 8 AMP 400v — 70220 — TAG 425 60p £5.75 £27.50 630.00

SLIDER POTENTIOMETERS

ALL AT \$\text{SX63} \ \frac{5}{2} \ \text{270} \ \text{ohmt} \ \text{Lir} \ \text{SX675} \ \text{\$\text{\$\$}\$} \ \text{47k Lin} \ \text{SX685} \ \text{\$\$} \ \text{27k Lin} \ \text{SX685} \ \text{\$\$} \ \text{27k Lin} \ \text{SX696} \ \text{\$\$} \ \text{100k Lin} \ \text{SX706} \ \text{1} \ \text{meg Lin} \end{align*} 50p PER PAK

SX40 250 Silicon Olodes—Switching like 1N4148 D0-35. All good—uncoded. Worth doubleourprice, 45v75mA. £1.2 250 Silicon Oiodes—General Purpose, like OA200/202. BAX13/16, Uncoded. 30-100v200mA DO-7.

SX44 10 5A SCR's T064. 3 x 50v. 3 x 100v. 2 x 200v, 2 x 400v. Super value less than 1/4 price. 10 5A SCR's T066 2 x 50v, 2 x 100v, 4 x 200v, 2 x 400v. All coded. Brand new, a



MINIATURE TOOLS FOR HOBBYISTS

A thronion shaft screwdriver for those awkward to get at screws. Overall length 8 Munch. Order No FS-1 Flat blade 4mm FS-2 Cross point no.1 £1.75 each

Sinch long screwdriver with spring loaded grip on end to hold screws in position while reaching into those difficult places Order No SD-1 Flat blade 4mm

mbined were stripper, cutter, comperinct 25 assi minals for comping. Order No WS2. Our low pince. £1.20 as

Plastic Boxes

4 % 2 ½ 1 ½ 6 3 % 2

Coloured Black. Close fitting.
Flanged Lid, fixing screws into brass bushes.
SIZE "L W M Order No. Price

Plastic as above but with aluminium top panel
4 2 % 1 146 £1.40
Plastic sloping front

slope

11/2 148 £1.00

£1.30 £1.50

€2.14

INEXPENSIVE TOOLS OF IMMENSE VALUE

FLEXEY ORIVER

Miniature round nose side cutters -

handles 51/zinch length Order No YO45

41/2inch length Order No YO46

cutter and serrated jaws - insulated handles Sinch length Order No Y042 All with insulated handles

1.25

Order No.

161

163

167

EXPERIMENTOR

21/2

PLASTIC

BOXES - ALUMINIUM -

ALUMINIUM BOXES

Made with Bright Aluminium folded construction with deep lid and screws

BA NUT DRIVER SET
Set of 5 BA spanner shafts plus universal handle in roll-up wallet. Sizes 0 BA 2-4-6-8 BA. Order No \$182

NEON SCREWDRIVER

7) in blade no NS1 0.65p sach

51in blade no NS2 0.50p each

Satisfaction or your money back has always been BI-PAK's GUARANTEE and it still is

All these Sale items are in stock in quantity and we will despatch the same day as your order is received

IC SOCKETS The lowest price ever.

The more you buy the cheaper they come! Pin. 10 olf 50 olf 100 ol 8 pin 85p £3.50 £6.00 14 pin 90p £3.75 £6.50 16 pin 95p £4.00 £7.00

VOLTAGE REGULATORS

T0220 | Positive + Negative + 7805 - 50p 7905 - 55p 7812 - 50p 7912 - 55p 7815 - 50p 7814 - 50p 7924 - 55p

BI-PAK'S OPTO 83 SPECIAL

A selection of Large & Small size LED's in Red Green, Yellow and Clear, plus shaped devices of different types. 7 Segment displays, photo transistors, emitters and detectors

Types like MEL11, FPT100 etc. Plus Cadmium Cell ORP12 and germ. photo transistor OCP71. TOTAL OF 25 PIECES



0/NO:SX57A Valued - Normal Retail £12,00 Our Price

= £5.00

SEMICONDUCTORS FROM AROUND THE WORLD

A Collection of Transistors, Diodes, Rectifiers, Bridges, SCR's, Triacs, IC's both Logic and Linear plus Opto's all of which are current everyday usable devices.

Guaranteed Value over £10 at Normal Retail Price

83p 83p

83p

£1.12

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



MW398 NI-CAD CHARGER

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

Charges: -Power PP3 (9V) 220-240V AC U12 (1 5V pentite) Dims: -U11 (1 5V "C") 210 x 100 x 50mm U11 (1 5V "C") €6.95 U2 (1.5V "D")

POWER SUPPLY OUR PRICE £3.25

Power supply fits directly into 13 amp socket Fused for safety Polarity reversing socket Voltage switch Lead with multi-plug
Input: - 240V AC 50HZ Output -3, 4 5, 6, .5. 9 & 12V DC Rating. - 300 ma MWBB

1 Amp SILICON RECTIFIERS

Glass Type similar IN4000 SERIES IN4001-IN4004 50 — 500v — uncoo.J — you select for VLTS ALL perfect devices — NO duds Min 50v 50 for £1.00 — worth double OROER NO SX76

Silicon General Purpose NPN Transitors T0-18 Case Lock fit leads — coded CV7644 Similar to BC147 — BC107 — ZT89 ALL NEW! VCE 70v IC500mA Hte 75-250 50 off 100 off 500 off 1000 off 300 off 300 off 1000 off 300 off 1000 off 300 off 1000 off 300 off 1000 off 300 off 3 PRICE \$2.00 \$3.80 \$17.50 \$30.00 \$

Silicon Gereral Purpose PNP Transistors T0-5 Case Lock fit leads coded CV9507 similar 2N2905A to BFX30 VC 60 IC 600mA Min His 50 ALL NEW 50 of 100 of 500 of 1000 of PRICE \$2.50 \$4.00 \$19.00 \$35.00

Silicon NPN'L' TypeTransitors

TO-92 Plastic centre collector Like BC182L — 183L — 184L Like BC182L — 183L — 184L VCBO 45 VCEO 30 IC200mA Hre 100-400

ALL perfect devices - uncoded ORDER AS SX183L 50 of 100 of 500 of 1000 of £1.50 £2.50 £10.00 £17.00

PNP SILICON TRANSISTORS:

Similar ZTX500 -- ZTX214 -- E-Line VCEO 40 VCBO 35 Ic 300mA Hte 50-400

Brand New - Uncoded - Petect Devices

50 off 100 off 500 off 1000 off £2.00 £3.50 £15.00 £25.00

DIGITAL VOLT METER MODULE

3 x 7 segment displays Basic Circuit 0- 2V± instructions provided to extend voltage & current ranges Operating voltage 9-12V Tyn Power Consumption 50mA D/NO.SX99 Once only price

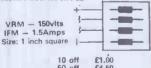
£9.95

ELECTRONIC SIREN 12× DC

Dur Price:- £5.50

SILICON BRIDGE RECTIFIERS

Comprising 4 x 1 amp rectifiers mounted on PCB



50 off £4.50 100 off £7.50 Order No. As: 4RI BRect.

MULTITESTERS

AC volts - 0-15-150-500-1,000. OE volts:- 0-15-150-500-1,000. DC currents - 0-1ma-150ma

Resistance:- 0-2.5 K ohms 100 K ohms. Oims - 90 x 61 x 30mm.

.O/No.1322.OUR PRICE £6.50 ONLY Decibels: - 20db to plus 56db.

me Tweeter for systems up to 50W, Impedence 8 ns, Frequency Response 2000-20000 Mz. Dims nm dia x 31mm deep.

OUR PRICE £2.85 O/No. DMT200

1,000 opv Including test leads & Battery. 30,000 opv. Including test leads and case AC valis: - 0.2.5-10-25-100-250-500-1,000: DC volts:- 0-0.25-1-2.5-10-25-100-250-1.000.

DC current:- 0-50ua 0-5ma-50ma 0-12amps. Resistance:- 0-6K ohms-70K ohms-6meg ohms-

60meg ohms

Short test- Internal buzzer. Dims - 160 x 110 x 50mm.

O/No. 1315, OUR PRICE **DNLY £24.75**

SPECIAL OFFER OF STEREO AUDIO MODULES

Fully built and tested in our factory
A COMPLETE SET TO GIVE YOU 70 WATTS TOTAL
35 WATTS (rms) PER CHANNEL 55v POWER SUPPLY

Kit comprises
2 x AL80 Power Amplifiers
1 x PA 200 Stereo Pre-Amplifier
1 x Front Panel Black with White lettering
4 x Black Knobs with White Pointer
NORMAL RETAIL PRICE FS2 COMPLETE NORMAL RETAIL PRICE £52 COMPLETE SAVE £14
OUR SPECIAL OFFER PRICE FOR 1 MONTH ONLY

Credit Card — ir Immediate despatch

1 × Transformer 55v 2 × Coupling Capacitors & 1 Reservoir Capacitor Full hook-up chart

end your orders to Dept. HE3. BI-PAK PO BOX 6 WARE HERTS
SHOP AT 3 BALDOCK ST., WARE, HERTS.
TERMS; CASH WITH ORDER, SAME DAY DESPATCH, ACCESS.
BARCL AYCARD ALSO ACCEPTED. TEL, 10920 3182, GIRO 388 7006
udd 15% VAT AND 50p PER ORDER POSTAGE AND PACKING



Use your credit card. Ring us on Ware 3182 NOW and get your order even taster. Goods normally sent 2nd. Class Mail

Remember you must add VAT at 15% to your order Total: Postage add 50o per Total order

Popamps Owen Bishop

Simple measuring circuits based on operational amplifiers.

No. 7: Low Range Ohmmeter

THIS CIRCUIT has two ranges, 0 to 9R and 0 to 900mR. A typical multimeter rarely has the ability to measure resistances as low as these, yet there are occasions on which you want to know the value of a resistance with some degree of precision. You may have made your own low-value wire resistor for use as a dropper in a current regulating circuit, for example, or you may want to measure the resistance of the coil of a loudspeaker or of a solenoid. Such devices often carry high currents when in use, and possibly the circuit is operating close to its limits. In this event the difference between 3.5 ohms and 3.7 ohms may make all the difference between safe operation and dangerous overloading of the other components. This device measures such resistances precisely. It can also be used for measuring the resistance of short lengths of cable, enabling you to calculate the resistance of a longer run. It can measure contact resistance in relays and similar devices, which usually have resistances of a few tens of milliohms.

Low Class Circuits

As in the previous circuit, the op-amp is wired as an inverting amplifier. The amplifier works in the same way as in that project, but the input to it is derived in a slightly different way. The principle is that a known current is made to flow through the unknown resistance, Rx, and the amplifier is used to measure the voltage developed across Rx. Since RX is very low, the voltage is very low too, but this is amplified to give a voltage which is measurable by an ordinary voltmeter.

The constant current is derived from ICI, which is a programmable constant current generator. Provided that the voltage across ICI exceeds about 1V5, the current flowing from ICI remains unchanged no matter what the operating voltage may be; this means that the current is independent of the freshness of the battery. The IC is programmed by the value of R1. With R1 = 10R as in Figure 1, the constant current is 6m77A at 25°C. It varies in proportion to the absolute temperature

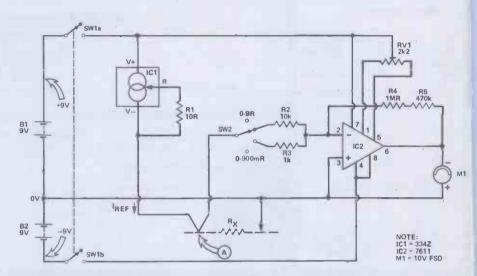


Figure 1. The Pop-Amp No. 7 circuit, a Low Range Ohmeter.

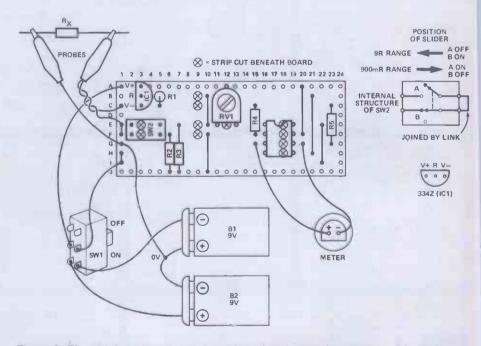


Figure 2. The stripboard component overlay, showing track cuts viewed from the top.

but, unless you are likely to be using the circuit at sub-zero temperatures, this results in an error of less than 1% in the readings.

Suppose that Rx has the value 9R; the voltage developed across it is $9 \times 6.77 \times 10^3 = 60 \text{m} 93 \text{V}$. If the voltage at point 'A' is 60 m 93 V, the current flowing through R2 is 60093 A. Note that the measuring circuit draws less than a ten thousandth of the current coming from the current

generator, making virtually no difference to the voltage across Rx. This current flows on through R4 and R5. Since R4 and R5 have a combined resistance 1M47, the voltage at the output must fall to $6.093 \times 10^6 \times 1.47 \times 10^6 = 8V96$.

When Rx is 9R, the meter reads 8V96, so the meter reading, in volts, is approximately equal to the resistance in ohms. To give a more precise reading it would be necessary to substitute an

Parts List

	RESISTORS (All 0.4 watt 1% metal film, unless noted)	IC2
100	R1	SW1 DPDT
	horizontal sub-min preset SEMICONDUCTORS	Stripboard, 27 × 63mm (24 holes × 10 strips); 8-pin DIL socket (IC2); 7 × 1 mm terminal pins; 2 × crocodile probe clips; connecting wire, solder etc. Optional case.
Ì	programmable constant current source	BUYLINESpage 34

8.2 resistor and 4k7 preset for R2, but in this application it is probably not worth while.

On the other scale, which covers 0 to 900R, the voltage across Rx has a maximum value of 6m093V, which is a tenth of the maximum of the 0 to 10R range. This means that amplification must be ten times greater, so R3 has the value 1kR range. This means that amplification must be ten times greater, so R3 has the value 1kR. Then a full scale reading of 9V corresponds to a resistance of 900mR.

You will have noted in Figure 1 that there are two wires going to point 'A'; this is to allow for a possible error due to the probe lead resistance. One wire delivers current direct to point 'A' - the whole current goes to this point. The other wire makes a direct connection between point 'A' and the voltage measuring circuit and the current in this lead is so small that the resistance of the wire causes negligible voltage drop at the IC.

As explained in Pop Amps No. 6, an op-amp may deliver an appreciable

output voltage even when its inputs are at equal potential. This 'offset voltage' is compensated by adjusting the setting of RV1

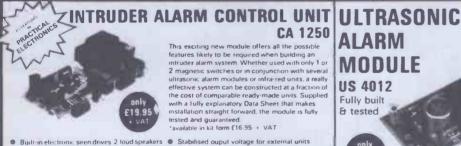
Construction

The circuit fits easily onto the smallest standard size of Veroboard, though you may want to use a larger board if you intend to fit trimmer presets for the two resistance ranges. The circuit requires so little current that it can be powered by two PP3 batteries. Note that the terminals of RV1 have to be slightly bent out of alignment in order to fit it into a convenient place on the board.

Complete the circuit before testing it, then clip the two probe wires together and switch on the power. The inputs of the op-amp are then joined together so they are at the same potential and the output should be zero; if not, adjust the setting of RV1 until the needle of the meter rests at OV. Unless you have decided to fit trimmer presets, no further adjustments are necessary. Clip the probes to a known resistance in the 0 to 10R range, and select the range using SW2. The voltmeter should indicate the resistance. Use two or more 1R resistors wired in parallel for testing the lower range.

MODULES FOR SECURITY & MEASUREMENT

CA 1250



Provides exit and entrance delays together with fixed alarm time

Battery back-up with trickle charging facility

Operates with magnetic switches, u/sonic or

This exciting new module offers all the possible features likely to be required when building an intruder alarm system. Whether used with only 1 or 2 magnetic switches or in conjunction with several ultrasonic alarm modules or infra-red units, a really effective system can be constructed at a fraction of the cost of comparable ready-made units. Supplied with a fully explanatory Data Sheet that makes installation straight forward, the module is fully tested and guaranteed.
*available in kit form £16.95 + VAT

- Stabilised outure voltage for external units
- 2 operating modes full alarm/anti-tamper and panic facility
- Screw connections for ease of installation
- Separate relay contacts for switching external
- Test loop facility

DIGITAL VOLTMETER MODULE DVM 314



- Positive & negative voltage with an FSO of 999mV which is easily extended
 Requires only single supply 7-12V
- High overall accuracy 0.1% + 1 digit ■ Large bright 0.43" LED displays
- Supplied with full applications data
- With this fully built and calibrated module a wide range of accurate equipment such as mithermometers, battery indicators etc. can be constructed at a fraction of the cost of ready-mad mermometers, battery indicators etc. can be constructed at a fraction of the cost of ready-made units. Full details are supplied for extending the voltage range, measuring current, resistance and temperature. Fully guaranteed, the unit has been supplied to electricity authorities. Government departments, etc.

Temperature Measurement Kit DT.10

Fully built & tested

Using the 1.C. probe supplied, this kit provides a linear output of $10\text{mV}^\circ\text{C}$ over the temperature range from -10°C to $+100^\circ\text{C}$. The unit is ideal for use in conjunction with the DVM module providing an accurate digital theorems.

Power Supply PS.209

£4.95 + VAT

This fully built mains power supply provides two stabilised isolated outputs of 9V, 250mA each. The unit is kleally suited for operating the OVM at Temperature Measurement module.

ALARM MODULE **US 4012**

Fully built & tested

effective fully built module containing both ultrasonic transmitter and ultrasonic transmitter and receiver and circuitry for providing false alarm suppression. This module, together with a suitable 12V power supply and relay unit as shown, forms an effective though inexpensive intruder alarm. Supplied with comprehensive Data Sheet, it is easily mounted in a wide range of enclosures. A ready-drilled case and necessary hardware is available below.

Power Supply & Relay Units PS 4012 £4.25 + VAT

Provides a stabilised 12V output and relay with 3A contacts. The unit is designed to operate one or two of the above ultrasonic units. Fully built and tested.

Siren Module **SL 157**

£2.95 + VA

Produces a loud and penetrating sliding tone operating from 9-15V. Capable of driving 2 off 8 ohm speakers to SPL of 110db at 2M. Contains an inhibit facility for use with shop lifting loops etc. or other break to activate

Add VAT & 50p post and packing to all orders. Shop hours 9,00 - 5,30 p.m. (Wed, 9.00 - 1.00 p.m.) Units on demonstration - callers welcome. S.A.E. with all

Hardware Kit HW 4012

£4.25 + VAT

Adjustable range from 5ft. to 25ft.

A suitable ready-drilled case with the various mounting pillars, mains switch socket and nuts and bolts.

Designed to house the ultrasonic alarm module together with its power supply. Size: 153mm x 120mm x 45mm

*** ACCESSORIES ***

n Key Switch for use with CA 1250 supplied with 2 keys

Magnetic switch (with magnet)
5" Horn speaker for use with CA1250
and SL157

€3.43 €1.17

RISCOMP LIMITED

Dept HE3

21 Duke Street, Princes Risborough, Bucks. Princes Risborough (084 44) 6326

The magazine with a different approach to micros.

Electronics and Computing Monthly looks at a computer as the beginning of something interesting rather than an end in itself.

We thought that using a micro to drive something other than a TV screen could open up fascinating possibilities.

A few simple circuits, used as building blocks, can stretch your computer, your imagination and your fun, a long way.

If you understand the basics of digital electronics, you'll appreciate the fun you can

have by linking logic circuits to your micro.

If you don't, then read our new series which starts this month and explains digital electronic circuits from basics. Also this month, we show you how to build an infrared remote controller for your micro.

That's what Electronics and Computing is all about – giving you ideas for new

applications, and giving you the software to expand your micro. Project by project we show you how to add another dimension to your computer.

For example, in this month's issue we explain dialogue programming using the PILOT system – what it is and how it works.

And inside is enough information to build your own hi-res graphics computer.

All you need is a hot soldering iron and a cool 75p.

WHERE ELECTRONICS AND COMPUTING INTERFACE.

