JUNE 1983

Hobby Electronics

AN ARGUS SPECIALIST PUBLICATION

Project Electronics For Everyone

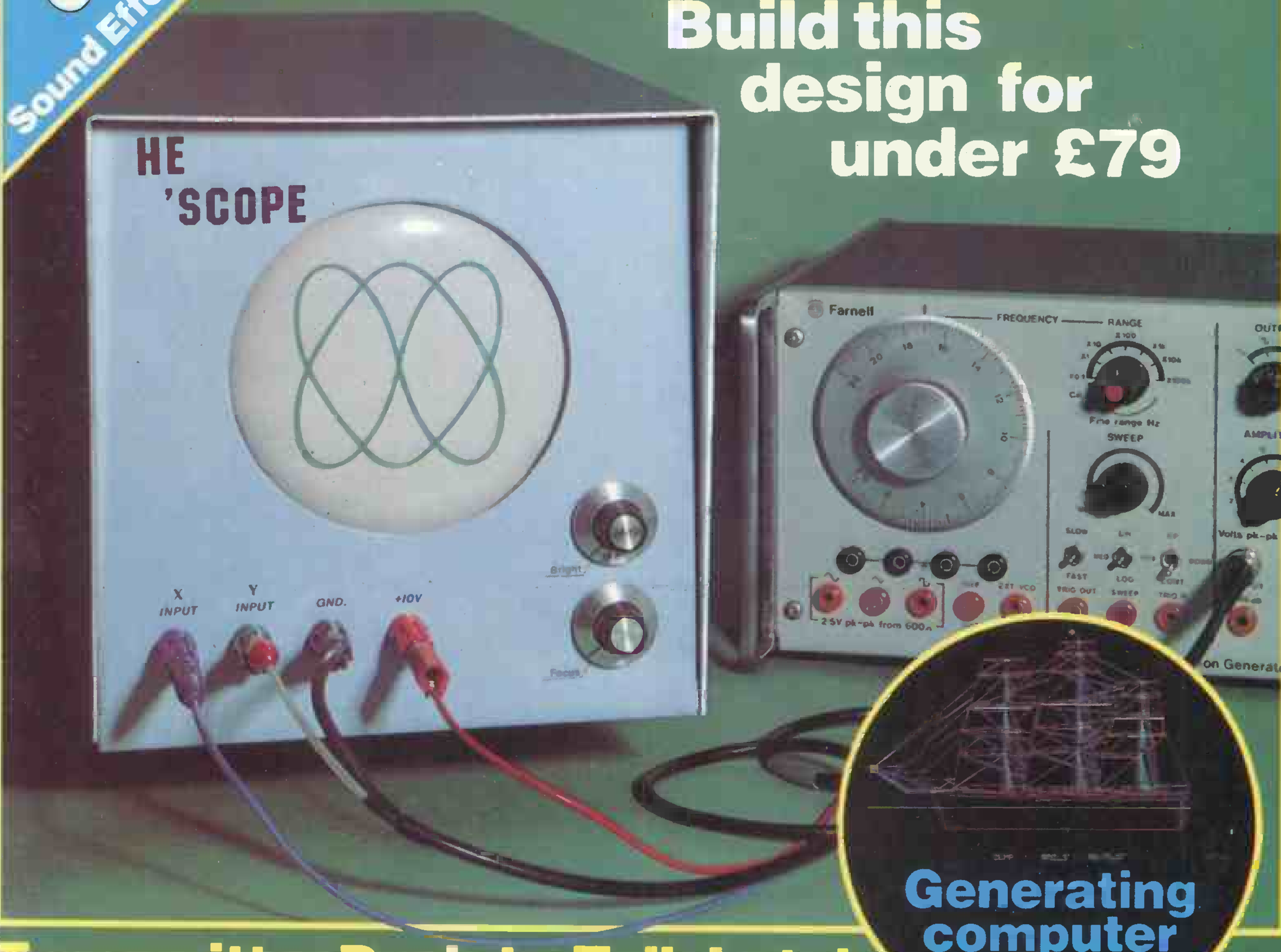
85p

POPULAR COMPUTING

Sound Effects for ZX Computers

LOW COST OSCILLOSCOPE PROJECT

Build this design for under £79



Generating computer displays

Transmitter Push-to-Talk Latch

Traffic Light Toy for Young Drivers

Play the AMBIT numbers game ......