THE HE BOOKSHELF is the easiest way to build up your library of electronics books. Order today to have these top titles delivered

DIRECT TO YOUR DOOR. 52 Projects BEGINNERS GUIDE TO MICROPROCESSORS PROJECTS USING SOLAR CELLS £1.95
A range of practical applications using silicon solar cells. ANO COMPUTING 52 PROJECTS
USING IC741 £1.25
More than 50 ways
of using the
ubiquitous IC741. E 1.75
Basic introduction to binary arithmetic, micro-processor operation and macine language programming. REMOTE CONTROL PREMOTE CONTROL
PROJECTS £1.95
Practical information
about many
applications of
remote control. 50 (FET) Field Effect Transistor 50 (FET) FIELO VMOS PROJECTS 50 (FET) FIELD
EFFECT
TRANSISTOR
PROJECTS £1.75
Contains a wide
range of projects, all
based on Field Effect
Transistors. vMOS PROJECTS £1.95 Contains a number of varied and interesting projects using VMOS power FETs. ELECTRONIC MUSIC PROJECTS £1.75 Many practical circuits for less complex items of electronic music equipment. IC 555 PROJECTS £1.95 The 555 timer users 'Rible' PROJECTS £1.95 Simple and advanced projects based on digital ICs. CHOOSING AND USING YOUR HI-FI COUNTER DRIVER
AND NUMERAL
DISPLAY PROJECTS
£1.75
Features many varied ELECTRONIC TEST
EQUIPMENT
CONSTRUCTION
£1.75
How to build and use £1.65
Concise information for all hi-fi enthusiasts. reatures many var-projects using numeral displays, counter and driver ICs. INTERNATIONAL INTERNATIONAL TRANSISTOR COUVALENTS GUIDE £2.95 Find possible equivalents for a popular user-orientated selection of modern a wide range of test equipment for the hobbyist. Radio Circuits Using IC's ELECTRONIC GAMES RADIO CIRCUITS
USING IC's £1.35
All you need to know
about using IC's for
AM or FM reception. £1.75
Amusing electronic games which can easily and inexpensively be constructed by the enthusiast. POWER SUPPLY PROJECTS £1.75 Packed with circuits for building various kinds of power of modem transistors HOW TO USE OP-AMPS £2.25 All you need to know about Op-Amps, a source book of circuits and design calculations. IC LM3900 PROJECTS £1.35 Provides the ground work for simple and supply. HOUSEHOLD PROJECTS £1.75 PROJECTS £1.75
Packed with circuits
for projects that can
be used in or around
the home. of IC LM3900. SINGLE IC PROJECTS £1.50 Easy to construct projects based around a single IC. PRACTICAL
CONSTRUCTION OF
PRE-AMPS, TONE
CONTROLS, FILTERS
AND ATTENUATORS
£1.45
Contains AUDIO PROJECTS PRACTICAL COMPUTER EXPERIMENTS £1.95 Clear information on A
MICROPROCESSOR
PRIMER £1.75
A painless approach
to understanding
computers and
computing. how to build pre-amps, mixers, power amps, tone controls E 1.45
Contains practical designs for use with home constructed equipment or commercial modules. £1.75
Suild and examine a number of basic computer circuit elements. To receive your books you have only to fill in the form below and send it, together with your payment, to the address stated. Please allow up to 21 days for delivery. This offer applies only within the U.K. Prices may be subject to change without notice SEND TO: HE BOOKSHELF, 513 London Road, Thornton Heath, Surrey CR4 6AR. I am enclosing my Cheque/Postal Order/ **Price Books Required** for: (delete as necessary) (Made payable to A.S.P. Ltd) OR Debit my Access/Barclaycard VISA (delete as necessary) Please use BLOCK CAPITALS and include post codes. Name (Mr/Mrs/Miss) Address

0.75

Add 75p p&p

Total Payment

£

"Holy Smoke",
exclaimed Robin,
"that's another bass
driver gone up in a
puff". The Caped
Crusader reached
for the stereo
headphones.
"I warned you,
Robin. You should
build the HE....



Signal Powered Loudspeaker Protector

NOT with a bang, not even with a whimper — most loudspeakers, when subjected to intolerable strain, simply stop, cease and desist from operating. The vital signs no longer present, the hapless audiophile sits for a moment in wonder at the pallid absense of sound before filling the air himself with tones of electric blue.

Usually, the power amplifier has gone faulty and applied the full DC supply to the loudspeaker terminals. Without some form of protection, the result is at least an open circuit bass driver — or worse. A protection circuit prevents this by monitoring the loudspeaker lines for the presence of DC, opening a set of relay contacts if this occurs and disconnecting the speakers from the

faulty amplifier.

However, conventional speaker protection circuits suffer from two disadvantages: first, they are active devices, and thus require a separate power supply, either from batteries or from mains. The second problem results from the type of filter used to distinguish between DC and the audio signal; a standard passive filter, set at around 10Hz, is often used, but it is possible that a large amplifier will produce sufficient energy at low frequencies to trigger the protector, even though there is not actually a fault present.

These problems are both overcome

by this new circuit. The result is a particularly small, compact circuit board which can be mounted inside a loudspeaker enclosure. Thus it is not necessary to run mains power leads, or to continually check and replace batteries (the unit, while suiting all types of loudspeakers in general, is therefore very suitable for sound reinforcement systems). The solution used in this project is to power the protection circuit from the audio signal itself.

This is done by placing a full wave rectifier across the speaker lines and charging a 1000u capacitor through a 47R resistor. The worst possible load presented to the speaker lines is therefore 47 ohms — and this is only while charging the capacitor and for signal voltages in excess of 12V. This ensures that the unit has no discernable effect on audio quality but makes possible a truly 'set and forget' speaker protector that can, if required, be mounted inside the enclosure.

The second problem, that of the filter, is solved by a new design which has an almost 'brick wall' response; it enables the unit to be used with very high power amplifiers without danger of false triggering by very low frequency content.

Power Monitor

Another cause of speaker failure is the

application of too much power for too long — a problem that is most often encountered in professional applications where the sound level can peak into the red and stay peaked for minutes, unless the sound engineer is alert. The Signal Powered Protector also tests for overpower, with an adjustable level control, and disconnects the speakers should the amplifier exceed the limit for more than a certain period.

This feature needs to be adjusted carefully when the unit is being used in a hifi set-up; if the trigger level is too low, the speakers will be cut out by the sudden dynamic peaks which normally occur in some types of music.

The maximum power is determined by the type of regulator transistor (Q1) used; we have specified a TIP31C for this device. It has a collector-to-emitter breakdown voltage (VCEO) of 100V, and since the emitter is at 12V, the maximum voltage that can be aplied to the unit is 112V. This is equivalent to an amplifier capable of supplying approximately 784 watts into an 8R load, or 1568 watts in four ohms. If the amplifier to be used is capable of powers greater than this(!), the regulator transistor should be changed for a device with a higher VCEO rating.

The relay pulls about 40mA when operated, so power dissipation in the regulator transistor will be around watts when there is 100V acros

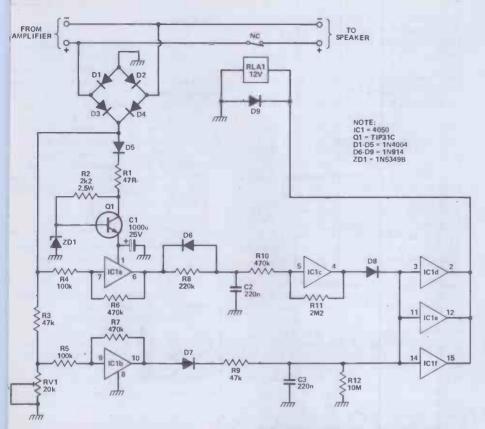


Figure 1. All there is to know about the circuit of the Signal Powered Loudspeaker Protector.

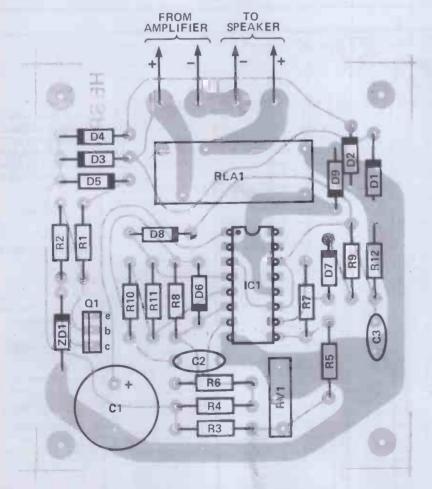


Figure 2. The component layout drawn on the PCB pattern; the full-sized foil is reproduced on the PCB Printout page.

Although this is not particularly high, it is high enough to be outside the safe operating limits of many high voltage transistors, so be careful when choosing a substitute.

Protection Circuit

The signal from the power amp is rectified by the fullwave bridge formed by D1-D4. The output from this is fed through a 12V regulator circuit formed by Q1 and the associated components, with ZD1 setting the regulated voltage. Capacitor C1 is charged to this level, and powers the remainder of the circuit. The output of the bridge rectifier also feeds the input of the DC sense circuitry and the over-power detector.

and the over-power detector.

Buffers IC1a and c form the DC filter.
Resistors R4, 6 with IC2a form a
Schmitt trigger with a small deadband.
When the signal goes above the trigger
voltage, the output of IC1a swings hard
to the positive supply rail, charging C2
through the 22Ok resistor, R6. Buffer
IC1c, together with R10 and R11, form
a second Schmitt trigger, monitoring the
voltage across C2. If this reaches the
second trigger voltage then its output
goes toward the positive rail, activating
IC1d, e and f, which pull in the relay and
disconnect the loudspeaker lines.

It takes about 100ms to charge C2 via R8. However, the input to IC1a is fullwave rectified unsmoothed DC. The output, therefore, will switch between high and low as the input swings above and below the trigger voltage. With a normal audio input, then, the output of

Parts List

raila List
RESISTORS (All ½ watt 5% unless noted) R1
DOTENTIONETEDO
RV1 20k min. trim pot
CAPACITORS
C1
CAPACITORS C1
C2,3 A
polyester
SEMICONDUCTORS
IC1
Q1
ZD11N5349B 12V/5W Zener diode
D1.5 1N4004
D1-5 1N4004 D6-9 1N914, 1N4148 etc.
MISCELLANEOUS
RLA1
SPDT, 10A contacts PCB, wire, solder etc.
BUYLINES page 34

IC1a will go low before C2 can charge to the second trigger level, and it will discharge rapidly into the low output via diode D6. Thus only signals which do not have a zero crossing for longer than 100ms will trigger the protector.

The over-power detector consists of a voltage divider, formed by R3 and RV1, driving a third Schmitt trigger. Whenever the voltage exceeds the trigger level, the output of IC1b will be driven high and C3 will commence to charge. If this condition persists for long enough, the output buffers will drive the relay, disconnecting the speaker lines.

Note that both the DC sense and the over-power detector charge C3 when a fault condition occurs. The circuits are decoupled from the capacitor by diodes, so that it can only discharge through R12 (the effect of the input impedance of the buffers is negligible). Together, R12 and C3 have a time constant of about one second, therefore the relay will hold on for this length of time. Thus the speaker lines are re-connected approximately one second after a fault condition has been detected.

Construction

Construction is straightforward since all of the components are mounted on the PCB. The usual precautions should be taken to ensure that all polarised

components have been mounted with the correct orientation. The IC used is a CMOS type and is therefore static sensitive. Solder this last, and preferably using an earthed soldering iron. It is a wise precaution to discharge yourself before handling the device by first touching an earthed metal appliance.

It is a wise precaution, also, to space the 2.5W resistor, R2, off the PCB slightly. In the case of a high powered loudspeaker going faulty with DC this component will get quite hot, and spacing improves ventilation around the component and prevents the possibility of charring the board. If you can't obtain a 2.5 watt type then a 5 W type may be substituted.

Before mounting the unit check operation by connecting around 20VDC across the speaker input terminals on the PCB. The relay should cut in after about one tenth of a second. If the protector passes this test, connect the speaker wiring. If the preset is turned fully down (turn it anticlockwise when viewing the board with the components on top and the relay to the right) the relay will cut in when the power exceeds around 20 watts for an extended period. The protector allows transients to the full supply rail to pass but will prevent a continuous 20W from being applied to the loudspeaker. To increase this, turn the preset clockwise until the desired response is achieved.

Performance

We tested the loudspeaker protector for its effect on audio performance as well as its reliability. A variety of power amps were used to ensure that the load represented by the protector would not affect audio performance. Even a very low power amplifier, with a comparatively small damping factor (high output impedance) could drive the unit with no degradation to the sound quality. During every test the protector worked well and cut in at the correct time to prevent damage to the loudspeakers.

NOTE. Some amplifiers are unstable when driven into an open circuit. This is particularly true of valve power amplifiers, some of which destroy themselves the moment the speaker is disconnected. Loudspeaker protectors are, however, not usually required for use with valve power amps, since the possibility of DC on the speaker lines is remote. But over-power protection may be required.

HE

HEMMINGS ELECTRONICS

Electronic Components & Microcomputers 16 BRAND STREET, HITCHIN, HERTS, SG5 1JE Telephone: (0462) 33031

		TBA820M 85p						
COMPUTER ICS	MEMORIES	TBA530Q 140p	TRANSIS	TORS I	BD679A	60p	TIP36A	175p
6502 350p		TBA550Q 280p	BC107	12p	BD6B0A	65p	TIP36B	185o
	2708 220p	TBA990Q 190p			BFY50	24p	TIP36C	199p
6522 340p	2114L 90p		BC107B	150	BFY51	24p	TIP41	50p
6800 290 p	2716 210p	TBA480Q 175p	BC108	12p	BFY90		TIP41A	
68B00 450p	2532 380p	TBA540Q 130n	BC108B	15p		85p		50p
6802 345p		TBA800 90p		12p	BF244A	30p	TIP41B	60p
					BSX19	28p	TIP41C	50p
	4164 500p			15p	BSX20	20 ₀	TIP42	58p
68B09 1350p	6116P3 390p	TCA650 390p	BC109C	15p	MJ2955	95p	TIP42A	60p
6809E 1295p	6116LP3 450p	TCA910 180p	BC147 .	9p				
6810 120p		TDA1004 290p	BC157	9p	MJE241	80p	TIP42B	75p
6821 160p	LINEAR ICs	TL061 40p	BC158	9p	MJE251	80p	TIP42C	65p
	AY-3-1270 725p				MJE340	50p	TIP47	50p
68B21 215p	AY-3-1350 350p		BC177	25p	MJE350	90p	TIP48	50p
6840 390p		TL064 98p	BC178	25p	MJE370	95p	TIP49	50p
68B40 580 p	AY-3-8910 435p	TL071 30p	BC179	25p			TIP50	
6844 1 295 p	AY-3-8912 620p	TL072 50p	BC182	10p	MJE520	90p		48p
6845 795p	AY-5-1230 450p	TL074 100p	BC182A	10p	MJE2955	90p	TIP110	30p
6850 140p	709 35p	TL081 25p	BC182B	10p	MJE3055	65p	TIP111	75p
	741 8 pin 25p				MPF102	45p	TIP112	50p
6852 250p		TL082 45p	BC183A	10p	MRF475	290p	TIP115	40p
6854 680p		TL084 95p	8C183C	10p	MPS2369	25p	TIP116	
6875 490p	741S 55p	UPC575 149p	BC184	10p				73p
8T26A 120p	747 65p	UPC1167 158p	BC184C	10p	MPS3640	30p -	TIP117	45p
8T28 120p	748 35p	UPC2002C 285p	BC212	10p	MPS3646	30p	TIP120	39p
	CA3080E 70p				MPSA06	20p	TIP121	80p
8T95 90p		UPD7002 450p	BC212A	10p	MPSA12	35p	TIP122	75p
8T96 90p	CA3130E 75p	ZN414 100p	BC212B	10p	MPSA13	20p	TIP125	45p
8T97 90p	LA4422 295p	VOLTAGE	BC213A	10p				
8T98 90p	LF355 80p		8C213C	10p	MPSA14	20p	TIP126	80p
8035L 340p	LF356 90p	REGULATORS	BC214	10p	MPSA18	20p	TIP140	130p
8039L 290p	LF357 100p	+ Ve	BC214C	10p	MPSA27	'45p	TIP141	140p
	LM301A 26p				MPSA42	25p	TIP142	180p
8080A 360p		100mA	BC237A	12p	MPSA56	25p	TIP145	140p
8085A 450p	LM307 50p	78L05 30p	BC237C	12p				
8155 450p	LM308A 95p	78L08 30p	BC238	12p	MPSA63	30p	TIP146	180p
8212 155p	LM311N 66p	78L12 30p	BC238A	12p	MPSA64	45p	TIP147	170p
	LM324 35p		BC238B		MPSA77	50p	TIP2955	70p
8216 100p	LM339 50p	78L16 30p		12p	MPSA92	30p	T1P3055	70p
8224 160p		500mA	BC238C	12p			TIS43	30p
8226 195p	LM348 75p	78M05 40p	BC239	12p	TIP29	3бр		
8228 250p	LM358 60p	78M06 55p	BC307A	15p	TIP29A	36p	TIS88A	48p
8243 210p	LM380 95p	78M08 55p	BC307C	15p	TIP29B	55p	TIS151	50p
	LM381 150p				TIP29C	40p	2N1613	25p
8251 300p	LM393 90p	78M12 50p	BC308	15p	TIP30	50o	2N1711	25p
82 53 450p		78M15 50p	BC308A	15p				
8255 280p	LM3909 85p	78M18 55p	BC308B	15p	TIP30A	36p	2N1893	35p
8257 450p	MC1310P 210p	78M24 55p	BC308C	15p	TIP30B	50p	2N2218A	45p
8259 450p	MC1455 66p	1A	BC309	15p	TIP30C	40p	2N2219	25p
	MC1456 135p				TIP31A	40p	2N2221	30p
8279 450p		7805 45p	BC309C	15p	TIP31B	42p	2N2221A	30p
75451 65p	MC1458 35p	7806 65 p	BC327	15p				
75452 65p	MC3242A 630p	7808 65 p	BC328	15p	TIP31C	45p	2N2222	25p
75491 70p	MC3302 95p	7812 45p	BC337	15p	TIP32	50p	2N2222A	25p
75492 70p	MC3340 120p		BC338	15p	TIP32A	45p	2N2369A	20p
	MC3401 65p				TIP32B	60p	2N2904A	25p
AY-3-1015D		7818 65p	BC477	28p	TIP32C	45p	2N2905	25p
300p		7824 66p	BCY70	18p				
AY-5-1013A	MC3456 107p	-Ve	BCY71	20p	TIP33	65p	2N2905A	25p
300p	MC3480 580p	100mA	BCY72	20p	TIP33A	65p	2N2906A	25p
MC1408 296p	MC34001 58p		BD135		TIP33B	70p	2N2907A	25p
	NE555 16p	79L05 35p		42p	TIP33C	75p	2N3053	30p
MC1488 55p		79L12 35p	BD136	45p	TIP34	75p	2N3054	70p
MC1489 55p	555 CMOS 90p	79L15 35p	BD139	40p				
MC3459 265p	NE556 56p	1A	BD140	40p	TIP34A	75p	2N3055	45p
Z80ACPU 350p	NE565 155p	7905 60p	BD165	45p	TIP34B	99p	2N3439	80p
	NE567 140p				TIP34C	90p	2N3440	60p
Z80APIO 300p	SN76023 180p	7906 70p	BD166	45p	TIP35	160p	2N3771	160p
Z80ACTC 300p		7908 70p	BD169	45p	TIP35A	165p	2N3772	160p
Z80ADART	TA7205A 125p	7912 60p	BD170	45p				
750p	TBA560Q 160p	7915 60p	BD538	95p	TIP35B	170p	2N3773	250p
. 500	TBA750 280p	7918 60p	BD677	60p	TIP35C	186p	2N3819	25p
	TBA820 95p				TIP36	170p	2N3821	120p
	dec order	7924 60p	BD678	60p				,p'

Shop opening hours Mon to Fri 9am to 5.30pm Sat 9am to 5.00pm Wed Closed

LIC LIQUID CRYSTAL
DISPLAY MODULES
PCIM177 Frequency Count
5 Digits, 0.35°
FM, SW, MW, MHz, KHz
Annunclators
Sample and Hold Capability
Reset Capability
25 Selectable IF Offsets
Prescaler Available
Incandescent Backlighting
Supply Voltage 5v
Operating Current 4mA

PCIM176 Digital Meter Module
3] Digits, 0.5"
+, - and Decimal Point
200mV Full Scale Input
True Differential Input
Guaranteed "0" Reading
Single 9v Operation
- Power Consumption 20mW
Accuracy 0.15%, +/- 1 Count
Temperature Drift 80ppm/C
Low Battery Indicator
Incandescent Backlighting £17.15

£22.50 Modules are supplied with Data Sheet.

FIBRE OPTIC POLYMER CABLE
A 10m coil of 1mm core optical
fibre cable sheathed in black
polyethylene for protection
£4.

TERMS OF BUSINESS — Professional quality electronic components brand new and fully guaranteed. Mail order by return of post. Cash, Cheque, Postal Order or Bankers Draft with order payable to HEMMINGS ELECTRONICS LTD. Access or Barclaycard available using our 24 hour answerphone service. Monthly Credit Accounts available on request to government and educational authorities. Industrial customers wishing to open a credit account are required to furnish a bank, reference and two trade references. Postage and packing add 45p to all orders under £10. All prices are exclusive of VAT. Please add 16% to total including pcp. No VAT on export orders or books.

3822	12Up	2N4922	96p	ALEAC ETCH
3823	95p	2N4923	95p	ALFAC ETCH
3824	95p	2N5190	75p	RESIST TRANSFERS
3866	90p	2N5191	75p	Make your own Printed Circuit
3903	15p	2N5192	75p	Boards with our PCB transfers
3904	15p	2N5193	90p	Draw your artwork on 0,1" grid
3905	15p	2N5194	90p	Transfer to copper board
3906	15p	2N5195	90p	using carbon paper
4123	25p	2N5400	40p	Burnish the Alfac transfers to
4125	25p	2N5401	40p	the board using a spatula using
4391	70p	2N5415	85p	carbon marks to assist in accurate
4392	70p	2N5416	90p	alignment
4400	20p	2N5457	35p	Using Alfac chemical eraser to
4401	25p	2N5458	35p	correct mistakes
4402	25p	2N5459	35p	Etch in Ferric Chloride
4403	25p	2N5460	35p	EC900/1 0.1" Edge Connector
4410	45p	2N5551	40p	EC902/1 0.156" Edge Connector
4416	95p	2SC495	60p	EC940 0.016" Lines
14856	80p	2SC1306	95p	EC941 0.031" Lines
14857	80p	2SC1678	105p	EC942 0.039" Lines
14918	95p	2SC2028	75p	EC943 0.049" Lines
4919	120p	2SC2078	106p	EC944 0.061" Lines
14920	130p	VN10KM	65p	EC945 0.079" Lines
14921	105p	40673	95p	EC946 0.100" Lines
21110	001/0	TAI		EC947 0.124" Lines
QUID	CHY5	IAL		EC950/1 0.031" 90° Bends
SPIAY	/ MOI	HILES	- 1	EC950/2 0.061" 90° Bends
SPLAY MODULES IM177 Frequency Counter				EC952/1 0.031 30°,45°,60°
		cy Counter		Bends
igits, O.	4\A/ 44L	1- VII-		EC952/2 0.061° 30°,45°,60°
, SW, A		nz, renz		Rands 0.001 30 ,45 ,00

Bends
EC908 0.063" Pads
EC910 0.094" Pads
EC911 0.189" Pads
EC960/1 TO-5 Transistor Pads
EC993/1 IC Pads with tracks
between pads
5 identical sheets in sealed 5 identical sheets in sealed pack Individual sheets Individual sheets Spatula ARR for burnishing Alfac knife Spare Blades (pack of 10) Alfac Fresion Grids Polyester film, mart finish 0.14mm thickness, 20 lines/in AR

Double Sided Fibreglass Board 1/16" thickness, 1oz Copper 5" x 4"

GO FORTH AND
MULTIPLY
MUCH QUICKER
MUCH QUICKER
JUPITER ACE COMPUTER
in stock
589.65 line VAT
Cerriege £2.00

CRYSTALS

	9111911109											
32.768 1.0000 1.8432 2.0000	MHz MHz	100p 320p 240p 225p	6.000MHz 6.144MHz 6.880MHz 8.000MHz	180p 180p 240p 160p								
2.4576 3.0000 3.5795 3.6864 4.000M	MHz MHz MHz Hz	225p 240p 120p 240p 150p		200p								
4.193M 5.0688I		190p 240p	27.000MHz 48.000MHz	170p 170p								

INFRARED TIL32 Emit

54p 45p **54p** 70p

TIL38 Emit TIL78 Phot TIL100 Pho	otransistor	
EPSON	MX80F/T	n

YPE III PRINTER

80 Characters per Second Friction and Tractor Feed High Resolution 960 Dots/Line Auto Underlining Subscripts and Superscripts £320

Securio VIC-20 COLOUR

£195 inc.VAT

COMPUTER ● SPECIAL OFFER ●

VIC-20 Colour Computer C2N Cassette Deck Programmer's Ref Guide Demonstration Cassette Game Cassette

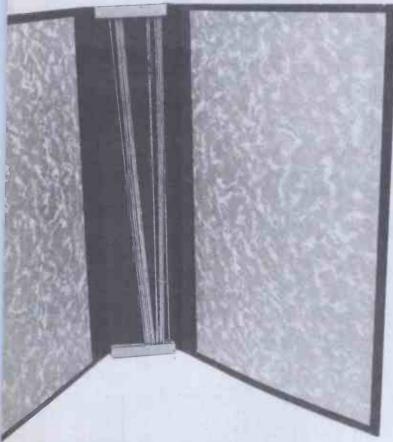
10 Blank Cassettes
VIC Computing Magazine

COMMODORE 64 COMPUTER

64K RAM, 26K ROM
25 Lines of 40 Characters
16 Colours, 512 × 256 Graphics
Options – VIC Peripherals
Alternative Languages Second Processo KEYNET Network

£299 Securicor £6

SAVE £4.25 by receiving a FREE magazine binder when you subscribe to Egyptonic



It's true, by subscribing to Hobby Electronics you will not only receive your personal copy direct to your door for a whole year but also have a superb A S P magazine binder in which to keep your copies AND IT'S FREE!

All you have to do to receive your FREE binder is book a new subscription or renew an existing subscription to Hobby Electronics before 30th April 1983. What could be simpler? Normally priced at £4.25, these attractive binders will hold approximately 12 issues of Hobby Electronics. Not for you any longer the chore of having to track down dogeared copies

having to track down dogeared copies of your favourite magazine, instead you will merely go to your bookshelf and they will be waiting for you in pristine condition.

Don't miss out on this outstanding offer — subscribe today and receive your FREE binder within 14 days of your order being received.

SPECIAL OFFER

Cut out and SEND TO ::

Habby Electronics

513, LONDON ROAD, THORNTON HEATH, SURREY, CR4 6AR ENGLAND.

Please send my free binder and commence my personal subscription to with the issue

SUBSCRIPTION RATES

(tick □ as appropriate)

 Debit my Access/Barclaycard *
(*delete as necessary)

Insert card no.

Please use BLOCK CAPITALS and include post codes.

Name (Mr/ Mrs/ Miss)

delete accordin

Signature

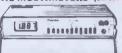
Date

CALL IN AND SEE FOR YOURSELF

TEST EQUIPMENT CENTRES ALL MODELS ON DISPLAY
OPEN SIX DAYS A WEEK

RETAIL • MAIL ORDER • EXPORT • INDUSTRIAL • EDUCATIONAL

DIGITAL MULTIMETERS (UK C/P Free)



MA ND MELD R 025 C* 13 range 0.2A DC 2 meg ohm K 030C * 26 range 1A AC/DC 20 meg ohm K 055 C* 28 range 10A AC/DC 20 meg ohm G010+22 range 10A AC/DC 20 meg ohm £34.95 £39.95 £34.40 7030+ As 6010 but 0.1% basic. £4,30 188M 16 range 10A DC. 2 mag plus Me tester £39.95 189M 30 range 10A AC/DC. 20 mag plus Me

HAND HELD AUTO RANGE DM2350#21 range 10A AC/OC 20 meg ohm £49.95 £41.95 £44.50 €58.95

TIS DE BENCH MODELS [3% digil unless stated]

TM353-27 range LCD 10A AC/DC £86.25
TM355-29 range LED 10A AC/DC £86.25
TM351-29 range LED 10A AC/DC £13.85
2001 28 range LED 10A AC/DC £13.85
2001 28 range LED 10A AC/DC plus 5 range
Cap. Meter with case £108.00
TM451 4½ dight LCD every facility [0.02%] £171.00
15034-8 (0.03%) basic version of above £189.00
- Hootingal carry case £2.68
- With fire carry case +Optional carry case £2.95 •With free carry case •Optional carry case £6.84

EDUCATIONAL DISCOUNTS AVAILABLE FOR ALL STOCKS - PLEASE ENQUIRE

FREQUENCY COUNTERS

TP1000 1 GHZ

IIIK C/P 85al

Y7206 20K/V.

SPECIAL PRICE

cont. buzze

19 range pocket meter SPECIAL PRICE

Range doubler 10A DC

C7081 50K/V 21 ranges.



LED 8.0 max. nano neid pocket 8 digit LED bench 2 ranges 100 MHZ £77.00 £8103 9 digit LED bench 2 ranges 600 MHZ £178.00 TF040* 9 digit LED 3 ranges 1 GHZ £178.00 TF040* 9 digit LCD 40 MHZ £126.50 Pptional carry case £6.64 Preacolors - Extended range of most counters TPC00 £00 MHZ £43.00 TP1000 E00 MHZ PFM200A 200 MHZ hand held pocket 8 digit £43.00 £74.00

ELECTRONIC INSULATION TESTER

£7.95

£15.95

YF 501 500 V/0-100m with carry case

ETC5000/5001 21 ranges, 50K/V, Range

830A 26 range 30K/V. 10A AC/DC overload

10A AC/DC plus Hie AT1020 18 range 20K/V. Deluxe plus Hie

ST303TR 21 range 20K/V plus Hie tester

protection, etc. 360TR 23 range 100K/V. Large scale

TMK 500 23 ranges 30K/V. 12A 0C plus

NH568 20K/V. 22 range pocket

EU102 14 range 2K/V pocket

VARIABLE POWER

PP241 0/12/24V. 0/1A. £35.00

PP2433 amp version £59.95

SUPPLIES

MULTIMETERS

FUNCTION : All sine/square/triangle/TTL etc TG 100 1 HZ - 100 KHZ TG 102 D.2 HZ - 2 MHZ PULSE TG105 Various facilities 5 HZ - 5 MHZ AUDIO: Multiband Sine/Square LAG27 10 HZ to 1 MHZ AG202A 20 HZ to 200 KHZ

intra O 60 5 5

SG402 100 KHZ to 30 MHZ LSG 17 100 KHZ to 150 MHZ AUDIO . RF . FUNCTION . PULSE







£90.00 £166.75

€97.75

£276.00 £299.00

Full specification any model on request SAE by post.

'MM' Series HAMEG: 'SC' THANDAR: 'CS' Series TRIO: '3' Series CROTECH

SINGLE TRACE €16 50 £23.95 £10.95 €5.95

sween delay

£83.00

£36.95

3030 15 MHZ 5mV. 95mm tube plus component tester C/P 63.00 £172.50 SC110A*. Miniature 10 MHZ battery portable Post free £171.00
MRI 103 15 MRZ 2mV. 6 x 7 display plus component lester C/P £3.00
£177.00
£177.00
Nicads £12.50 DUAL TRACE (UK C/P £4.00)

HM203/4 Dual 20 MHZ plus component tester CS 1566A Qual 20 MHZ, Alt facilities HM204 Qual 20 MHZ plus component tester

£419.75 OPTIONAL PROSE KITS X1 - X10 £7.95 £10.50 X10 X100 STOCKISTS FOR TRIO: MAMEG: CROTECH: SAFGAN'SCOPES. MOST MODELS IN STOCK.

DIGITAL THERMOMETER

TH301 LC0 -50 'C to +750' with

AC CLAMPMETER

(UK C/P £1.00)

\$T300 0/300A; 0/600 VAC, 0/1 Kohm 9 ranges With carry case (UK C/P 65p) €28.50

LOGIC PROBES LP10 10 MHZ LDP076 50 MHZ

HIGH VOLTAGE METER Direct reading 0/40 KV. _____ 20K/Volt. (UK C/P 85p) £18.40

DIGITAL CAPACITANCE 0.1 pf to 2000 mtd LCO 8 ranges DM6013 £57.95 (Carry case £2.95)

TRANSISTOR TESTER Direct reading PNP: NPN, etc. (UK C/P 65p)



AUDIO ELECTRONICS Cubegate

301 EDGWARE ROAD, LONDON W2 1BN. TEL: 01-724 3564 ALSO AT HENRYS RADIO. 404/406 EDGWARF ROAD LONDON W2





"BIG TRAK" MOTORIZED GEARBOX

These units are as used in the "Big Trak" computerized vehicle, and offer the experimenter in robotics the opportunity to purchase the electro-mechanical parts required in building remote controlled vehicles. The unit comprises:

a) 2 × 3V motors, linked by a magnetic clutch, thus enabling turning of the vehicle;

b) 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, as well as a direction controller circuit, enabling the unit to turn right, left or go straight shead.

SIMON GAME

. . . is back again. Another supply of ready built PCB's for this flashing light/pulsating tone computerised game is now with us. Supplied, tested and working with speaker & instructions £4.95.

REED RELAYS

Manufacturers rejects — DIL and other PCB mounting types. SP, DP and 4P — make, break & c/o contacts. Not tested, so may be only partially working or o/e etc, so very low price — pack of 10 ing or o/c etc, so very low price assorted £1; 25 £2.00; 100 £7.00

FERRIC CHLORIDE

New supplies just arrived — 500 mg bags of granules, easily dissoved in 500ml of water. Only £1.15 Also abrasive polishing block 95p.

AA NI-CADS 10 for £9.95

Brand new nickel cadmium batteries by GE, standard 1.2V 1 450mA/H. Professional quality with solder tags both ends. Special price, £1.40 ea; 10 for £9.95; tags both ends. Special price, £1.40 ea; 10 for £3.95; Box of 80 £65. Not of Charger: Charges up to 4AA, C or D cells + PP3. Only £7.95

FILAMENT DISPLAYS

2653 7 seg displey 12.5mm high. Ideal for TTL operation, taking 5V BmA per seg. Std 14 DIL package. Only £1 each, 4 for £3.00. Data supplied.



Electrical combination lock for maximum security, absolutely pick proof! One million combinations! Dial is turned to the right to one number, left to a second number, then right again to a third number. Only when this has been completed in the correct sequence will the electrical contacts close. These can be used to operate a relay or solenoid etc. Overall dia 65mm x 60mm deep. Flinished in bright chrome. With combination the price is reduced to £3.95. Electrical combination lock for maximum securi-



LIE DETECTOR

Not a toy, this precision instrument was originally part of an 'Open University' course, used to measure a change in emotional balance, or as a lie detector. Full details of how to use it are given, and a circuit diagram. Supplied complete with probes, leads and conductive jelly. Needs 2 4½V batts. Overall size 155 x 100 x 100mm. Only £9.95 — worth that for the case and meter alone!

COMPONENT PACKS

K603 150 wirewound resistors from 1W to 12W, with a good range of values £1.75 K505 20 sacorted potentiometers, all types including single ganged, rotary and slider £1.70 K514 100 sliver mica caps from 5pF to a few thousand pF. Tolerances from 1% to 10% £2 K520 Switch Pack. 20 different rocker, slide, rotary, toggle, push, micro, etc. Only £2

COMPUTER BATTLESHIPS

Probably one of the most popular electronic garnes on the market. Unfortunately the design makes it impractical to test the PCB as a working model, although it may well function perfectly. Instead we have tested the sound chip, and sell the board for its component value only (PCB may be chipped or cracked). SN/5647 sound IC; TMS1000 uprocessor; batt clips, R's, C's etc. Size 160 x 140 mm. Only £1.50. Instruction book and circuit 30p extra.

1982/3 CATALOGUE

Bigger! Better!! Buy one!!!
Only 75p inc. post — Look what you get!!
Vouchers worth 60p
1st class reply paid envelope
Wholesele list for bulk buyers
Bargain List with hundreds of surplus lines
Huge range of components
Low, low prices

Low, low prices
 Sent free to schools, colleges etc.

REGULATED PSU PANEL

Exclusive Greenweld design, fully variable 0-28V & 20mA-2A. Board contains all components except pots and transformer. Only 17.75. Suitable transformer and pots £6. Send SAE for fuller details.

ALL PRICES INCLUDE VAT - JUST ADD 50p P&P

443F Mill Brook Road, Southampton SO1 0HX

RADIO RULES

lan Sinclair

Propagation and aerials

YES, AERIALS! I know that all of the US magazines use the word antenna, but what Marconi called it is good enough for me. As you might have gathered by now, this Part is about how you get that modulated carrier winging its way from the transmitter to the receiver, which means that we're dealing with the most tricky of all electronic components, emp-

ty space.

As it happens, most of the space that we use is not exactly empty, but the presence of air makes so little difference to the way a radio wave behaves that it might as well be empty space. One of the great mysteries that baffled great brains for centuries was how light waves could reach us from the sun if there was no material between us and the sun to carry the waves. The problem was finally solved by Clark Maxwell (see Famous Names, HE May '81) who, in a brilliant piece of theoretical reasoning, showed that a wave consisting of both electrical and magnetic fields could move through empty space. In this respect, electromagnetic waves are totally unlike the more familiar waves of sound and of water.

Both electrostatics and magnetism are involved in the electromagnetic field. A varying voltage between any two points causes a magnetic field, and a varying magnetic field causes a voltage. The electric and magnetic fields chase each other along, needing no matter to contain them or be affected by them, and their speed is around 300 million metres per second. What we call 'light' is just one of the huge range of electromagnetic waves, all of which travel at the same speed in space, and which are distinguished from each other only by their different frequencies and wavelengths. These two quantities are, incidentally, related, because frequency x wavelength = speed, and the speed is constant - see Table 1. For radio waves, then, we can always find what the wavelength is for any given frequency, or the other way round, and Figure 1 shows some examples.

Electromagnetic waves can travel in insulators, though at a lower speed than in air or in free space, but they cannot travel in their normal form through good conductors, because a good conductor will short-circuit the electric field part of the wave. Waves can travel along the surface of a metal, however, and can be reflected from conducting surfaces. For many of our purposes, the electric field component of a wave is the important one, and most of our transmission systems cause the electric field to move in one particular direction. When this is so, the wave is said to be plane-polarised. If the electric field is parallel to the surface of the Earth, the wave is horizontally

polarised, and if the electric field is 90° to the surface of the earth, the wave is vertically polarised. The direction of the magnetic field is always at 90° to the direction of the electric field, and both fields are at 90° to the direction of motion (Figure 2).

WAVELENGTH	FREQUENCY	= VELOCITY
(in metres)	(in Hertz)	OF LIGHT
		$(3 \times 10^8 \text{ m/s})$

VAVELENGTH	FREQUENCY
85 m	3.5 MHz
42 m	7 MHz
30 m	10 MHz
21 m	14 MHz
14 m	21 MHz
10.7 m	28 MHz

FREQUENCY = 11,24 MHz = 11.24 x 106

WAVELENGTH =
$$\frac{3 \times 10^8}{11.24 \times 10^6}$$
 = 26.69 m

Table 1. Calculations on wavelength and frequency.

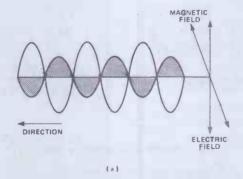


Figure 1a. The electric and the magnetic waves are at 90° to each other and also at 90° to the direction of movement.

Propagation

Propagation means the way in which a wave travels from one place to another. Over short distances, the path of a wave can be taken as a single straight line, the 'line of sight' from the transmitter to the receiver. For many of the distances we are interested in, however, the path of the wave will involve at least one reflection from the ionosphere, which is the reflecting layer above the atmosphere of the Earth (Figure 3). This reflecting layer is created by the action of sunlight on the low-pressure gases more than 70 miles above the surface of the Earth. The highenergy ultra-violet rays of the sun (which at that height would burn you up to a fraz-zle in seconds) separate the oxygen and nitrogen of the air into charged particles, called ions, so making the low-pressure gas behave like a conductor. In darkness, these particles recombine (sometimes causing a glow in the sky, hence the Northern Lights or Aurora Borealis), which is why there are such considerable differences between daytime and nightime radio ranges. There are also considerable

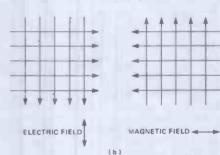


Figure 1b. Another representation of the polarisation of electromagnetic waves.