The long awaited implementation of on-line order processing is with us at last, and whilst this means that orders for in-stock items can now be processed more efficiently, it also means that orders should be submitted using stock codes for best results. Our current catalogue (75p) includes all order codes (watch out for the new expanded Spring edition), but here's an abstract from some of the more popular lines to use as a quick reference.

Remember that you can also access our catalogue via REWSHOP on REWTEL, which now includes on-line current price and delivery information. You need a 300 baud MODEM and RS232 terminal, (various suitable configurations based on popular micros have been published in recent past issues of Radio and Electronics World).

Prices shown here exclude VAT, and the P&P charge is currently 60p per order (unless otherwise indicated). Remember that our tele-sales service operates with human beings (not 'dumb' machines) from 8am to 7pm (and frequently later) Monday to Friday, and 9am to 6pm on Saturdays. REWSHOP operates 24 hours a day, 365 days a year with full price and delivery information.

ALWAYS USE STOCK NUMBERS WHEN ORDERING PLEASE.

4000 CMOS

Type	Stock No	Price
4000UB	22-04000	0.11
4001	23-04001	0.11
4002	23-04002	0.12
4007	23-04007	0.13
4008	23-04008	0.50
4009UB	22-04009	0.25
4011	23-04011	0.11
4011UB	23-04011	0.11
4012	23-04012	0.14
4013	23-04013	0.25
4015	23-04015	0.50
4016	23-04016	0.22
4017	23-04017	0.40
4020	23-04020	0.55
4021	23-04021	0.55
4022	23-04022	0.55
4023	23-04023	0.15
4024	23-04024	0.33
4025	23-04025	0.15
4027	23-04027	0.28
4028	23-04028	0.50
4029	23-04029	0.55
4035	23-04035	0.67
4040	23-04040	0.68
4042	23-04042	0.50
4043	23-04043	0.60
4044	23-04044	0.68
4046	23-04046	0.60
4049UB	22-04049	0.24
4050	23-04050	0.24
4051	23-04051	0.55
4052	23-04052	0.55
4053	23-04053	0.55
4060	23-04060	0.75
4066	23-04066	0.30
4068	23-04068	0.16
4069UB	22-04069	0.14
4070	23-04070	0.16
4071	23-04071	0.16
4072	23-04072	0.16
4073	23-04073	0.16
4075	23-04075	0.16
4076	23-04076	0.55
4077	23-04077	0.18
4078	23-04078	0.18
4081	23-04081	0.18
4082	23-04082	0.18
4093	23-04093	0.30
4099	23-04099	0.80
4175	23-04175	0.80
4502	23-04502	0.60
4503	23-04503	0.50
4506	23-04506	0.70
4507	23-04507	0.37
4508	23-04508	1.50
4510	23-04510	0.55
4511	23-04511	0.45
4512	23-04512	0.55
4514	23-04514	1.25
4515	23-04515	1.25
4516	23-04516	0.60
4518	23-04518	0.35
4520	23-04520	0.60
4521	23-04521	1.30
4522	23-04522	0.89
4526	23-04526	0.80
4527	23-04527	0.80
4528	23-04528	0.65
4529	23-04529	0.70
4531	23-04531	0.85
4532	23-04532	0.80
4534	23-04534	4.00
4536	23-04536	2.50
4538	23-04538	0.85
4539	23-04539	0.80
4543	23-04543	0.80
4549	23-04549	3.50
4553	23-04553	2.70
4554	23-04554	1.20
4555	23-04555	0.35
4556	23-04556	0.40
4557	23-04557	2.30
4558	23-04558	0.80
4559	23-04559	3.60
4560	23-04560	2.50
4561	23-04561	1.00
4562	23-04562	2.50
4566	23-04566	1.20
4568	23-04568	1.45
4569	23-04569	1.70
45672UB	23-04572	0.32
4580	23-04580	3.25
4581	23-04581	1.40
4582	23-04582	0.70
4583	23-04583	0.80
4584	23-04584	0.27
4585	23-04585	0.45
4702	23-04702	4.50
4703	23-04703	4.48
4704	23-04704	4.24
4705	23-04705	4.24
4706	23-04706	4.50
4720	23-04720	4.00
4723	23-04723	0.95
4724	23-04724	0.95
4725	23-04725	2.24
40014	23-40014	0.54
40085	23-40085	0.99
40098	23-40098	0.54
40106	23-40106	0.89
40160	23-40160	1.05
40161	23-40161	1.05
40162	23-40162	1.05
40163	23-40163	1.05
40174	23-40174	1.05
40175	23-40175	1.05
40192	23-40192	1.08
40193	23-40193	1.08
40195	23-40195	1.08