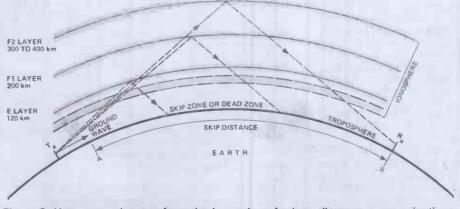


Figure 2. How waves bounce from the ionosphere for long-distance communications.

variations in the ultra-violet output from the sun, which leads to the degree of ionisation varying considerably from time to time.

The way in which radio waves travel by bouncing from the ionosphere also accounts for reception problems. Fading is caused because waves that have travelled along different paths can be received simultaneously. Because the path length is never constant as the ionosphere churns around, waves which meet at the receiver may be in phase, out of phase, or any amount of phase degrees apart, causing the amplitude of the received signal to vary considerably, right down to almost zero at times. For some reflecting conditions, the phase of the reflected wave may depend on its frequency, so that the two sidebands of the AM signal may be out of phase, causing severe distortion. This is why suppressed-carrier SSB signals are so often superior in signal quality.

Launching-Pad

An aerial is a form of launching-pad for waves, and since all of our aerials are made of metal, they create an electric field in the air around them, so that what you acutally launch is the electric-field part of the wave. Liké Mary's little lamb, its magnetic field is sure to go every where with it.

Launching a wave into space (Figure 4) is like transferring power to anything; it needs some matching of impedance. You can't, for example, expect to transfer much power to an eight ohm loudspeaker from an amplifier with a 2k output resistance, and the same applies to aerials, so that the action of an aerial depends to a large extent on the imedance of space. What on earth do we mean by the impedance of space? Just this: a radio wave carries power, and power means volts and amps. When a radio wave travels through space, we can measure the volts between two points in the wave, and we can also measure the amps that are flowing. The ratio of volts to amps is called the impedance, and it is measured in ohms (R). The ratio of peak voltage to peak current in a wave is called the characteristic impedance of free space, and that's a figure which can be calculated (rather than measured) at about 377 ohms. When we put an aerial into this space, however, the aerial acts as a contact which alters the impedance to some extent, so that what we have to match is not the impedance of free space, but the impedance of aerial plus space, which is usually a lower quantity.

The most efficient aerial for transmitting purposes is one which has the maximum amount of electric field between its ends when a wave is sent to it. The shortest possible aerial of this type, called a half-wave dipole (yes, it's half a wavelength long) will also have a fairly low impedance, around 70 ohms, and is almost perfectly resistive — it dissipates power into space with no reflections. In general, an efficient aerial needs to be cut to a length which is a whole number of half-wavelengths. For example, the wavelength of a 28MHz wave in space is 10.7 metres, and if we allow for the wavelength on the wire of the aerial being

about five per cent less than this, we arrive at the figure 10m. Half a wavelength is 5m, so that aerial lengths of 5m, 10m, 15m, 20m and so on would be acceptable. Table 2 shows the half-wavelength lengths corresponding to some popular amateur bands.

The reason for preferring aerials of this half-wave length can be understood more easily if we superimpose against a drawing of the aerial a diagram of the voltage in a wave (a 'standing wave'), using the same scale. A half-wave aerial has a pattern of the type shown in Figure 5. The maximum voltage is at each end, so that the electric field across the aerial is large, and the maximum current is in the middle. The conditions for drawing these standing waves are that there should always be maximum voltage at the ends and maximum current in the middle — the

FREQUENCY	HALF-WAVE
(MHz)	(metres)
1.8	74.9
3.5	39.0
7.0	20.1
14.0	10.05
21.0	6.7
28.0	5.02
70.0	1.8
144.0	0.97
430.0	0.32

Table 2. Half-wave lengths in metres for the popular amateur bands.

wave cannot be stable otherwise. Figure 6 shows the standing-wave pattern for a full-wave aerial length.

The ratio of voltage to current obvious ly varies from one part of an aerial to another, being very large at the ends of a half-wave aerial, and very small at the middle. Note, however, that if the aerial is correctly cut to length, there is no phase difference between current and voltage — they rise and fall in step. These standing-wave patterns are permanent on an aerial of the correct length — there will never be a time when the voltage at the centre of the half-wave aerial is large and the current small, for example.

An aerial which is cut to a number of half-waves in length is said to be resonant, and an aerial of this type works most efficiently at the frequency for which it is designed, though it may radiate at some harmonic frequencies as well, because it will also be a number of halfwaves long for some harmonic frequencies. The radiation of a horizontal halfwave aerial is not equally strong in all directions; it tends to be strongest along a line at right angles to the aerial's length, following the pattern shown in Figure 7. Longer resonant aerials, (one-wave, oneand-a-half-wave, two-wave, etc.) radiate over a wider range, and very long resonant aerials will radiate almost in the direction of the wire, but few people, unless they live on farms, can use long resonant aerials, particularly on the lower frequency, longer wavelength bands. When the half-wave aerial is used ver-

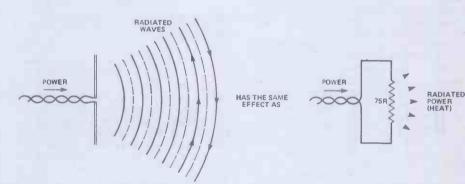


Figure 3. A half-wave dipole radiates waves, behaving as far as the transmitter is concerned like a 75 ohm resistor (which radiates heat).

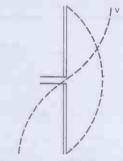
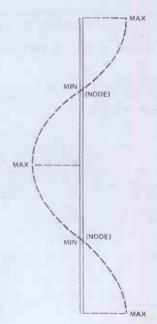


Figure 4. Wave pattern of a half-wave dipole aerial. The maximum wave voltages are at the ends, and the minimum in the middle.

Figure 5. The wave pattern for a fullwave aerial. There are three maximum positions and two minimum positions.



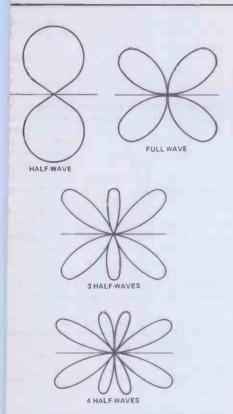


Figure 6. Theoretical radiation patterns for aerials — these show how the wave goes out in different directions.

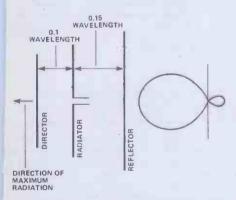


Figure 7. A three-element Yagi, made by adding a director and a reflector to the dipole. The director is shorter than the dipole, and the reflector is longer.

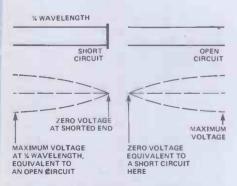


Figure 8. Quarter-wave sections. A shorted quarter-wave piece of cable acts like an open circuit; an open circuit quarter-wave section acts like a short circuit because of the wave patterns, shown here.

tically, however, its radiation pattern is omnidirectional — equal in all directions around it.

These patterns are theoretical and are found in practice only when aerials are spaced well away from the ground and any other conducting objects, but they form a reasonable guide to what we can expect. We can modify the patterns very considerably by adding 'dummy' aerials or parasitic elements parallel to the main half-wave aerial and spaced some distance away from it. One popular arrangement is the three-element Yagi of Figure 8 in which a slightly longer element, the reflector, is set at 0.15 wavelength from the radiating aerial, and a shorter element, the director, is set at 0.1 wavelength in the opposite side. This arrangement gives a very much more directional beam, and if you want to change the direction of transmission, you will have to turn the whole assembly just about possible for a 10m wavelength.

Feeding the Power

One of the most critical parts of radio transmission practice is the correct feeding of power from the transmitter to the aerial, and it's all a matter of wavelengths again. We get accustomed to the idea that if you have a voltage on one end of a piece of wire, you'll have exactly the same voltage on the other end. That's true of AC and DC generally when no current flows, but not when the length of the wire is something like the wavelength of the AC. When a piece of wire is some appreciable fraction of a wavelength long, like a quarter wavelength, then it can have very different voltages on its ends, simply because a wave has formed on the wire.

Normally, this effect doesn't bother us. Our electronics equipment is made so that the dimensions of conductors are all very small compared to the wavelength of the signals that they are handling. This becomes much more difficult for UHF signals, and that's why UHF is so tricky to work with. In any transmitter circuit, however, there is one piece of connecting wire which just has to be long - the wire that connects the output of the transmitter to the aerial, called the tranmission line. For best results, an aerial should be placed as far away from buildings as possible, and that means that the transmission line, or feeder, will be long, often considerably longer than one wavelength. Ideally, we want the waves to travel along this line from transmitter to aerial, but if we get things wrong, the waves may be reflected back to the transmitter, causing a loss of radiated power. The transmission line can, if not correctly designed, waste a lot of that precious power.

What happens? The line is carrying a wave and it, like the space round the aerial, has a characteristic impedance, usually of 75 ohms or 300 ohms, depending on the construction of the line. Unlike space, though, we can do things to a line, such as shorting or open-circuiting the ends. When we do such things, the line can behave very differently, as we can demonstrate by drawing wave diagrams. A shorted line one quarter wavelength

long, for example, will behave like an open circuit for waves of that length, (Figure 9) and an open circuit quarterwave line will behave like a short circuit. Pieces of line attached to the main line can therefore be made to act like transformers, or as resonant filters, making the way the waves behave work for us instead of against us.

Standing Waves and Travelling Waves

Our ideal transmitter rig would feed waves from the transmitter, up the transmission line to the aerial where they would be wholly radiated into space. The speed of the waves along the transmission line is not as high as their speed in free space, and can be taken as about 66% of free space speed in coaxial cable and 85% of free space speed in twin-line feeder. These ideal conditions are met if the transmitter output impedance, the feeder impedance and the aerial - plus -space impedance are all identical at the frequency of transmission. This is what is termed a perfectly equalised load condition, with a non-resonant feeder. Such conditions can be approached even if the equalisation is not perfect, providing that

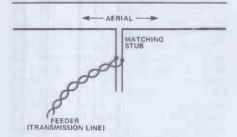


Figure 9. Using a matching stub to match an aerial to a transmission line. The stub acts like a transformer.

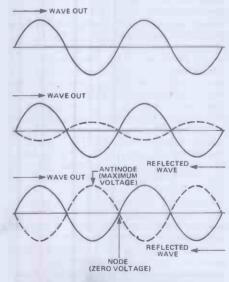


Figure 10. Reflection in lines. (a) Pattern of a wave travelling along a line with no reflections. (b) A wave travelling along a line, with some reflection which causes a wave to travel in the opposite direction. (c) Total reflection, so that the pattern shown, a standing-wave pattern, forms. No energy is being radiated from the line now.

the length of the feeder can be adjusted, or some other means of matching used. As transmitters are universally constructed nowadays to have an output impedance of 50 ohms, aerials can be constructed to a variety of impedance values, and feeders generally have an impedance of 75 ohms or of 300 ohms. We usually have to take some steps to match these different impedances to each other.

At the aerial, this is achieved by the correct shaping of the aerial, or by the addition of 'matching stubs', which are the short sections of line that behave like transformers (Figure 10). At the transmitter, the transmission line is matched to the output impedance of the transmitter by using a wideband variable transformer which is called an aerial tuning unit (or antenna tuning unit, if you must), shortened to ATU.

How do we know when we have achieved matching? The answer lies in the way that waves behave when a mismatch is present. The worst possible mismatches are open circuits or short circuits, and these will both cause power to be completely reflected back down the line (Figure 11). Even a small mismatch, however, will reflect some power, so that measuring the reflected power is a good way of measuring the closeness of the matching. When a reflection occurs, standing waves form on the line, causing some parts of the line to be permanently at higher voltages than other parts. The ratio of the amplitude of such a standing wave to the (desirable) travelling wave amplitude (the one which goes up the spout and radiates away) is another good measure of matching, and we can obtain instruments which measure this standing wave ration, SWR for short. The SWR meters use a type of bridge circuit to balance the amplitude of waves travelling up the transmission line against the amplitude of waves reflected back, and the lower the SWR reading the better is your system. The minimum possible value (because of the way the SWR is defined) is one, but it's practically impossible to obtain such a reading - if you do it's time to have the meter checked! A SWR reading of less than two is pretty good, and if the line is a low-loss type, then you work with SWR values greater than two without greatly reducing the efficiency of your system, because in such circumstances, the amount of power which you get out will not be greatly affected by the SWR value. If the line is lossy (low-grade coax, for example), then high SWR spells low power output, and there is also the danger, whenever the SWR is high, that the reflected power will damage PA stages. Valve output stages are very much less likely to be damaged in this way than transistor stages.

Note by the way that the ATU will be used to match the transmitter to the transmission line. If the aerial is not correctly matched to the line, then no amount of fiddling with the ATU will get the SWR really low.

Aerial Shapes and Sizes

One thing that will strike you when you look through magazines and books is the huge range of aerials that you will find described, and the claims that are made

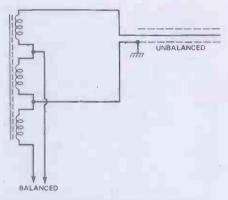


Figure 11. A balun circuit. A transformer construction is shown, but the balun can be constructed with lengths of transmission line.

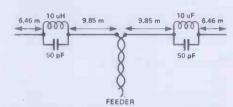


Figure 12. A trap dipole aerial. The trap is the parallel resonant circuit in each arm of the aerial.

for them. You might easily conclude that almost anything could act as an aerial — and you're quite close to the mark. Almost any piece of wire will act as an aerial for reception and for transmission anything that can be matched reasonably well will get a signal out. To get the best from the power of your transmitter, though, a correctly designed, constructed and matched aerial is essential.

The simplest type of aerial to construct is the half-wave dipole. This means a length of wire or rod equal to half a wavelength (allowing for the length of a wave on a wire being about 80 per cent of the length in free space), and cut at the centre to allow two connections. The impedance at the centre of such an arrangement is about 70 ohms, and resistive for the frequency at which the aerial is one half wavelength long, or an odd number (one, three, five, seven etc) of halfwavelengths long. An aerial of this type looks like a good impedance match for 70 ohms coaxial cable, but there is one snag the aerial is a 'balanced' arrangement, requiring signals of opposite phase on its two arms, and arranged so that the sum of the signals is zero. Coaxial cable, by contast, is unbalanced, with all of the signal on its inner core, and the outer core earthed. To ensure correct matching of a dipole aerial with coaxial feeder, then, we need a unit which will obtain balanced signals at the end of the coaxial cable; such a unit is called a 'balun', short for balanced to unbalanced transformer (Figure 12). This can be constructed — it consists of tightly-coupled windings on a ferrite core - but is more easily bought. Coaxial cable is convenient because most transmitter outputs are unbalanaced, so the coax is the most obvious type of feeder to use, being comparatively cheap, and with a balun at the end it operates

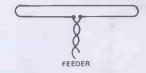


Figure 13. A folded dipole. Folding increases the impedance fourfold.

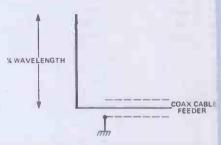


Figure 14. A simple vertical aerial. The snag is getting an efficient earth.

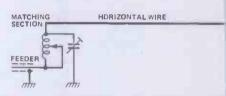


Figure 15. A horizontal (Hertz) type of aerial, and matching section.

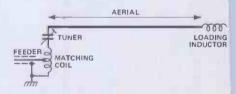


Figure 16. A Marconi aerial, much favoured at low frequencies.

very satisfactorily. If you use a transmitter which has a balanced output, then you must use either twin line (balanced line) of the correct impedance (usually 300 ohms), and no balun at the aerial end, or you can use coax with a balun at each end of the cable. In general, the fewer devices like baluns that you need to use, the better, because each device must lose some power.

Because the simple half-wave dipole is a one-frequency (plus odd-numbered harmonics) aerial, many variations on the design attempt to extend its use to other bands. The most successful of these variations is the 'trap dipole', which uses two sections in each half of the aerial, separated by a parallel LC circuit (tuned circuit). At its resonant frequency, its impedance is so high that it completely isolates the outer sections of the aerial, so that only the inner sections radiate. Figure 13 shows the arrangement of a trap dipole aerial that can be used at amateur frequencies ranging from 3.75MHz to 30MHz. The trap uses a 10uH coil and 50pF capacitor, making it resonant at around 7.1 MHz. The inner dipole is of 9.85 m and the outer of 6.46 m. It can give SWR figures of less than 2.5 on all the amateur bands within its range.

At 7MHz, the resonant trap completely isolates the outer sections of the aerial

from the inner ones, so that the inner sections are used as a straightforward 7MHz dipole. At 3.5MHz, the total length of the aerial, plus the equivalent length of the inductor of the trap, gives an aerial which will operate well at this low frequency. Above 7MHz, the end sections are not isolated but, with the operating frequency well above the resonant frequency of the traps, the traps act as capacitors which will resonate with the inductance of the outer sections of the aerial at frequencies which are odd harmonics of the fundamental frequency. At 14MHz, for example, with a wavelength of around 17m in wire, the half-way length is 8.57m, and 3/2 wavelengths (three half-waves) amount to 25.7m. The combination of the 2 x 6.45m outers with 2 × 9.75m inners, plus the capacitance of the trap, produces the same effect as this length of aerial. Similarly, it acts as a five-halfwave aerial at 21 MHz, and as a seven-halfwave aerial at 28MHz. The aerial matches well to a 75 ohm line, but, like all multiband arrangements, will not have the same high performance in every band. You can't have it all ways.

A simple dipole matches to 750hms, but if the dipole is folded, as shown in Figure 14 then its impedance is four times as much, 300 ohms, and this arrangement can be fed by 300 ohm twin line, providing that suitable matching exists at the transmitter. A dipole can always be matched by using 'matching stubs':

quarter wavelength pieces of transmission line (Figure 10) with the feeder attached at any point which gives the minimum SWR reading.

Dipoles can be formed into Yagi arrangements by adding reflector and director wires parallel to the dipole. A Yagi is much more directional than a plain dipole, so that it's useful mainly if you are trying to get out with maximum power in one direction only. The impedance of a dipole is considerably reduced by adding the other sections to make a Yagi but, by folding the dipole part, a reasonable match to 75ohms can usually be achieved.

Unbalanced Aerials

An aerial can be fed from one end rather than from the centre, and in such a case unbalanced coax cable is appropriate as a feeder. One form of unbalanced aerial is the vertical type, using a quarter-wave-length of vertical wire fed by 50 ohm coaxial cable (Figure 15). This type of aerial needs an earth under the wire, and because satisfactory low-resistance earth connections are difficult to make unless you live in a bog (I mean a peatbog, of course), the 'ground-plane' construction, using wires a quarter of a wavelength long arranged as radii of a circle on, or just under, the ground can be used in place of an earth connection (Figure 16). For VHF, the roof of a car makes a good ground plane, and lower frequencies can be catered for by using a loading inductor to increase the effective length of the aerial.

Another type of unbalanced aerial is the end-fed horizontal wire of Figure 17, which, for best results, should be half a wavelength long. Careful matching is needed to avoid harmonic radiation, and it's usually better to use a dipole unless you are keen on experimenting. An aerial of this type for the lower amateur frequencies needs a lot of wire, and shorter lengths can be used in what is called the Marconi aerial. This one uses an inductor connected at the far end of the aerial (remote from the feeder), with an autotransformer and capacitor at the feeder end for matching purposes (Figure 18). An earth directly into soil (NOT to mains earth or to a water pipe) will be needed.

In general, if you want to make your own aerial, then you must consult some of the magazines and books which are published by the RSGB (in Britain) or the ARRL (in the US). These are gold-mines of information on amateur radio, and if you are a determined constructor you will find in their pages information on every imaginable thing which has any application to amateur radio transmission and reception.

Next month: interference problems, and what to do about them.

HE





ELECTRONICS STEREO TUNER MODULE

3 BAND - L.W./M.W./F.M. MONO/F.M. STEREO

FULLY ASSEMBLED CIRCUIT DIAGRAMS

CIRCUIT DIAGRAMS
FERRITE ROD AERIAL
4 WAY FUNCTION SWITCH
WITH POINTER KNOB
12V d.c. INPUT SUPPLY
OUTPUT 0-1V R.M.S. ADJUSTABLE WAVERAND COVERAGE.

L.W. 155-270KHz M.W. 525-1650KHz F.M. 87.5-108MHz F.M. SENSITIVITY 2.5uV

PRICE £6.00 (PLUS £1.25 p&p)

2 WAY SPEAKER KIT — High Quality Peerless 6½" Full Range & 2" Tweeter. 8 ohms, 25W rms. Complete with Crosswester. John S. Complete With Cross-over Network and Full Wiring Diagram. PRICE £5.75 (PLUS ₾ pθp) ★3 WAY SPEAKER KIT — High Quality Peerless 8" Woofer ₺ 5" Midrange & 2" Tweeter. 8 ohms, 40W rms. Complete with Crossover Network and Wiring Diagram. PRICE £9.25



12V d.c. POWER SUPPLY UNIT 220/240V 50Hz input. 14.3V d.c. output Max. 1.1VA. Manufactured in U.K. to BS4435. Switched-Centre Off. 3 Forward and 3 Reverse positions. Complete with input and output leads. PRICE £2.50 (PLUS 75p pGp)

ALL GOODS FULLY GUARANTEED. DESPATCH BY RETURN OF POST. PRICES APPLY U.K. ONLY. TRADE ENQUIRIES WELCOME: CALLERS BY APPOINTMENT ONLY PLEASE.

MEON ELECTRONICS

49 Wadeson St., London E2 9DP. Tel: 01-981 7834

NEW SURPLUS RELEASE

Ex-GOVT LEAD ACID ACCUMULATORS. Brand new 10V 5Ah famous manufacture, Easily tapped in 2V stages. Size only 7inx5inx2in. Ideal for emergency lighting and power supplies. Burglar alarms, etc., Must have cost Govt over £20 each, Our price £5.69 each, carriage £5.0. Two for £10 carriage £10. All despatched unfilled. Robust wooden tray with carrying handles. Noids 8 accumulators £5.

CORDLESS INDUCTIVE LOOP HEADPHONES. Self powered, Input via loop or eternal min BNC socket. Contains translatorised high gain amplifier. Operates from internal batteries. Noise excluding muffs. Switch on when placed on head. Special offer while stocks last £8 pp £2. Two pairs for £12 coret free.

phones in good condition.

SCOOP PURCHASE: PYE SOCKET PHONE RECEIVERS. Type PF1 normal freq. 450 mHz.

SUpplied in used condition less battery. £4.50 each. Carriage £1. Two pairs £8.00 post free. Four

SCOOP PURCHASE: TE
SCOOP PURCHASE: TE
SUpplied in used condition less battery. £4.50 each. Carriage £1. Two pairs £9.00 post free. Pour pairs £16.00 post free.

THE GOVT. SURPLUS WIRELESS EQUIPMENT HANDBOOK. Gives detailed information and circuit diagrams for British and American Government Surplus Receivers. Transmitters and Test Equipment, for Carriage septement of the standard relegionement, etc. Also suggested modification details and improvements for Surplus equipment. In-corporated is a Surplus/Commercial cross referenced valve and transistor guide. The standard reference work in this field. Only £7.50 p + p £1.50. No VAT on books.

New nelease of MODERN DYNAMIC MOVING COIL MICROPHONES. 200 ohms impedance, Switch incorporated. Mostly with lead and DIN plug. Used but nice condition. Three designs of case housing. Price one mike our choice £2 plus 50p pp. Bargain offer all three mikes £4.50 pp £1. GENUINE £X-GOVT. COLLAPSIBLE ÆRIALS. A fully adjustable highly efficient with paerial in five sections. Length 1½ metres. Closed 300 m/m. Copper plated sections, As used on ex-Govt. Manpacks. Brand new in makers box £2.50 each pp 75p. Two for £5 post free.

HAVE YOU SEEN THE GREEN CATT 1000x of new components, radio, electronic, audio at unbelievably low prices. Send 50p and receive catalogue and FREE RECORD SPEED INDICATOR.

Try a JUMBO PACK Contains transistors, resistors, caps, pots, switches, radlo & electronic devices Over £50 worth for £111 Carriage & packing £2.50. A

MINI JUMBO PACK (620 worth)

For £5 nn £1.50. PLEASE ADD 15% VAT to all orders include

12/14 Harpur Street, Leeds, LS2 7EA. Tel: 452045

New retail premises at above address (opposite Corals)
Callers welcome 9 to 5 Mon to Sat. Sunday 10 till 3. Govt Surplus items always in stock

UNIVERSAL NICAD CHARGER TYPE FC4 £24.50 + £1.50 P&P

Power requirement : 240 V AC 60 Watts.

Constant current generator

Auto Timer

: Variable from 10 mA to 4 amps, Log Scale. 'Regulation OK' lamp

extinguishes on too high a load.

Variable from 1 min, to 60 mins. + 14 hrs. switched At 4 amp rate position.

Manual start and stop buttons. Timer on lamp.

: Power on lamp, mains switch on current control knob. Other Indicators

Capabilities

: Will trickle charge at 14 hrs, rates up to 12, 1.2 V Cells or 2 110 mAH 8.2 V mass plata cells.

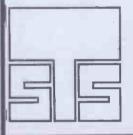
Will fast charge up to 7 of most types of sintered 1.2 V cells within one hour.

: D Cells 60 mins. C Cells 30 mins 506 C Cells . . . 18 mins

(Note: Lower currents and longer times may of course be used)

AA Cells





SOUTHERN TECHNICAL SYSTEMS, UNDERLYN FARM, MAIDSTONE ROAD. MARDEN. KENT TN12 9BE . Telephone Maidstone 831022



ELECTRONICS MICRO

Dept HE3, 180a Bedford Road, Kempston, Bedford MK42 8BL

WITCHED MODE PSUs

pecially for those interested in extending their knowledge of ectronics (which must be about 100% of you), we are turning to the Designer's Notebook feature with not one ut two articles. As you may gather from the heading, one of hese is not a million miles away from the subject of switched ode power supplies, one of the design fields often regarded s a no-go area for the hobbyist - that is, until that hobbyist eads ETI. The other Designer's Notebook will be on voltage nultipliers, so start queueing at the newsagents now.

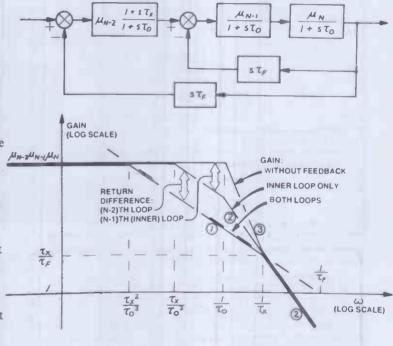
REAL-TIME CLOCK CALENDAR

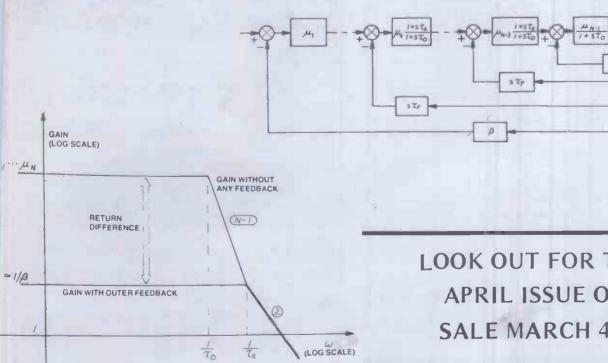
A project for all those readers with 6502-based micros that an't tell the time, or remember what day it is. If you liked the 5502 Sound/DAC card this month, you'll love this project: only in the April edition of ETI.

ZX81 MUSIC BOARD

This is a quite sophisticated though cost-effective music board or the ZX81. The board is capable of playing music without continuous CPU maintenance, and three notes may be played at once, each with independently variable volume. If you want more out of your micro, get next month's ETI.

NDF what? We're afraid you'll have to wait until the next ETI is published to find out what those letters stand for, but it will culminate in an entirely new audio amplifier design. Sounds interesting. Meanwhile, here are a few clues . . .





LOOK OUT FOR THE APRIL ISSUE ON SALE MARCH 4th

Articles described here are in an advanced state of preparation. However, circumstances may dictate changes to the final contents.

VOYAGER CAR COMPUTER

Keith Brindley

Ex HE-Man Keith returns with a tale about a kit designed for more economical motoring.

THE Voyager kit arrives through the post, from Sparkrite, securely packed in a polystyrene foam box, which has formed spaces for each main part. Everything you need to build and fit the kit (except tools) comes with it, and that includes wire, solder, nuts & bolts, and screws. All you have to supply are the necessary tools (a small soldering iron, long-nosed pliers, wire cutters, a small screwdriver and a small cross-head screwdriver) plus a reasonable competance at soldering.

There are, apparently, over 300 parts (mechanical and electronic) in the kit (I didn't stop to count them) and it took about five hours' continuous work to get the Voyager ready for installation into a car. A very good instruction booklet takes the builder through each stage, in a clear and concise, step-by-step way. The tasks are divided into the assembly of three printed circuit boards (PCBs):

1) Ice-warning PCB 2) Main display PCB

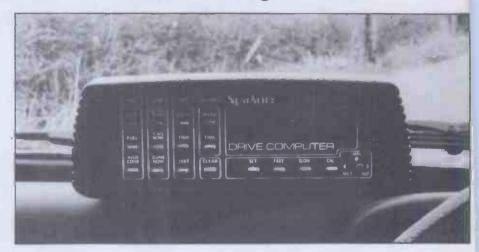
3) Keyboard PCB

followed by instructions for fitting the ice-warning PCB into its metal housing and fitting the other two boards into the plastic Command Module housing.

Without a doubt, the most difficult board to construct is the main display board. There are about 80 electronic components to insert and solder, including a fair number of polarised components, so great care must be taken to select the correct components. This PCB holds all main integrated circuits and they all are soldered directly into the board — no IC sockets are used. But the instructions are quite clear on how to solder them in without damage. The vacuum fluorescent display also mounts onto this board, but is raised (by about 5 mm) from the board's surface.

The keyboard PCB contain sixteen push-button switches and a bank of six small bulbs (to backlight the front panel); only three other components are soldered onto this board.

These two PCBs are interconnected in a number of places but, instead of wired connections (which can mean a 'birds-nest' of leads), the connections are made by fixed PCB connector plugs and sockets. Thus, the two boards are literally pushed together and pulled apart. A thin sheet of plastic film fits between them to prevent possible short-circuits. The whole arrangement makes a neat and professional combination



which fits easily into the plastic Command Module housing which is then ready for its front panel and fitting into the car.

Three sensors, one to measure temperature for the ice warning, one for fuel-flow and one for distance/speed measurement, have to be fitted to the vehicle. Temperature is detected by a thermistor, which should be mounted somewhere away from possible sources of heat which could affect accuracy. The Voyager fitting instructions, in a separate fold-open booklet, suggests that the temperature sensor be mounted either in the space behind the vehicle grille (but well clear of the radiator) or behind the front bumper.

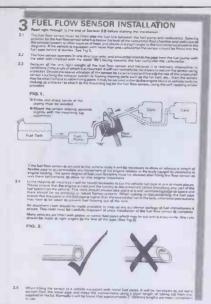
Fuel-flow has to be measured by inserting the sensor, the right way round, into the carburrettor feed pipe. All necessary clips and connection pieces, for all standard petrol-engined cars but not high-pressure fuel systems such as diesel or petrol injection), are supplied,

Next, the speed sensor and magnets have to be fitted to the vehicle so that the magnets rotate past the sensor at a rate proportional to the speed of the car. The magnets are tied securely onto the car's propellor shaft on a rear-wheel drive car, or to one of the two drive shafts of a front-wheel drive car. The number of times a magnet passes the sensor is proportional to the number of times the road wheels turn, and hence proportional to vehicle speed. This, incidentally, is the same system used in the HE Digital Speedometer of the December 1980 issue.

I fitted my Voyager Command Module centrally, above the dashboard



The collected parts of the Voyager kit.



The manual is well written and clearly illustrated.

of my car, using the special windscreen fitting, self-adhesive pad and short, ball-jointed connecting rod. A variety of fitting methods are supplied in the kit to enable the module to be mounted above or below the dash in most required positions.

Connections between the various sensors and the Command Module are made by joining the leads from each sensor to one end of a length of ribbon cable. The ribbon cable is fitted with a female connector to mate with the male connector in the rear of the Command Module. At the sensor end of the cable, individual plugs and sockets are used to connect to the sensor leads. Power connections are all made using fuses and the special cliptype connectors supplied. Again, easily understandable instructions make the module fitting an easy - if timeconsuming - job. Voyager is, at this time, ready to test, calibrate and use.

Road Test

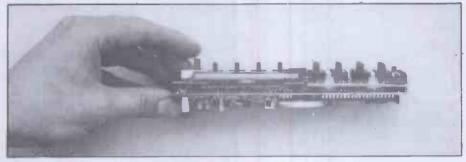
Testing is a straighforward procedure, given in the operating handbook, to make sure all functions are up and running.

The microcomputer, within Voyager, needs to be programmed to suit the car it is fitted to. This entails driving over a measured distance and keying in that distance (to calibrate the distance/speed sensor) and then using a measured amount of fuel and keying in that amount (to calibrate the fuel sensor). At the end of this calibration period, Voyager can be programmed to provide two figures which the user should note. Then if, at some future date, Voyager is removed for any reason, or if the car battery is taken out and Voyager's internal memory is erased, the figures can simply be re-inserted, thus saving the bother of having to go through the whole calibration procedure again. The kilometrespaced marker-posts on a motorway are a convenient measure of the distance to programme into Voyager.

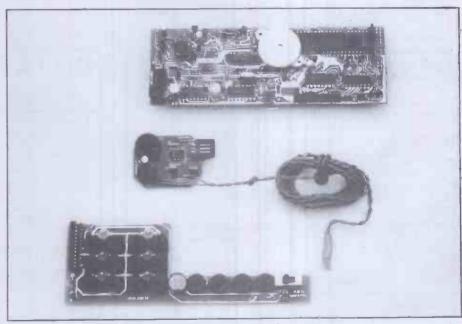
Eating up the miles, my car went through about seven gallons of petrol on a motorway trip, so I was very quickly



Installation of the speed sensor.



The two PCBs are fitted back-to-back.



The assembled PCBs before installation.

able to see Voyager fully operational.

One of the most amazing things you become aware of on a 'consumption now' reading ie, how many miles-pergallon the car is doing on a second-by-second basis, is how little fuel is used cruising at high speed, and how much fuel is being guzzled around town, in lower gears. For example, at a constant 70 mph in top gear my car registered about 32 mpg, whereas in second gear the car registered no higher than 12 mpg (at any engine speed) and in third gear: 22 mpg. The most economical speed of

all was about 60 mph, when the car returned over 40 mpg.

All-in-all, Voyager represents good value for money as a well presented and well produced kit. It's fun to build, and can, in fact, save you money if you watch your fuel consumption figures. If you feel that you're not capable of building it yourself, Voyager is also available from Sparkrite, (at 82 Bath Street, Walsall, West Midlands WS1 3DE) as a ready-built and working device — all you have to do is fit it to your car.



Bigger and Better

the colourful Wilmslow Audio brochure - the definitive loudspeaker catalogue!

Everything for the speaker constructor - kits, drive units, components for HiFi and PA.

50 DIY HiFi speaker designs including the exciting new dB Total Concept speaker kits, the Kef Constructor range, Wharfedale Speakercraft, etc.

Flatpack cabinet kits for Kef, Wharfedale and many others.

* Lowest prices — Largest stocks * * Expert staff - Sound advice *

* Choose your DIY HiFi Speakers in the comfort of our * two listening lounges

(Customer operated demonstration facilities) * Ample parking *

Send £1.50 for catalogue

(cheque, M.O. or stamps - or phone with your credit card number)

Access – Visa – American Express accepted * also HiFi Markets Budget Card.



0625 529599

35/39 Church Street, Wilmslow, Cheshire SK9 1AS



Lightning service on telephoned credit card orders!



CAN WE SELL YOU SOME

FRESH AIR?

ZEPHION NEGATIVE ION GENERATORS



Dr 1.B.Smith writes:— "Did you know that the air you breathe is made up of billions of tiny molecules, many of which may be either positively or negatively charged?. The negatively charged molecules (called ions) are particularly interesting. For example, they attach themselves to dirt, smoke and pollen particles in the air making them heavier so that they fall to the ground, leaving behind purer air for you to breathe! The ZEPHION negative ion generator produces millions of these negatively charged molecules every second, flooding your home or office with invigorating mountain-fresh air.

Many users of these ion generators claim greatly increased alertness, loss of lethargy (particularly in stuffy, smoky offices) and relief from hay fever, asthma and many breathing problems."

BUILD IT YOURSELF	clip the coupon.
TO:- Dataplus Developments	NAME:-
81,Cholmeley road	
Reading, Berks.	ADDRESS:-
RG1 3LY TEL:- 0734 67027	
PLEASE SEND :-	
ZEPHION KITS @ £21.50p	
(Kits include all parts)	
ZEPHION AIR TONERS	Money immediately refunded if
BUILT AND TESTED. @ £29.80p	items returned in good condition.
Prices include VAT & postage; allo	14 days for delivery. DATAPLUS PE

WHOLESALE & TRADE COUNTER BOWNESS MILL, SHAWCLOUGH ROAD, WATERFOOT, ROSSENDALE, LANCS. TEL: **ROSSENDALE 215556 RETAIL SHOP**

6A TODD STREET, MANCHESTER (next to VICTORIA STATION) TEL: 061-835 1185

Teletekst Panels

Main Board, and information, untested.....£15 set

200 MHz frequency counter kits
Kit contains 2 PCB's one for main component and one for
displays. 8 digit. All parts except case (using the ICM 7216B

Stereo Cassette Deck

COmplete with pre-amplifiers.....£14.95 + £1.50 P&P

ICL 7103 ICL 7106 ICL 7109 ICL 8038BM	200p 200p 200p 150p 150p 1000p 400p 750p 800p 300p	LM 319 LM 324 LM 339 LM 380 LM 1458 LM 2901 LM 3401 LM 3900 MC 1310 MC 1312	200p 35p 60p 85p 50p 80p 80p 55p	NE 562 NE 565 NE 566 NE 5018 NG 5553 NG 5554 TBA 810P TDA 1001A TDA 1003A TDA 1004	350p 120p 160p 700p 120p 120p 80p 220p 300p	TDA 1327 TDA 2524 TDA 2530 TDA 2540 TDA 2541 TDA 256073 TDA 25713 TDA 25713 TDA 2611A TDA 3310	300p 350p 350p 350p 375p 325p 225p
	000p	MC 1327		TDA 1008	300p	TDA 3950 Computer ICs	
ICL 8260		MC 1349 MC 1350	80p	TDA 1050 TDA 1071	250p	2732	450p
	900p	MC 1357		TDA 1170	200p	4116	80p 90p
ICM 7211	400p	MC 1456	80p	TDA 1190	200p	2114	aob
ICM 7212	300p	MC 1488	150p				
	800p	MC 1489	200p				
	900p	MC 1495	320p	C-11 :- 4h		for lines one	4 0
	800p	MC 1496	80p			for lists and	
ICM 7217C	700p	MM 53100N	200p			el sure you v	
ICM 7218	700p	MM 57105	200p	be pleasa	intly s	urprised at 1	the
ICM 7235A IM 5600	400p 150p ●	NE 536T		stock we			
	1000	NE 540L	000				
LF 155T LF 355T	100p	NE 543K	200p	ALL PRI	CES II	NCLUDE VA	T
LF 356H	100p	NE 541	90p			50p P&P	
LF 350H	100p	NG 550		FLEASE	ADD	out car	
LF 3571	150p	NE,555	16p				