74LSXX

Type	Stock No	Price
74LS00	31-07400	0.11
74LS01	31-07401	0.11
74LS02	31-07402	0.11
74LS03	31-07403	0.11
74LS04	31-07404	0.14
74LS05	31-07405	0.14
74LS08	31-07408	0.14
74LS09	31-07409	0.14
74LS10	31-07410	0.14
74LS11	31-07411	0.14
74LS12	31-07412	0.14
74LS13	31-07413	0.32
74LS14	31-07414	0.32
74LS15	31-07415	0.14
74LS20	31-07420	0.14
74LS21	31-07421	0.14
74LS22	31-07422	0.14
74LS26	31-07426	0.14
74LS27	31-07427	0.30
74LS28	31-07428	0.18
74LS30	31-07430	0.14
74LS32	31-07432	0.14
74LS33	31-07433	0.14
74LS37	31-07437	0.18
74LS38	31-07438	0.14
74LS40	31-07440	0.18
74LS42	31-07427	0.30
74LS47	31-07447	0.75
74LS48	31-07448	0.40
74LS49	31-07449	0.80
74LS51	31-07451	0.14
74LS54	31-07454	0.14
74LS55	31-07455	0.14
74LS74	31-07474	0.21
74LS75	31-07475	0.21
74LS76	31-07476	0.25
74LS78	31-07478	0.19
74LS83	31-07483	0.33
74LS85	31-07485	0.44
74LS86	31-07486	0.15
74LS90	31-07490	0.24
74LS91	31-07491	0.36
74LS92	31-07492	0.32
74LS93	31-07493	0.24
74LS95	31-07495	0.36
74LS107	31-74107	0.31
74LS109	31-74109	0.25
74LS112	31-74112	0.21
74LS113	31-74113	0.21
74LS114	31-74114	0.21
74LS122	31-74122	0.27
74LS123	31-74123	0.36
74LS125	31-74125	0.27
74LS126	31-74126	0.27
74LS132	31-74132	0.27
74LS133	31-74133	0.24
74LS136	31-74136	0.20
74LS138	31-74138	0.30
74LS139	31-74139	0.30
74LS151	31-74151	0.30
74LS153	31-74153	0.34
74LS155	31-74155	0.30
74LS156	31-74156	0.33
74LS157	31-74157	0.27
74LS158	31-74158	0.27
74LS160	31-74160	0.34
74LS161	31-74161	0.36
74LS162	31-74162	0.38
74LS163	31-74163	0.38
74LS164	31-74164	0.40
74LS165	31-74165	0.60
74LS166	31-74166	0.58
74LS168	31-74168	0.68
74LS170	31-74170	0.63
74LS173	31-74173	0.47
74LS174	31-74174	0.37
74LS175	31-74175	0.40
74LS181	31-74181	0.87
74LS183	31-74183	1.05
74LS190	31-74190	0.39
74LS191	31-74191	0.39
74LS192	31-74192	0.39
74LS193	31-74193	0.39
74LS194	31-74194	0.39
74LS195	31-74196	0.39
74LS196	31-74196	0.39
74LS197	31-74197	0.47
74LS221	31-74221	0.50
74LS240	31-74240	0.60
74LS241	31-74241	0.60
74LS242	31-74242	0.55
74LS243	31-74243	0.55
74LS244	31-74244	0.60
74LS245	31-74245	1.00
74LS251	31-74251	0.36
74LS253	31-74253	0.36
74LS257	31-74257	0.36
74LS258	31-74258	0.36
74LS259	31-74259	0.51
74LS260	31-74260	0.26
74LS266	31-74266	0.20
74LS273	31-74273	0.70
74LS279	31-74279	0.35
74LS283	31-74283	0.40
74LS290	31-74290	0.40
74LS293	31-74293	0.40
74LS298	31-74298	0.54
74LS365	31-74365	0.34
74LS366	31-74366	0.40
74LS367	31-74367	0.30
74LS368	31-74368	0.30
74LS373	31-74373	0.72
74LS374	31-74374	0.72
74LS375	31-74375	0.31
74LS377	31-74377	0.60
74LS378	31-74378	0.44
74LS379	31-74379	0.44
74LS385	31-74385	1.30
74LS386	31-74386	0.27
74LS390	31-74390	0.51
74LS393	31-74393	0.48
74LS398	31-74398	0.80
74LS399	31-74399	0.65
74LS490	31-74490	0.60
74LS670	31-74670	1.15