NG 556 NG 558

62 NAYLOR ROAD LONDON N20 0HN



All items full spec and by well known manufacturers. Prices VAT inclusive, Postage

	order only. Phand others.	ione 01-445 82	24, SAE 1	or full	list inclui	ding ca	pacitors,
DOLLIER OLL	PRIM POR 4	1 45 /51//191/	ı 2N4061	6p	7421	22p	74190 42p
	PPLY PCB for		2N5458	40p	7423	23p	74191 440
Full data sup	plied	80p	2N5459	35p	7425	21p	74192 400
MAINS TRA	ANSFORMER 2	A/9V robust	2N6027	180	7426	21p	74193 46p
	air-link		3N128	20p	7427	16p	74194 46p
Compact by	air-iirik	400P . 444			7428	17p	74195 46p
PRESETS	norizontal mini	100R to 1M	CMO	S	7432	170	
	***************************************	4p	4000	11p			74198 89p
LOG POTS	4K7, 22K, 47K,	220K 470K	40018	11p	7433	22p	TTL 'LS'
2442	TICE, EETS, TETS)	200	4006B	40p	7441	58p	LS00 10g
ZIVIZ		01/0 . 071/	4007	10p	7442	25p	LS01 10p
ZENER DIC	DES (400mW)		4008	33p	7444	72p	LS02 10p
		Бр	4009	28p	7445	38p	LS03 12p
LEDS 3mm	red, green, yell	ow and 5mm	4010B	33p	7446	57p	LS04 13p
EEDO OHIII	v 9p. ORP12	600	40118	11p	7447A	35p	LS08 11p
			4012		7448	25p	LS10 11p
	PACKS useful v		4013B	15p	7472	25p	LS12 110
100 ceamic	capacitors	150p	4014	23p	7473	14p	LS12 \ 11p
100 nolvetyr	ene capacitors .	200p	4014 4015B	52p	7474	16p	LS13 22p
	er capacitors			40p	7475	20p	
100 polyeste	a capacitois	E00-	4016	20p	7476	18p	LS20 11p
100 electroly	tic capacitors	quup	4020B	43p	7482	56p	LS21 14p
. 100 carbon f	film resistors	70p	4021	43 p	7483	35p	LS32 13p
			4022	40p	7489	110p	LS42 28p
THYRISTORS	AC187K 13p	8F195 9p	4023	11p	7490	20p	LS47 36p
8A/400V 30p	AC188 20p	BF196 7p	4025	14p	7492	26p	LS48 45p
12A/100V 16p	AD149 50p	BF197 10p	4027	20p	7493	27p	LS73 20g
	BC107 80	8F244C 15p	4028	42p	7494	27p	LS74 16p
VOLTAGE	BC108 8p	8FR39 20p	4029	45p	7495	35p	LS75 20p
REGULATORS	BC109C 8p	BFX87 23p	4030	14p	7497	98p	LS76 19p
79M12 15p		BFY50 20p	4035	46p	74100	. 70p	LS78 20p
7812 40p	8C158 6p		4041	42p	174105	46p	LS86 18p
7815' 40p	BC159 9p	BFY52 18p	4042	44p	74107		LS90 23d
7818 40o	BC167 10p	BU205 105p	4043	46p	74109	18p	LS93 24p
7905 45 p	8C173 7p	BU208 115p	4044	40p		19p	LS95 40p
7912 450	8C177 10p	MJ2955 90p	4048	43p	74110	33p	LS122 280
7915 46p	8C178 13p	OC28 50p	4049	24p	74118	61p	LS123 36p
7918 45p	8C179 12p	TIP298 28p	4050B	240	74121	21p	LS157 28c
7924 45p	8C182 9p	TIP30 25p	4066	25p	74122	30p	LS163 39p
BRIDGE	BC184L 9p	T1P30B 28p	4068	14p	74123	40p	LS221 52p
RECTIFIERS	BC212 9p	TIP34A 46p	4069		74125	35p	
	BC212L 9p	TIP36A 127p		11p	74126	33p	LS251 32p
W06M 17p.	BC213 9p	TIP2955 58p	4070B	15p	74132	33p	LS253 36p
1A/50V 18p	BC213L 9p	ZTX300 9p	4071	15p	74141	48p	LS279 30p
1A/200V 17p	BC214 9p		4072	15p	74145	40p	LINEAR IC
1A/400V 20p	BC214L 9p		4073	15p	74147	85p	747-14 306
1A/600V 17p	8C477 18p	2N1131 11p	4081	14p	74150	51p	748-8 250
2A/100V 20p		2N1304 23p	4082	14p	74151	36p	CA3080 65
DIODES		2N2222A 15p	4516	580	74153	40p	CA3090AQ 70
1N4148 4p	BC549 9p	2N2369 14p	4518	45p	74155	36o	CA3130E 75
1N4005 4p	8C557 7p	2N2484 18p		w 6	74157	35p	LF351N 30
DIL	BC558 7p	2N2904 17p	TTL		74161	29p	LF356N 60s
SOCKETS	8C559 13p	2N2906 17p	7401	11p	74162		LM301N-14 18
	BD131 35p	2N2907 17p	7403	10p		26p	
18 pin 11p	BD132 36p	2N2926G 10p	7405	11p	74163	40p	LM308N-8 50
22 pin 14p	BD135 to	2N3053 25p	7406	15p	74164	38p	LM318H 92:
24 pin 16p	8D138 27p	2N3055 44p	7407	18p	74165	46p	LM339N 36
28 pin 18p	BD139 35p	2N3702 to	7408	15p	74167	70p	LM380N 55
40 pin 20p	8D140 35p	2N3711 6p	7409	13p	74174	40p	LM381N 95
TRANSISTO-	BF180 22p	2N3823 52p	7410	110	74175	20p	LM382N 70
RS RS		2N3866 40p	7412	15p	74177	37p	LM1458N 30
0.00			7413		74180	30p	LM3900N 35
AC127 20p	BF184 21p	2N3903 11p	7413	16p	74184	70p	ME566 100
AC128 22p	8F185 15p	2N4037 35p		16p	74185	92p	TBA6418X1 15
AC187 12p	BF194 12p	2N4058 to	7420	9p			

Herman Hollerith

An inventor who made a fortune from...a piece of cardboard?

THE HOLLERITH CARD was a device which was widely used in the dawn of computing, but the life and work of Herman Hollerith is not as well-known as it might be, despite this major contribution

to the 20th Century.

Herman Hollerith was born in 1860 in Buffalo, New York State in the USA, of German immigrant parents. He went through school with little distinction, and graduated from Columbia University School of Mining in 1879. He is, therefore, yet another example of an inventor who made his name in a field of activity for which his training was virtually irrelevant. The moral of this is, that it's a background knowledge of subjects like maths, chemistry and, especially, physics, along with that indefinable urge to solve problems which motivates the true inventor that counts, rather than what you specialise in sharpens your mind to have specialised in something. Hollerith, in fact, never pursued a career in mining engineering.

Computer Challenges

One of the lecturers at Columbia at that time was William P. Trowbridge, who was placed in charge of the 1880 census by the US Government. Trowbridge found that Hollerith was interested in what he (Trowbridge) was doing, and appointed Hollerith as his assistant in the slow and laborious process of gathering and analysing statistics for the census. When most of the work was finished, Hollerith took a teaching job at the newlyfounded Massachusetts Institute of Technology, and after that, for the best part of ten years, he worked for the US Patent Office in Washington as a Patent examiner. There must be something about this type of work that provokes curiousity, because this is the job that Einstein also was doing while he formulated the Laws of Relativity.

Hollerith seems to have spent most of his time outside the office in brooding over the problems of the census. The tabulation work in the 1880 census had been done by hand, and even by that time the job was clearly becoming too much, with the looming danger that the results of one census would not be analysed by the time of the next one! Hollerith realised that only an automated system could possibly cope with the information from the next census in 1890, because of the huge increase in the population of the US and the number of new headings that would have to analysed. There were, for example, several hundred new job titles to account for, and the flood immigrants to the US meant that the statistics on the

origins of new citizens were expanding enormously. Hollerith set about designing a system that would cope with the expected flood, and the results of his work were the beginning of data processing, the foundations of information technology.

A Simple Idea

The idea he came up with was, like so many good ideas, basically quite simple. Each census result was tabulated by punching holes in a card, using a card of as many columns (for headings) and as many hole positions (for data under each heading) as were needed. Modern cards use ten hole positions 40 columns. Each of these columns would be used to represent some measurable quantity, such as age range, and the position of the hole punched in that column would show the answer of that particular respondant. Similarly other answers on the sex. employment, marital status, number of children and educational achievement of the people who replied could be coded into one small card by the position of the hole punched in each column. The holes were punched by a small machine, like a cash register, and the rate at which a skilled operator could prepare cards from census forms was an enormous improvement on the filling-in of tables by hand.

The Hollerith cards were made from a non-conducting material, cardboard, so that the presence of a hole in a card could be detected electrically. This meant that comparatively simple electromechanical machines, using contacts and relays (no electronics in these days!) could carry out sorting. Even nowadays, the sight of a Hollerith card sorter in operation is rather awe-inspiring, as the cards are whipped across the sorting slots and pushed into the correct piles by small solenoids. Hollerith hoped, incidentally, that letters would be sorted in the same way, but this development did not take place.

Beasties THOUGHT FOR THE MONTH: -WHAT DID BEUROCRATS HAVE TO BLAME THINGS ON BEFORE COMPUTERS WERE INVENTED ?

Statistical Breakthrough

Hollerith's cards, and the punches and readers that he had developed to make use of them, were just the breakthrough that statisticians needed, because methods of tabulation that depended on metal rods fitting into the cards had proved to be much too slow and cumbersome. By using electrical contacts on each side of the card, Hollerith's system ensured very rapid reading, so that the results of a census could be available in a few months. His system was ready for the 1980 census, and it proved enormously successful, drastically shortening the time that was needed to obtain results from the census. It would probably be no exaggeration to say that this prompt availability of statistics laid the foundation for the expansion of the US economy which persisted for the next 40 years. Oddly enough, though, despite the clear advantages of the system, and the undoubted success that it had, it was not widely adopted in the US outside the census office. For some curious reason, companies in the US at that time did not appear to realise the usefulness of Hollerith's data processing system.

In a strange reversal of the normal procedure, Hollerith took his invention to Europe, where it was enthusiastically taken up for statistical purposes (but not, at that time, in the conservative UK), and encouraged by this success, Hollerith returned to the US to form the Tabulating Machine Co., incorporated in New York in 1896, to manufacture tabulators of all types. This time the idea caught on, and tabulating machines bearing the Hollerith imprint started to appear in the accounts offices of organisations all over the world. The name 'Comptometer' started to be used - how many readers remember the number of job vacancies for comptometer operators in the late 40s and early 50s? The punched-card system became a world standard, and when I first started computer programming, the program had to be punched onto Hollerith-type cards. Herman Hollerith himself died in 1929 in

Washington, D.C.

Whatever became of the Tabulating Machine Co.? Well, it's a fact of life that a lot of companies that start off with a few employees, and are successful, will eventually grow to be very big companies. The Tabulating Machine Co. was absorbed by one take-over after another, devoured other companies in turn, and eventually changed its name to International Business Machines, now the jolly green giant of computer manufacturers. I wonder if Acorns grow as fast?

ELECTROVALUE

Understandably Britain's most popular and relied-upon suppliers of **SEMI-CONDUCTORS** LCs COMPONENTS COMPUTING EQUIPMENT **TOOLS, BOXES, CONNECTORS** and much, much more

THE LATEST PRICE LIST TELLS ALL Large S.A.E. brings your FREE copy by return GOOD PRICES - GOOD SERVICE -DISCOUNTS

ELECTROVALUE LTD.

Head Office, Mail Order Dept. and Shop 289 St. Judes Road, Englefield Green, Egham, Surrey TW20 0HB Telephone Egham (STD 0784; London 87) 33603; Telex 264475

Also in Manchester for personal shoppers at: 680 Burnage Lane, Burnage, Manchester M19 1NA - Telaphone 061-432 4945

Computing Shop - 700 Burnage Lane, Manchester - Telephone 061-431 4866

BATTERIES NICAO rechargosible 1.2V 8V GE: 'AA' HIP' 5AH 74p. C' U11 1.8AH 61.87' D' U2 1.2AH 61.87' D' U2 1.4AH 62.52 PP3 (9V) 0.75 AH 62.53 ATIS U1000000000000000000000000000000000000	TRANSISTORS AC127/8	ZTX300/500 15p 27K220A 17p 27K22AA 17p 27K22AA 17p 27K22AA 17p 27K25AB 27K2AB 2	FUSEHOLDER PCB HSINK TO3 29p POLYESTER PLUG STYLE 10% SY VEX. MULL PLE All at 6p PCM 0.0022/400v 10 0.0022/400v 10 0.003/400v 10 0.0047/400v 10 0.0047/250v 10 0.0047/250v 10 0.0081/100v 10 1.1/250v 10 In MFDS sizes in mm	IN BOX S ETC All at 8p PCM 22/250v 15 33/250v 15 47/250v 22 68/100v 15 All at 12p 1.0/250v 15 1.5/100v 22 2.2/250v 22 All at 18p 3.3/100v 22 4.7/100v 27
TANT BEAD 5mm Val 1	BC477/8 59 BC527/8/8 99 BC557/8/8 99 BC557/8/8 99 BC557/8/8 99 BC557/8/8 149 BC79/07/1 149 BC79/07/1 149 BC79/07/1 149 BC79/07/1 149 BC79/07/8 149		an 6 assorted types 50p PLUG IN 9 2.2/35p 3.3/63w 4.7/63w 10/16v 10/63w 22/63w 33/63w 4/63w 15p 100/16v 200/63w 220/63w 330/63w 470/16w 220/63w 1000/10w 220/63w 1000/10w 220/63w 1000/10w 220/63w	POLYESTER AXI(AL 10% 5p 9p 01 250y 33 100v 022 250v 47 250v 047 250v 48 400v 1 160v 10.250v 22 400v 1.5 100v 10 100ES 8 4157/8/9 5p 84157/8/9 5p 11/8/9/9/9/9/9/9/9/9/9/9/9/9/9/9/9/9/9/9
LM317K 22.35 LIST GIVING LM723 350 1004 -PRICES - LM7805/12/15 350 29 £1. 301 (8) 22p 555 (8) 16p 308 (8) 42p 556 (14) 42p 311 (8) 45p 557 (8) 599 324 (14) 36p 557 (8) 599 339 (14) 44p 651 (10) 348 (14) 56p 57 BA 589 (8) 599 709 (14) 18p 358 (8) 599 709 (14) 18p 358 (8) 599 709 (14) 381 (14) 449 574 (8) 435/82N £3.75 747 (14) 42p 748 (8) 32p	IIIP4' IIIP1' IIP1' II	TO: CRIMS	0 73p 01 10p 19 30 33p 06 42p 21 14p 20 3 33p 06 42p 21 14p 20 45p 08 28p 23 31 33p 10 11p 24 9 52p 11 10p 25 52p 13 4 58p 16 12p 24 52p 34p 15 22p 34p 15	30 470/1000/1500 2200 5p LEDS .125" TIL 209 Green 12p Red 7p Yellow 13p CLIPS 3p 2" TIL220 Green 12p Red 9p Yellow 13p CLIPS 5p

TECHNICAL TRAINING IN ELECTRONICS, **TELEVISION AND AUDIO** IN YOUR OWN HOME - AT YOUR PACE

ICS can provide the technical knowledge that is so essential to your success, knowledge that will enable you to take advantage of the many opportunities open to the trained man. You study in your own home, in your own time and at your own pace and if you are studying for an examination ICS guarantee coaching until you are successful.

City & Guilds Certificates

Radio Amateurs Basic Electronic Engineering (Joint C&G/ICS)

Certificate Courses

TV and Audio Servicing Radio & Amplfier Construction Electronic Engineering* and Maintenance Computer Engineering* and Programming Microprocessor Engineering* TV, Radio and Audio Engineering Electrical Engineering,* Installation and Contracting *Quality for IET Associate Membership



CACC Approved by CACC



Member of ABCC

POST OR PHONE TODAY FOR FREE BOOKLET

Please send me your FREE School of Electronics Prospectus. Subject of Interest Address



Dept E262 ICS School of Electronics 160 Stewarts Road, London SW8 4UJ



Send for my CATALOGUE ONLY 75p

(plus 25p post/packing)

My all-inclusive prices quoted in the Catalogue are the lowest. All below normal trade price — some at only one tenth of manufacturers quantity trade. See my prices on the following:

CAPACITORS . . . ELECTROLYTIC; CAN, WIRE END, TANTALUM, MULTIPLE, COMPUTER GRADE, NON POLAR, PAPER BLOCK, CAN, POLY, MICA, CERAMIC. LOW AND HIGH VOLTAGE, RESISTORS. 1/8th WATT TO 100 WATT; 0.1% TO 10% CARBON, METAL AND WIRE WOUND + NETWORKS. FANS, BATTERIES, SOLENOIDS, TAPE SPOOLS, VARIABLE CAPACITORS AND RESISTORS, TRIMMERS, PRESETS, POTS . . . SINGLE, DUAL, SWITCHED, CARBON, CERMET AND WIREWOUND, SINGLE OR MULTITURN, ROTORY AND SLIDE. DIODES, RECTIFIERS, BRIDGES, CHARGERS, STYLII, SOCKETS, PLUGS, TRANSISTORS, IC'S, CLIPS, CRYSTALS, ZENERS, TRIACS, THYRISTORS, BOXES, PANELS, DISPLAYS, LED'S, COUPLERS, ISOLATORS, NEONS, OPTO'S, LEADS, CONNECTORS, VALVES, BOOKS, MAGAZINES, TERMINALS, CHOKES, TRANSFORMERS, TIMERS, SWITCHES, COUNTERS, LAMPS, INDICATORS, BELLS, SIRENS, HOLDERS, POWER SUPPLIES, HARD-WARE, MODULES, FUSES, CARRIERS, CIRCUIT BREAKERS, KNOBS, THERMISTORS, VDR'S, INSULATORS, CASSETTES, METERS, SOLDER, HANDLES, LOCKS, INDUCTORS, WIRE, UNITS, MOTORS, COILS, CORES, CARTRIDGES, SPEAKERS, EARPHONES, SUPPRESORS, MIKES, HEATSINKS, TAPE, BOARDS and others.

Prices you would not believe before inflation!

RIAN J. REED

TRADE COMPONENTS

ESTABLISHED 26 YEARS

161 St. Johns Hill, Battersea, London SW11 1TQ Open 11 am till 7 pm Tues, to Sat. Telephone: 01-223 5016

Manchester Home Computer Show MIDLAND HOTEL April 22/23/24

Sponsored jointly by:
Personal Computing Today
ZX Computing
Computing Today
Micro Update
Personal Software

At the Home Computer Shows will be a complete cross section of the hardware and software available to the home user. The emphasis is on the lower end of the price bracket with computers from £50-£400.

If you are interested in computers and what they can do for you then come along to our **COMPUTER ADVICE CENTRE**: experts will be on hand to give you impartial advice on equipment available.

Try out the machines in our own demonstration area and see programs running covering educational, games and small business applications.

There is a **COMPETITION** at every show to:

WIN TWO COMPUTERS.

Win a computer for yourself as well as one for the school of your choice: free entry form with advance tickets. Also available at the show with the show catalogue.

ADMISSION £2.00 (CHILDREN UNDER 8 & O.A.P's FREE) AND IF YOU'RE A PARTY OF 20 OR MORE, THERE'S A 25% DISCOUNT

Friday 22 April '83 (10am-6pm) Saturday 23 April '83 (10am-6pm) Sunday 24 April '83 (10am-4pm)

The Manchester Home Computer Show Midland Hotel. (Opposite Town Hall).

For advance tickets send cheque/postal order to:
ASP Exhibitions
Argus Specialist Publications
145 Charing Cross Rd,
London WC2H OEE
Tel: 01-437-1002

AN ANCHESTER HOME COMPUTER SHOW

Overvoltage Cut-out

A super circuit protector for all mains-powered projets.

WHEN a stabilised supply becomes faulty, this often results in a substantial increase in the output voltage, but the first indication that a fault has occurred is likely to be when the supplied equipment fails due to semiconductors or other delicate components being damaged by the excessive supply potential! The voltage difference between the unregulated and regulated supplies can be surprisingly large, incidentally, with an overload in the region of 50% being quite possible if the unregulated supply finds its way to the output.

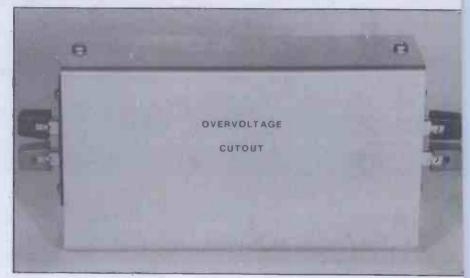
A simple method of protecting equipment against an excessive supply voltage is to use an overvoltage cutout between the power source and the equipment concerned. The circuit described here is of the 'crowbar' type that instantly short circuits the power supply if an input potential above a certain threshold level is detected. The virtual short circuit that is placed across the supply almost instantly pulls the supply voltage down to a safe level, and limits the duration of the overload to an insignificant period of a fraction of a millisecond. A fuse, in series with the input of the cutout, then blows so that power is cut off altogether until the fault has been rectified and the fuse has been replaced.