74CXX

Type	Stock No	Price
74C00	29-07400	0.35
74C02	29-07402	0.35
74C04	4069C	
74C08	29-07408	0.35
74C10	29-07410	0.35
74C14	4584C	
74C20	29-07420	0.35
74C30	29-07430	0.35
74C32	29-07432	0.35
74C42	29-07442	1.05
74C48	29-07448	1.50
74C73	29-07473	0.75
74C74	29-07474	0.75
74C76	29-07476	0.60
74C83	29-07483	1.30
74C85	29-07485	1.30
74C86	29-07485	1.30
74C89	29-07489	3.60
74C90	29-07490	1.05
74C93	29-07493	1.05
74C95	29-07495	1.25
74C107	29-74107	0.60
74C151	29-74151	2.10
74C154	29-74154	3.05
74C157	29-74157	2.10
74C160	40160	
74C1610	40161CM	
74C1620	40162CM	
74C1630	40163CM	
74C164	29-74164	1.05
74C165	29-74165	1.10
74C173	4076C	
74C1740	40174CM	
74C1750	40175CM	
74C1920	40192CM	
74C1930	40193CM	
74C1950	40195CM	
74C200	29-74200	6.50
74C221	29-74221	1.55
74C901	29-74901	0.55
74C902	29-74902	0.55
74C903	29-74903	0.55
74C904	29-74904	0.55
74C905	29-74905	6.50
74C906	29-74906	0.55
74C907	29-74907	0.55
74C908	29-74908	1.10
74C909	29-74909	2.10
74C910	29-74910	5.00
74C914	29-74914	1.10
74C918	29-74918	1.30
74C925	29-74925	6.00
74C926	29-74926	6.00
74C927	29-74927	6.00

74HCXX

Type	Stock No.	Price
74HC00	30-07400	0.56
74HC02	30-07402	0.56
74HC04	30-07404	0.68
74HC10	30-07410	0.56
74HC20	30-07420	0.56
74HC86	30-07486	0.74
74HC132	30-74132	1.26
74HC266	30-74266	0.81
74HC4002	30-04002	0.56
74HC4075	30-04075	0.56
74HC242	30-74242	2.00
74HC243	30-74243	2.00
74HC74	30-07474	0.74
74HC109	30-74109	0.88
74HC175	30-74175	1.08
74HC373	30-74373	2.40
74HC374	30-74374	2.40
74HC533	30-74533	2.40
74HC534	30-74534	2.40
74HC165	30-74165	1.96
74HC173	30-74173	1.20
74HC160	30-74160	1.33
74HC161	30-74161	1.33
74HC162	30-74162	1.33
74HC163	30-74163	1.33
74HC4538	30-74538	2.10
74HC85	30-74280	2.95
74HC280	30-74280	2.95
74HC42	30-07442	1.00
74HC138	30-74138	1.08
74HC139	30-74139	1.08
74HC4514	30-04514	3.40
74HC4543	30-04543	2.75
74HC157	30-74157	0.92
74HC158	30-74158	0.90
74HC257	30-74257	0.90