It is possible to have a purely electronic cutout, and this 'crowbar' method may seem a little crude. However, it has the advantage of a negligible voltage drop through the fuse (which is the only component in series with the supply), so that adding a unit of this type should give no degradation of performance.

The Circuit

The circuit diagram of the Overvoltage Cutout is shown in Figure 2. Operational amplifier IC1 is used as the comparator, while R5 provides a small amount of positive feedback over IC1 so that the output triggers either to the high state or low state, but cannot be at an intermediate level. The output is low if the inverting input (pin 2) is at a higher voltage than the non-inverting input (pin 3), or the high state if the comparative input levels are reversed.

The inverting input is held at a stable



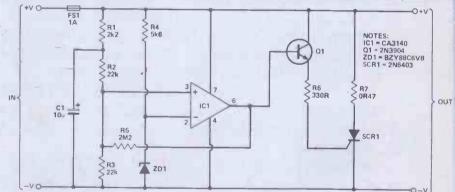


Figure 1. The circuit diagram of the Overvoltage Cut-out.

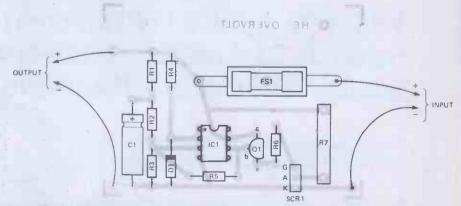


Figure 2. The PCB component overlay. The full-sized foil pattern is reproduced on the PCB Printout page.

potential of 6V8 by the simple Zener stabiliser circuit formed by R2 and ZD1. The non-inverting input is fed from the supply lines via a potential divider which is formed by R1, R2 and R3, and this divider

circuit supplies a little under half the supply voltage to the non-inverting input. R1 and C1 form a simple filter which prevents transients on the supply from producing spurious triggering of the unit.

With a nominal 12V supply (allowing for the fact that some items of equipment, such as a mains power supplies for CB transceivers, actually give about 13.8 V, and a car supply can reach a similar level), the potential fed to the noninverting input of IC1 is still below the

6V8 reference potential applied to the inverting input. IC1's output is low, Q1 is biased off and SCR1 is switched off.

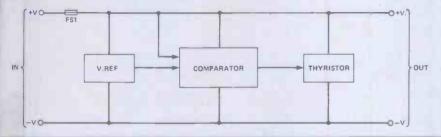
The situation is different if a fault occurs; if the supply voltage rises above about 14.3V, the non-inverting input is then the one at the higher potential. This

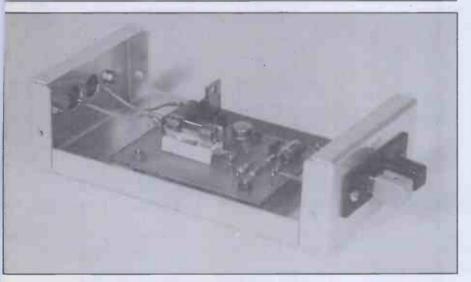
How It Works

A COMPARATOR is used as the basis of the circuit; this compares the supply voltage with a stable reference voltage. Normally the difference between the reference potential and the supply voltage is quite small and the output of the comparator is consequently at a low voltage. The thyristor, which it drives via Q1, is therefore switched off and has no effect.

If the supply voltage rises to a high enough level the potential difference between the reference and supply

voltages is sufficient to trigger the comparator to the high state and the thyristor is then switched on via Q1. It virtually short circuits the supply, so that the voltage is reduced to a low and safe level, but the high current flow causes FS1 to blow and completely cut off the supply from the output. The unit is primarily intended for use with 12 V equipment such as power supplies for mobile CB transceivers. The nominal trigger voltage is 14.3 V.





Parts List

RESISTORS (All ¼ watt 5% unless note	ed)
R1	22k
R4	2M2
R6 OR47	

CAPACITORS

SEMICONDUCTORS

.BZY88C6V8 6V8 400mW Zener

	_				-
				2N3904	
IC1 .				CA3140	
SCR1				. 2N6403 or similar	

MISCELLANEOUS

FS1 20mm quickblow fuse current rating as required Chassis mounting 20mm fuseholder; input and output ter-20mm minals; printed circuit board; case; 6BA fixings, connecting wire, solder

BUYLINES Page 34

causes the output of IC1 to be triggered to the high state, turning on Q1 and SCR1; the supply is 'crowbarred', with SCR1 effectively short circuit, and fuse FS1 blows. The output current ot IC1 is insufficient to reliably operate most thyristors, and Q1 is therefore used as an emitter follower buffer stage to produce a suitably high drive current; R6 prevents excessive gate current from flowing into SCR1. R7 gives a certain amount of current limiting when SCR1 is triggered, although this is probably not, strictly, necessary as SCR1 only has to conduct for a few milliseconds before FS1 disconnects the supply, and a considerable current overload could probably be tolerated for such a short duration.

FS1 is a 1 amp fuse on the prototype, but the rating of this fuse must obviously be varied to suit the particular item of equipment fed from the output. It should have a current rating approximately equal to or a little higher than the maximum current drain of the equipment being powered. For example, a current consumption of 1.8A would require a 2A fuse, this being the nearest current rating available, but higher than the 1.8A figure.

Construction

All the components (including FS1 and its chassis mounting fuseholder) are mounted on a printed circuit board which is detailed in Figure 2. This is constructed in the usual way, but bear in mind that IC1 has a MOS input stage and therefore needs the standard MOS handling precautions. Both the CA3140E (which is an 8 pin DIL package) and the CA3140T (which has an 8 pin TO-99 metal package) will readily fit onto the printed circuit board. Note that SCR1 does not need a heatsink, as it conducts too briefly to heat up significantly. Any thyristor having a current rating of about 12A or more should be satisfactory in this design, and it is not essential to use a 2N6403.

The printed circuit board is small enough to fit into practically any small metal or plastic case. Pairs of spring terminals are fitted at each end of the case to provide an easy way of connecting the input and output leads to the unit, and these are colour coded red and black to indicate the polarity of the supply lines. Clearly mark which set of contacts are the input terminals and which are the outputs, and be sure to connect the unit correctly. There will be dire consequences if a mistake is made here since, if the unit is triggered, the fuse will not blow because it would be at the output of the unit instead of the input.

A simple way to test the unit is to use a bench power supply to provide an input voltage which is steadily increased from about 10 volts until the circuit triggers; a voltmeter is used to monitor the voltage. The current limiting facility of the supply can be used to prevent FS1 from blowing, and the circuit can then be reset by reducing the supply voltage and momentarily disconnecting the supply from the input of the unit. If necessary, the trigger voltage can be reduced slightly by decreasing the value of R2, or increased by raising the value of this resistor.

HE PCB SERVICE

PCBs For Readers

PRINTED CIRCUIT BOARDS (PCBs) for HE projects have often represented an obstacle for our readers. Some of you, no doubt, make your own but our PCB Service saves you the trouble.

NOW you can buy your PCBs direct from HE. All (non-copyright) PCBs will be available automatically from the HE PCB Service. Each board is produced from the same master as that used for the published design and so each will be a true copy, finished to a high standard.

Apart from the PCBs for this month's projects, we are making available some of the popular designs from earlier issues. See below for details. Please note that only boards for projects listed below are available: if it isn't listed we can't supply it.

October 80	!	September 81	04.00	Computer PSU	€7.68
Nobell Doorbell	£2.64	Power Pack	£1.69	Solar Radio	£1.98
Intruder Alarm	£2.51	Reaction Tester Game	£1.71	A : 00	
Tug O' War	£2.65	'Diana' Metal Detector	£3.31	August 82	
		0 : 1 04		Digital Millivoltmeter	04.04
November 80		October 81	00.05	(Set of Two)	£4.34
Memory Bank Synth:	00.04	Combination Lock	£2.65	Audio Analyser	C11 FF
Mainboard PCB	£3.31	21 04		(Set of Two)	£11.55
Keyboard PCB	£3.60	November 81	CE 01	Carta and the CO	
Party Grenade (set of three)	£3.47	Sound Torch (Set of Two)	£5.31	September 82	
Double Dice	£2.95	December 81		Signal lights Main Module	£1.96
D	1	Pedalboard Organ	£5.64		£1.70
December 80 Stereo Power Meter	£2.83	Pedalboard Organ	15.04	Junction Module ZX PCB	£3.34
Stereo Power Meter	12.83	January 82		Slot Car Controller	£1.98
Innuena 9.1		Intelligent NiCad Charger	£2.83	Siot Car Controller	L1.30
January 81 Car Rev Counter	£2.99	Intembent Micad Charger	L2.03	October 82	
Car Nev Counter	12.33	February 82		Flash Point Alarm	£2.13
February 81		Relay Driver	£2.07	Negative Voltage Generator	£1.49
Heartbeat Monitor	£2.53	Mast-Head Amp	£1.08	Squelch Unit	£2.52
Audio Signal Generator	£2.47	Mast-rieau Amp	L1.00	Squeich Onit	L2.52
Audio Signal Generator	L2.47	March 82		November 82	
March 81		Digital Dice	£1.40	Pedometer/Odometer	£2.13
Steam Loco Whistle	£2.65	Digital Dicc	21.40	- edothetel/Odollietel	22.10
Steam Loco Willstie	12.00	April 82		December 82	
April 81		Digital Capacitance Meter	£4.02	Phase Four	£2.83
Super Siren	£1.97	Dual Engine Driver	£3.27	Microlog	£3.98
Russian Roulette Game	£1.60	Bike Alarm	£2.45	Tape/Slide	£5.26
Tradatari Francisco da Como	21.00			(two boards)	
May 81	- 3	May 82		TV Amp	£5.70
Voice Operated Switch	£1.67	Digital Thermometer	£4.62	Loftv	£2.61
Organ 1	£4.64	(Set of Two)			
- 3	- 1	Echo-Reverb	£5.63	January 83	
June 81		Cable Tracker	£1.85	Chip Probe	£1.82
Envelope Generator	£1.87			Switched Mode Regulator	£1.96
Organ 2	£2,53	June 82			
		Power Supply Design	£2.48	February 83	
July 81		Auto-Wah	£3,08	Incremental Timer	£7.13
Organ 3	£6.00	Auto Greenhouse Sprinkler	£3.45	DigiTester PSU	£6.70
Organ 4	£6,00	Telephone Timer			
Ultrasound Burglar Alarm	£2.53	(Set of Two)	£6.50	March 83	
				Loudspeaker Protector	£2.51
August 81		July 82		Overvolt Cut-out	£2.25
RPM Meter	£1.77	Tanover	£2.13		
Thermometer	£1.67	TVI Filter	£1.78		

PLACE an order for your PCBs using the form below (or a piece of plain paper if you prefer not to cut the magazine), then simply wait for your PCBs to drop through your letterbox, protected by a Jiffy bag.

HE PCB Service, Argus Specialist Publications Ltd. 145 Charing Cross Road, London WC2H 0EE

I enclose a cheque/Postal Order made payable to ASP Ltd, for the amount shown below Price.	Boards Required	Price	
OR			
I wish to pay by Barclaycard. Please charge my account number		T T	
OR VISA			
I wish to pay by Access. Please charge to my account number			
SIGNATURE			
NAME			
ADDRESS			
	Add 45pp&p	0.45	
Places allow 21 days for delivery	Total Enclosed £		

Lightning ELECTRONIC COMPONENTS

THE CHOICE IS YOURS - CALL AT OUR NEW SHOWROOM OR USE OUR VERY FAST MAIL ORDER SERVICE

EITHER WAY WE'LL KEEP YOU HAPPY *****

Furthermore we promise if any part ordered by mail fails to please just return within 7 days for a full refund.

For a vast selection of electronic components & equipment of all kinds. Here is just a selection of our stocks. Many more items listed in our catalogue available now 70p post paid.

		op poor p	aru.				
RESISTORS W 5% C.F.	1M 2p each 820K 5p each 680K 5p each		POTENTION Proset : I'W Horiz : I'W Veri Std single Pot Single & Switch Dual Geng	METERS 11p 29p 60p 75p	TRANSIST AC128 AF117 BC107 BC107C BC108	0-24 TIP29A 0-52 TIP29C 0-10 TIP30A 0-12 TIP30C 0-10 TIP31A	2-60 0-39 0-45 0-39 0-45 0-39
Ceramics 56pF	to 47pF to 220pF to 1000pF to 4700pF			8p (100 for (5) 10p (100 for (5)	BC108C BC109 BC109C BC182L BC184L BC212L BC214L	0-12 TIP31 C 0-10 TIP32A 0-13 TIP32C 0-10 TIP33C 0-10 TIP35C 0-10 TIP35C 0-10 TIP36C	0-45 0-39 0-45 0-85 1-85 1-90
- Ve 100mA + Ve 1 Amp - Ve 1 Amp	78L05 - 78L12 79L05 - 79L12 7805 - 7812 7905 - 7912	78L15 31p 79L15 59p 7815 80p 7915 86p	V. REGULATORS (VA LM317K 1.5 Ar LM338K 5 Ame LM396K 40 Ar L723 14 DR L123 TO99	PD E3 31 E4-77 PD (111-01 F0 48 E0-60	BD112 BD115 BD124 (Met)	0-80 TIP41A 0-59 TIP41C 1-58 TIP42A TIP42C 0-60 TIP110 0-60 TIP115	0-45 0-48 0-45 0-48 0-82 0-82
FOTO COATE! precoated with positive for Imm single sided 12" x 1.6mm Single sided 100 x 160mm Euro	oto resist. For sm	all batch production of 1 6mm Doub	of PCB's	ninate 1-70	BF180 BF199 BF244B BF257	0-30 TIP121 0-18 TIP126 0-29 TIP141 0-30 TIP142	0-99 0-99 1-20 1-20
203 × 114mm 203 × 228mm 467 × 305mm	1 83 3 80 8-10	20	33 × 114mm 33 × 228mm	2-10 6-10	BFR39 BFR40 BFR64 BFR79	0-24 TIP146 0-24 TIP147 3-00 TIP2955	1-25 1-25 0-69 0-57
Chemical Dishes 12" a 1 Acetate Sheet Transfer Pack 5 assid sh	0° £1 50 £0-20 eers £2-40	PI	estic Tongs elo Pen	E0-96 60-88	BFR80 BFW14 BFY53	0-26 TIS43 0-25 TIS90 0-21 2N1309	0-30 0-28 0-60
PANEL METE Until now panel meters h proved an expensive part project Now available this new q fit type. 32mm Square Meter	not your	50 50	e following Dc ranges vA = 100vA = 500v nA = 10mA = 50mA 0mA = 1A = 5A = 3 NLY £1:95 each	A - 1mA - 100mA	BFY90 BLY93A BU126 BU208A MPSA05 MPSA06	0-86 2N3053 14-20 2N3054 2-25 2N3055 2-00 2N3904 0-20 2N3773 0-21 40673	0-22 0-48 0-48 0-14 2-25 0-92
		order (free over £	(10) Please add \	/AT at 15%.	MJ15003 MJ15004	4-05 40871 5-04 40872	1-06 1-05

LIGHTNING ELECTRONIC COMPONENTS

Showroom & Mail Order Distribution Centre at:-18 Victoria Road, TAMWORTH, Staffs B79 7HR Telephone 0827-65767.



POST 65p

25p PACKS!

ADD VAT 15%

100 6BA Washers 10 No 8x}" Woodscrews 3 TO5 Heatsinks

3 8-pin DIL Skts 2 1000μF/50v Cans 8μF/350v Ax

1 B7G Skt 2 18-pin DIL Skts

10 No 8 Cup Washers 3 PP3 Snaps 10m Connecting Wire 1 100K Multiturn Preset 10 100μF/40v Elects 8 680R 1W Res 1 B9A Skt 1 28-pin DIL Skt

5 5-way Tag Strips 3 3.5mm Jack Skts 4m 1mm Sleeving 4 100K Presets 3 100 µF/16 v PCB

1 20mm Panel Fuse 1 B9A Skirted

40v Min Ceramic Plates: 25p/pack. 8 per pack ene value. 1p, 2.2p, 3.3p, 3.9p, 5.5p, 6.8p, 7.5p, 8.2p, 10p, 15p, 18p, 33p, 47p, 68p, 220p, 270p, 390p, 470p, 820p, 1000p, 1500p, 470p, 000p, 150,00p, E.g.: 8 x 2.2p = 25p.

53v Min Polystyrenes: 25p/pack. 8 per pack one value. 12pF, 27p, 39p, 47p, 68p, 82p, 100p, 180p, 220p, 300p, 470p, 560p, 680p, 1000p, 2700p, 4700p, 5600p, 6800p, 8200p. Eq.; 84x70p = 25p.

VALVES

OF96/63p, EABC/78p, ECH81/70p, ECL80/70p, EF80/57p, EF85/59p, EF86/72p, EF89/99p, EF91/E1 25, EF92/E1 75, EL34/E1 70, EL84/70p, E280/65p, E281/75p, KT66/E8, KT86/E1 2.50, PY500A/E1 70, UABC80/76p, UCC85/65p, UCH81/85p, UL84/85p, 524QT/99p, 6BA6/68p, 68W6/E6, 80Y/£1 45.

LETCHWORTH ELECTRONIC COMPONENTS

Spirella Bullding, Bridge Road, Letchworth, Herts SG6 4ET TEL: (04626) 70354/79681

FREE CATALOGUE!

OUR GREAT NEW ILLUSTRATED CATALOGUE IS PACKED WITH INFORMATION ON SUPERB QUALITY, PROFESSIONAL BURGLAR ALARM EQUIPMENT



AT UNBEATABLE PRICES!

SEND S.A.E. OR PHONE NOW FOR YOUR COPY



THIEFCHECK BURGLAR ALARM DILY SYSTEM



DISTRIBUTOR

A.D. ELECTRONICS DEPT. HE3 217 WARBRECK MOOR AINTREE LIVERPOOL 19 0HH/051 523 8440

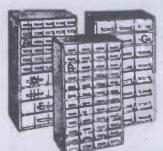
RECHARGEABL

PRIVATE OR TRADE ENQUIRIES WELCOME FULL RANGE OF NICADS AND SEALED LEAD AVAILABLE SEND SAE FOR LISTS £1.45 for booklet Booklet 'Nickel Cadmium Power'

SANDWELL PLANT LTD

2 Union Drive, Boldmere, Sutton Coldfield, West Midlands 021-354 9764 After hours 0977 616913

STORAGE CABINETS



Steel cabinets, 12" wide × 52" deep × 22" high finished blue with clear plastic drawers.

Available units:-Drawers .. 60 × A ... 48 × B ... 24 × C Type 2260 2248 2224 . 8 × E 30 × A, 4 × D, 2 × E

ONLY £19.90

MILLHILL SUPPLIES STREET, CROWMARSH, WALLINGFORD OXON, OX10 8ES. Tel. 0491 38053 66 THE

SAVE fff's ON HOME HEATING BILLS UNIQUE DIGITAL THERMOSTAT

POSSIBLE FUEL

SAVINGS OF **UP TO 25%**



Normally manufactured exclusively for the trade. Features: • Continuous readout of ambient temp via 3 digit 7 segment display ● LED indicates when pump is in operation ● 0.2°C Hysterises

240v 3A control contacts • Switched set temperature



High specification - Simple to calibrate Connect in place of existing thermostat -Requires 240v 2VA supply - Kit includes all necessary components, Enclosure, diagrams and instructions.

Kit price only £39.90. Assembled Price £49.90

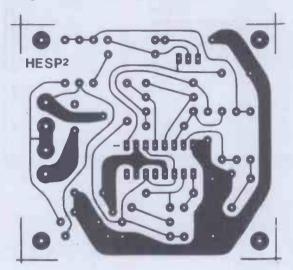
Prices include P&P and VAT

Send cheque or PO to: DICON ELECTRONICS LIMITED Bond Street, Bury, Lancs BL9 7DU Tel 061-797 5666

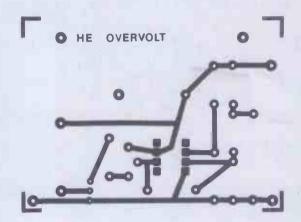
Access/Barclaycard

HE PCBs

Below: The PCB foil pattern for the Signal Powered Loudspeaker Protector.