LINEAR ICs

Type	Stock No.	Price
LM10CN	61-00010	3.88
MF10	61-00011	5.05
L149	61-00149	1.86
ZNA234	61-02340	8.50
U237B	61-00237	1.28
U247B	61-00247	1.28
U257B	61-00257	1.28
U267B	61-00267	1.28
LM301AH	61-03010	0.67
LM301AN	61-03011	0.27
LM308H	61-03080	0.70
LM308CN	61-03081	0.65
LM324	61-03240	0.45
LM339N	61-03390	0.66
LF347	61-00347	1.60
LM348	61-03480	0.90
LF351	61-03510	0.49
LF353	61-03530	0.76
LM380N	61-00380	1.00
LM381	61-00381	1.81
LM382	61-00382	1.81
ZN419CE	61-00419	1.98
ZNA423	61-04230	1.00
ZN425E/8	61-04250	3.50
ZN426E/8	61-04260	3.00
ZN427E/8	61-04270	6.28
ZN428E/8	61-04280	4.78
ZN429E/8	61-04290	2.10
ZN432CJ10	61-04320	28.09
ZN433CJ10	61-04330	22.59
ZN450E	61-04500	7.61
NE542	61-05420	1.20
NE544	61-00544	1.80
NE555N	61-05550	0.20
NE556N	61-05560	0.50
SL560C	61-05600	1.86
NE562	61-00562	4.05
NE564	61-00564	4.29
NE565	61-00565	1.00
NE566	61-00566	1.30
NE567	61-00567	1.30
NE570N	61-00570	3.85
SL624	61-00624	3.28
uA709HC	61-07090	0.64
uA709PC	61-07091	0.38
uA710HC	61-07100	0.64
uA710PC	61-07101	0.59
uA711CN	61-07110	0.85
uA733CN	61-07330	0.89
uA741CH	61-07410	0.66
uA741CN	61-07411	0.20
uA747CN	61-07470	0.70
uA748CN	61-04780	0.30
uA758	61-00758	2.35
TBA820M	61-00820	0.78
TDA1028	61-01028	2.11
TDA1029	61-01029	2.11
ZNA1034	61-01034	2.10
LM1035	61-01034	2.10
TDA1054M	61-01054	1.45
TDA1062	61-01062	1.95
TDA1072	61-01072	2.69
TDA1074A	61-01074	5.04
TDA1083	61-01083	1.95
TDA1090	61-01090	3.05
HA1137	61-12411	1.20
HA1196	61-01196	2.00
HA1197	61-01197	1.00
TDA1220	61-01220	1.40
LM1303	61-01303	0.99
LM1307	61-01307	1.55
MC1310P	61-01310	1.90
MC1330	61-01330	1.20
MC1350	61-01350	1.20
HA1370	61-11370	1.90
HA1388	61-01388	2.75
LM1458N	61-14580	0.45
MC1496P	61-01496	1.25
SL1610	61-01610	1.92
SL1611	61-01611	1.92
SL1612	61-01612	1.92
SL1613	61-01613	2.08
SL1620	61-01620	2.50
SL1621	61-01621	2.50
SL1623	61-01623	2.50
SL1625	61-01625	2.50
SL1626	(SL6270)	
SL1630	61-01630	1.62
SL1640	61-01640	2.25
SL1641	61-01641	2.25
MC1648	61-01648	3.25
TDA2002	61-02002	1.25
ULN2240	61-02240	3.25
ULN2242	61-01090	3.05
ULN2283	61-02283	1.00
CA3080	61-03080	0.70
CA3089	61-03089	1.84
CA3123	61-03123	1.40
CA3130E	61-31300	0.80
CA3130T	61-31301	0.90
CA3140E	61-31400	0.46
CA3189E	61-03189	2.20
CA3240E	61-32400	1.27
MC3357	61-03357	2.85
MC3359 (see ULN3859)		
ULN3859	61-03859	2.95
KM3701	61-03701	85.53
KM3702	61-03702	74.84
LM3900	61-39000	0.60
LM3909N	61-39090	0.68
LM3914N	61-03914	2.80
LM3915N	61-03915	2.80
KB4400	61-04400	0.60
KB4412	61-04412	1.95
KB4413	61-04413	1.95
KB4417	61-04417	1.80
KB4420B	61-04420	1.09
TDA4420	61-14420	2.65
TDA4421	61-14421	2.65
KB4423	61-04423	2.30
KB4424	61-04424	1.65
KB4430	61-04430	2.30
KB4431	61-04431	1.95
KB4432	61-04432	1.95
KB4433	61-04433	1.52
KB4436	61-04436	2.53
KB4437	61-04437	1.75
KB4438	61-04438	2.22
KB4441	61-04441	1.35
KB4445	61-04445	1.29
KB4446	61-04446	2.75
KB4448	61-04448	1.65
NE5044	61-05044	2.28
MC5229	61-05229	9.60
NE5532	61-55320	1.85
KM5624	61-05624	4.35
SD6000	61-06000	3.75
SL6270	61-06270	2.03
SL6310	61-06310	2.45
SL6440	61-06440	3.38
SL6600	61-06600	3.75
SAS6610	61-06610	1.48
SL6640	61-06640	2.75
SL6690	61-06690	3.75
SL6700	61-06700	2.75
SAS6710	61-06710	1.48
LS7225	61-07225	3.65
ICM7555	61-75550	0.80
CL8038CC	61-08038	4.50
MSL9362	61-09362	1.75
MSL9363	61-093..	1.76
K10170	61-10170	1.87
TK10321	61-10321	2.75
HA11223	61-11223	2.15
HA11225	61-11225	1.45
HA12002	61-12002	1.22
HA12017	61-12017	0.80
HA12402	61-12402	1.95
HA12411	61-12411	1.20
HA12412	61-12412	1.55
LF13741	61-13741	0.33
MK50366	61-50366	3.35
MK50375	61-50375	3.85
MM53200	61-53200	3.90