Foil pattern of the Overvolt Cut-out.



MASTER ELECTRONICS NOW! The PRACTICAL way!

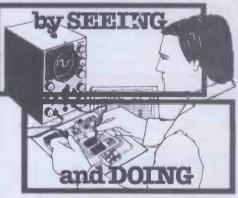
This new style course will enable anyone to have a real understanding of electronics by a modern, practical and visual method. No previous knowledge is required, no maths, and an absolute minimum of theory.

You learn the practical way in easy steps mastering all the essentials of your hobby or to start or further a career in electronics or as a selfemployed servicing engineer.

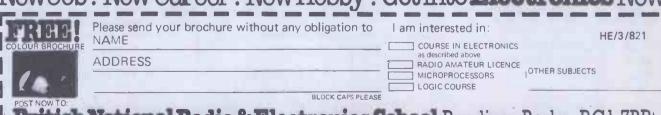
All the training can be carried out in the comfort of your own home and at your own pace. A tutor is available to whom you can write personally at any time, for advice or help during your work. A Certificate is given at the end of every course.

You will do the following:

- Build a modern oscilloscope
- Recognise and handle current electronic components
- Read, draw and understand circuit diagrams
- Carry out 40 experiments on basic electronic circuits used in modern equipment
- Build and use digital electronic circuits and current solid state 'chips'
- Learn how to test and service every type of electronic device used in industry and commerce today. Servicing of radio, T.V., Hi-Fi and microprocessor/computer equipment.



New Job? New Career? New Hobby? Get into Electronics Now



En itish National Radio & Electronics School Reading, Berks. RG1 7BR



DVERTISEMENT ATES Semi-Display (min 2 cms)

1-3 insertions £7.50 per cm

4-11 insertions £7.00 per cm

12 + insertions £6.50 per cm

Lineage 26p per word (min 15 words) Box Nos. £2.50

Closing date 2nd Friday of the month preceding publication date.

All advertisements in this section must be prepaid. Advertisements are accepted subject to the terms and conditions printed on the advertisement rate card (available on request)

Send your requirements and cheque P O in

HOBBY ELECTRONICS CLASSIFIED ADVERTISING, 145, CHARING CROSS RD, LONDON WC2H 0EE

PRINTED CIRCUITS. Make your own simply, cheaply and quickly! Golden Fotolacilight-sensitive lacquer — now greatly improved and very much faster. Aerosol cans with full instructions, £2.25. Developer 35p. Ferric Chloride 55p. Clear acetate sheet for master 14p. Copper-clad fibreglass board, approx. 1mm thick £1.75 sq. ft. Post/packing 75p. White House Electronics, Castle Drive, Praa Sands, Penzance, Cornwall. Sands, Penzance, Cornwall.

AMAZING ELECRONIC PLANS Lasers, Super-powered Cutting Rifle, Pistol, Light Show, Ultrasonic Force Fields, Pocket Defence Weaponry, Giant Tesla, Satellite TV Pyrotechnics, 150 more projects. Catalogue £1 (refundable) — from Plancentre, Bromyard Road Industrial Estate, Ledbury HR8.

TELETEXT (ORACLE/CEEFAX) add-on adaptors for any television only £149.95 inclusive. Also Prestel/Viewdata and Telesoftware. Cytel (HE) Freepost, Bristol BS10 6BR. (0272) 502008 any time.

HAVEN HARDWARE

ZX81 F49.90. Inverse Video £4.50. Repeating Keymodule £5.95.
ZX Spectrum software: Repulser fruit machines and Solitair
£4.95 each. Mancala and Patience £5.95 each.
Jupiter Acc £8.90. Inverse Video £4.95.
Access taken. SAE for details.
HAVEN HARDWARE
4 Asby Road, Asby, WorkIngton, Cumbria
04-686 £27.
Agency enquiries welcome

WAVEBANDS

Auto Electronics, 103 Coventry Street, Kidderminster. Tel: (0562) 2179

Brand new components by return post or ring with Access/Barclaycard number for same day despatch.

All manufacturers guaranteed new stock. All at most competitive prices. Catalogue available only 50p. All prices inclusive of VAT.

LIE DETECTORS Brand new in steel case with 100-0-100 microamp meter. Complete with probes and gel. Price £7.00 (This includes VAT but not postage). "Q" Services, 29 Lawford Crescent, Camberley, Surrey. (Yateley) 871048.

PARAPHYSICS JOURNAL Russian translations); Psychotronic Generators, Kirlianography, gravity lasers, telekinesis. Details: S.A.E. 4 × 9" Paralab, Downtown, Wilts.

ELECTONIC kits for sale: Morse Practice £4.10, Dice £8.10. SAE for details. Bee Micro, 33 Bevendean Crescent, Brighton, E. Sussex

CLEARANCE SALE of High Quality assorted Electrical Terminal Connectors. Rings, Spades, Forks etc. at £5.56 for 100. Space Enterprises, Springfield, The Ridge, Epsom, Surrey.

CONVERT ANY TV into Large Screen oscilloscope (by external unit). Costs approx. £12 to build. Circuit and plans £3 or SAE details. J. Bobker, 29 Chadderton Drive, Unsworth, Bury, Lancs.

POWERAMPLIFIERS 200 WATT £11.95pl — case and controls, volume, balance and sockets. 4 × MJ3001 outputs, 100 + 100 watts!! (R.R.P. + data = £38.40). Kia, 8 Cunliffe Road, Ilkley.

SPECTRUM GAMES SALE. Venture (7 games in 1), was £6. 3 Compulsive Games, was £5. The lot on one cassette for just £6. Bobker, 29 Chadderton Drive, Unsworth, Bury, Lancs.

SELLING YOUR PRODUCTS? SELL THEM QUICKLY AND CHEAPLY FOR FURTHER INFORMATION CALL

ASP CLASSIFIED 01-437 1002 extn. 213 or 282

BUMPER BOX OF BITS

WOWIII We've got so many components in stock, we can't possibly list them all!! — So buy a box, in it you'll find resistors, capacitors, displays, switches, panels with transistors, diodes, IC's, etc., coils, pots... and so on. All modern parts — guaranteed at least 1000 items. Minimum weight 10lbs. ONLY £8.50 inc.

ELECTRONICS WORLD 1F Dews Road, Salisbury, Wilts SP2 78N

POWERFUL SW Medium FM portable radio, only £14.95 p+p £2.55. Sharland Enterprises, 7 Mountview, Mill Hill NW7 3HT.

DIGITAL WATCH REPLACEMENT parts. Batteries, displays, backlights etc. Also reports, publications, charts. S.A.E. for full list. Profords, Copnersdrive, Holmergreen, Bucks HP15 6SGE.

ELECTRONICS BOOKS. International publishers. Lowest rates. Ask list. Businesspromotion. 376 Lajpatrai Market Delhi India.

BURGLAR ALARM EQUIPMENT. Please visit our 2,000 sq. ft. showrooms or write or phone for your free catalogue, C.W.A.S. Ltd. 100 Rooley Avenue, Bradford BD6 1DB. Telephone 0274-308920.

ELECTRONICS component shop in MAID-STONE, KENTI Thyronics Control Systems, Road, Maidstone, Sandling Maidstone 675354.

AERIAL AMPLIFIERS Improve television reception. Price £6.70. S.A.E. for leaflets. Electronic Mailorder, Ramsbottom, Lancashire BL0 9AGH.

CENTURION

We manufacture, you save £££'s Send s.a.e. or phone for our Free list of professional D.I.Y. Burglar Alarm Equipprofessional D.I.Y. Burglar Alarm Equipment and accessories.
Discount up to 20% off list prices, e.g. Control Equipment from £15.98, Decoy Bell Boxes from £5.95 inc.

TRADE ENQUIRIES WELCOME

'0484-21000
or 0484 35527 (24 hr. ans.)

CENTURION ALARMS (HE)
1265 Wakefield Road, Huddersheld
HD5 9BE, W. Yorkshire
Access 6 Visa
Orders Welcomed

HOBBY ELECTRONICS CLASSIFIED ADVERTISEMENT — ORDER FORM

If you have something to sell now's your chance! Don't turn the page — turn to us! Rates of charge: 26p per word per issue (minimum of 15 words). Box Nos. £2.50 and post to HOBBY ELECTRONICS, CLASSIFIED DEPT., 145 CHARING CROSS ROAD, LONDON WC2

		-	
			1
			£3.90
			£5.20
			£6.50
	 ·		£7.80
			£9.10
			£10.40
			£11.70
			£13.00

Please place my advert in HOBBY ELECTRONICS	for issues commencing as soon as possible.
am enclosing my Cheque/Postal Order/International Money	Please use BLOCK CAPITALS and include post codes.
Order for: (delete as necessary) £ (Made payable to A.S.P. Ltd)	Mama (Ma/Max/Mix/Mix)

OR Debit my Access/Barclaycard	(delete.accordingly) Address
(Delete as necessary)	ome Access
	Signature

All classified advertisements must be paid for in advance.

ADVERTISERS INDEX

A.D.E	1	
AITKEN BROS	14	
AMBIT INTERNATIONAL	0	
AMTRON3		
AUDIO ELECTRONICS5		
BIB AUDIO		
BI-PAK		
B K ELECTRONICS	C	
BNRS	12	
J BULL 3		
CRICKLEWOOD		
CRIMSON COMPONENTS 6	32	
DATAPLUS DEVELOPMENTS6		
DELTA TECH	14	
ELECTRONICS & COMPUTING		
ELECTRONIZE DESIGN1		
ELECTRO SUPPLIES		
ELECTROVALUE	6	
ENFIELD ELECTRONICS	1	
EXPO LTD. 5		
GREENWELD		
GENSON ELECTRONICS		
G.S.C.		
HEMMINGS5		
ICS6		
ILP38, 3	19	
KELAN ENGINEERING	C	
KEMPSTON6	0	
LETCHWORTH7	79	
LIGHTNING ELECTRONICS		
MAGENTA ELECTRONICS		
MEON ELECTRONICS 6		
MILL HILL SUPLIES		
MYERS ELECTRONICS		
RAPID ELECTRONICS1		
BRIAN J REED6		
RELAY-A-QUIP	9	
RISCOMP4		
SANDWELL PLANT		
SINCLAIR RESEARCH 24, 2		
SOUTHERN TECHNICAL SYSTEMS		
SPARKRITE		
TECHNOMATIC1		
T.K. ELECTRONICS		
WILMSLOW AUDIO6	4	

to complain about

advertisements.

The Advertising Standards Authority.

If an advertisement is wrong, we're here to put it right.

A.S.A. Ltd., Brook House, Torrington Place, London WCIE 7HN.



MULLARD SPEAKER KITS

MULLARD SPEAKER KITS

Purposefully designed 40 watt R.M.S. and 30
watt R.M.S. 8 ohm speaker systems recently
developed by MULLARD'S specialist team in
Belgium. Kits comprise Mullard woofer (8* or
5*) with foam surround and aluminium voice coil.
Mullard 3* high power domed tweeter. B.K.E.
built and tested crossover based on Mullard
clicuit, combining low loss components, glass
fibre board and recessed loudspeaker terminals.
SUPER SOUNDS AT LOW COST. Kits supplied
in polystyrene packs complete with instructions.
8* 40W system — recommended cabinet size 240
x 216 x 445mm
Price £14.30 each + £2.00 P & P.
5* 30W system — recommended cabinet size
160 x 175 x 295mm
Price £13.90 each + £1.50 P 8 P.
Designer approved flat back cabinet kits.

Designer approved flat pack cabinet kits, including grill fabric. Can be finished with iron on veneer or self adhesive vinyl etc.

8' system cabinet kit 82.00 each + £2.50 P & P.
5" system cabinet kit £7.00 each + £2.00 P & P.



NO 80 LOUDSPEAKER

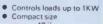
The very best in quelity and value. Ported tuned cabinet in hardwearing black kynide with protective corners and carry handle. Butl and tested, employing 10in British driver and Piezo tweeter. Spec: 80 watts RMS; 8 ohms; 45Hz-20KHz; Size: 20in x 18in x 12in; Weight: 30

Price: £49.00 each. £30 per pair Carriage: £5 each. £7 per pair

BK ELECTRONICS

Promot Deliveries VAT inclusive prices **Audio Equipment Test Equipment** by Thandar and Leader

1K.WATT SLIDE DIMMER



4%" × 13" × 2%

- Easy snap in fixing through panel/cabinet cut out
 Insulated plastic case Full wave control using 8amp
- Conforms to BS800
- Suitable for both resistance and inductive loads

Innumerable applications industry, the home, and discos/ theatres etc.

Price: £11.70 each + 50p P&P

(Anti-quantity

BSR P256 TURNTABLE

P256 turntable chassis ● S shaped tone arm
● Belt driven ● Aluminium platter ●
Precision calibrated counter balance ● Anti-Precision calibrated counter balance ● Anti-skate (bias device) ● Damped cueing lever ● 240 volt AC operation (Hz) ● Cut-out template supplied ● Completely manual arm and is designed primarily for disco and studio use where all the advantages of a manual arm are required. Price: £28.50 + £2.50 P&P

POWER AMPLIFIER MODULES



KEYBOARDS

MEMBRANE KEYBOARDS
manufactured from a tough polycarbonate film mounted on 1 mm
glass fibre printed circuit board
assembly incorporating silver plated
contacts.
16 way numeric keyboard
Standard keyboard providing 0-9
and A-F functions.
Size: 100mm x 100mm x 2mm. Price: (\$5.99 + 35p p&p

Alpha Numeric Keyboard Full size 55 key non encoded keyboard with the commonly required functions in a Overty array. Matrix output via a 16 pm DIL socket.

Size: 350mm × 100mm × 2mm. Price: £13.99 + 50p p&p



100 WATT R.M.S. AND 300 WATT R.M.S.

Power Amplifer Modules with integral roroidal transformer power supply, and heat sink. Supplied as one complete built and tested unit. Can be fitted in minutes. An LED Vu meter is available as an optional extra.

optional extra.

SPECIFICATION:
Max Output Power: 110 watts R.M.S. (OMP 100)
310 watts R.M.S. (OMP 300)
Loads: Open and short circuit proof. 4.16 chms.
Frequency Response: 20Hz — 25KHz ±3dB.
Sensitivity for Max. Output:
500mV at 10K (OMP 100)
1V at 10K (OMP 300)
1T.H.D.: Less than 0.1%
Supply: 240V 50Hz
OMP 300 460 × 153 × 66mm
Prices: OMP 100 360 × 115 × 72mm
OMP 300 480,00 each + 12.00 P&P
Vu Meter £8.50 each + 50.0 P&P



STEREO CASSETTE TAPE DECK MODULE.
Comprising of a top panel and tape mechanism coupled to a record/play back printed board assembly. Supplied as one complete unif or horizontal installation into cabinet or console of own choice. These units are brand new, ready built and tested.
Features: Three digit tape counter. Autostop. Six piano type keys, record, rewind, fast forward, play, stop and eject. Automatic record level control. Main inputs plus secondary inputs for stereo microphones. Input Secondary inputs for stereo microphones. Input Sensitivity: 100mV to 2V. Input Impedance: 68K. Output level: 400mV to both left and right hand channels. Output Impedance: 10K. 'Signal to noise ratio: 450k. Now and flutter: 0.1%. Power Supply requirements: 18V DC at 300mA. Connections: The left and right hand stereo inputs and outputs are via individual screened leads, all terminated with phono plugs (phono sockets provided.). Dimensions: Top panel 5½in x 11½in. Clearance required under top panel 2½in. Supplied complete with circuit diagram and connection diagram. Attractive black and silver finish. Pice 28.70 + £2.80 postage and packing.

Hene 28.70 + £2.80 postage and packing.

Pice 26.70 + £2.80 postage and packing.

Supplied complete with circuit diagram and connection. The propose of th



LOUDSPEAKERS
15" 100 watt R.M.S. (HI-FI, P.A., DISCO, BASS GUITAR) Die cast chassis, 2" aluminim voice coil, white cone with aluminium centre dome. 8 ohm imp., Res. Freq. 20Hz., Freq. Resp. to 2.5KHz., Sens. 97dB (As photograph). Price: £32.00 + £3 carriage.

97d8 (As photograph). Price: £32.00 + £3 carriage.

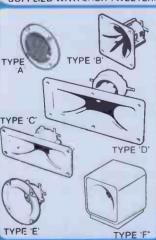
12" 100 watt R.M.S. (HI-FI) Die cast chassis. 2" aluminium voice coil. Black cone. 8 ohm imp., Res. Freq. 20Hz., Freq. Resp. to 4.5KHz. Sens. 95dB. (As photograph). Price: £23.50 + £3 carriage. 8" 50 watt R.M.S. (HI-FI, P.A.) 1%" aluminium voice coil. White cone. 8 ohm imp. Res. Freq. 40Hz., Freq. Resp. to 6KHz. Sens. 92dB. Also available with black cone fitted with black metal protective grille. (As photograph). Price: White Cone £8.90, Black cone/grille £9.50 P&P £1.25.

12" 85 watt R.M.S. McKENZIE C1285GP (LEAO GUITAR, KEYBOARO, DISCO) 2" aluminium voice coil, aluminium centre dome, 8 ohm imp., Res. Freq. 45Hz., Freq.

aluminium voice coil, aluminium centre dome, 8 ohm imp., Res. Freq. 45Hz., Freq. aluminium voice coil, aluminium centre dome, 8 ohm imp., Res. Freq. 45Hz., Freq. Resp. to 6.5KHz., Sens. 98d8. Price: £22.00 + £3 carriage.
12" 85 wat R.M.S. McKENZIE C1285TC (P.A., DISCO) 2" aluminium voice coil. Twin cone. 8 ohm imp., Res. Freq. 45HZ, Freq. Resp. to 14KHz. Price £22 + £3 carriage.
15" 150 wat R.M.S. McKENZIE C15 (BASS GUITAR, P.A.) 3" aluminium voice coil. Die cast chassis. 8 ohm imp., Res. Freq. 40Hz., Freq. Resp. to 4KHz. Price: £47 + £4

PIEZO ELECTRIC TWEETERS - MOTOROLA

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



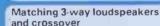
TYPE 'A' (KSN2036A) 3" round with protective wire mesh, ideal for bookshelf and medium sized Hi-fi speakers. Price £3.45 each.

TYPE 'B' (KSN1005A) 3 %" super horn. For superse speakers, disco and P.A. general purpose speakers, o systems etc. Price £4.35 each

TYPE 'C' (KSN6016A) 2" - 5" wide dispersion horn. For quality Hi fi systems and quality discoslete. Price £5.45 each.

TYPE 'E' (KSN1038A) 3%" horn tweeter with attractive silver finish trim. Suitable for Hi-fi monitor systems etc. Price £4.35 each.

TYPE 'F' (KSN1057A) Cased version of type E Free standing satellite tweeter. Perfect add on tweeter for conventional loudspeaker systems. Price £10.75 each.
P&P 20p ea. (or SAE for Piezo leaflets).



Build a quality 60watt RMS system 80hms Build a quality 60 watt R.M.S. system.

★ 10" Woofer 35Hz-4.5KHz

★ 3" Tweeter 2.5KHz-19KHz

★ 5" Mid Range 600Hz-8KHz

★ 3-way crossover 6dB/oct 1.3 and 6KHz Recommended Cab-size 26" × 13" × 13"

Recommended Cab-size 26" x 13" x 1: Fitted with attractive cast aluminium fixing escutcheons and mesh protective grills which are removable enabling a unique choice of cabinet styling. Can be mounted directly on to baffle with or without conventional speaker fabrics. All three units have aluminium centre domes and rolled foam surround Crossover combines spring loaded loudspeaker terminals and recessed mounting panel.

Price f22.00 per kit + £2.50 postage and packing Available separately, prices on request

12" 80 watt R.M.S. loudspeaker.

A superb general purpose twin cone loud-speaker. 50 oz. magnet 2 aluminum voice coil. Rolled surround. Resonant fre-quency 25Hz. Frequency response to 13KHz. Sensitivity 95dB. Impedance Bohm. Attractive blue cone with aluminium centre dome. Price £17.99 each + £3.00 P&P.













37 Whitehouse Meadows, Eastwood, Leigh-on-Sea, Essex SS9 5TY ★ SAE for current lists. ★ Official orders welcome. ★ All prices include VAT. ★ Mail order only ★ All items packed (wher applicable) in special energy absorbing PU foam. Callers welcome by prior appointment, please phone 0702-527572.