PRESCALER

Type	Stock No.	Price
U264	61-02640	2.27
U265	61-02650	3.16
U266	61-02660	2.43
11C90DC	61-01190	12.95
MSL2312R	61-02312	3.94
MSL2318	61-02318	3.84
MSM5523	61-05523	11.30
MSM5524	61-05524	11.30
MSM5525	61-05525	7.85
MSM5526	61-05526	7.85
MSM55271	61-55271	9.75
ICM7106CP	61-07106	9.55
ICM7107CP	61-07107	9.55
LC7137	61-07137	7.50
ICM7216B	61-72161	19.50
ICM7216C	61-72162	19.95
ICM7217A	61-07217	9.50
SP8629	61-08629	3.85
SP8647	61-08647	6.00
SP8793	61-08793	7.70
95H90	61-09590	7.80
HD10551	61-10551	2.45
HA12009	61-12009	6.00
HD44015	61-44015	4.45
HD44752	61-44752	8.00
MC145151P	61-14151	6.00
MC145152P	61-14151	6.60
MC145156P	61-14156	4.60

SMALL SIGNAL AUDIO

Type	Stock No.	Price
BC182	58-00182	0.10
BC212	58-00212	0.10
BC237	58-00237	0.08
BC238	58-00238	0.08
BC239	58-00239	0.08
BC307	58-00307	0.08
BC308	58-00308	0.08
BC309	58-00309	0.08
BC327	58-00327	0.13
BC337	58-00337	0.13
BC413	58-00413	0.10
BC414	58-00414	0.11
BC415	58-00415	0.10
BC416	58-00416	0.11
BC546	58-00546	0.12
BC550	58-00550	0.12
BC556	58-00556	0.12
BC560	58-00560	0.12
BC639	58-00639	0.22
BC640	58-00640	0.22
MPSA13	58-04013	0.30
MPSA63	58-04063	0.30
ZTX108	58-01108	0.10
ZTX212	58-01212	0.10
ZTX653	58-01653	0.20
ZTX753	58-01753	0.20
2N2904	58-02904	0.25
2N2905	58-02905	0.25
2N3905	58-03905	0.10
2SB646A	58-03646	0.30
2SB648A	58-03648	0.40
2SD666A	58-03666	0.30
2SD668A	58-03668	0.40
2SA872A	58-02872	0.19
2SA1084E	58-01084	0.25
2SA1085E	58-01085	0.25
2SC1775A	58-01775	0.19
2SC2546E	58-02546	0.24
2SC2547E	58-02547	0.24

AUDIO POWER

Type	Stock No.	Price
BD139	58-15139	0.29
BD140	58-15140	0.31
BD165	58-15165	0.46
BD166	58-15166	0.48
BD179	58-15179	0.38
BD180	58-15180	0.41
TIP31A	58-15031	0.35
TIP32A	58-15032	0.35
MJ2955	58-12955	0.88
2N3055	58-13099	0.58
2SB720	58-15720	0.80
2SD760	58-17600	0.60
2SJ49	60-01049	3.10
2SJ50	60-01050	4.25
2SJ83	60-01083	3.55
2SK134	60-00134	3.10
2SK135	60-00135	4.25
2SK227	60-00227	3.55
2SD753	58-03753	2.34

SMALL SIGNAL RF

Type	Stock No.	Price
BFY50	58-06500	0.22
BF241	58-06241	0.18
BF273	58-06273	0.18
BF274	58-06274	0.20
BF362	58-06362	0.49
BF440	58-06440	0.21
BF441	58-06441	0.21
BF479	58-06479	0.66
BF6795	58-06679	0.55
BFR91	58-07091	1.33
BFT95	58-10095	0.99
BFW92	58-08092	0.60
BFY90	58-09090	0.90
NE21936	58-21936	5.00
ZTX323	58-06232	0.60
2N2369A	58-02369	0.38

RF POWER

Type	Stock No.	Price
BFW16A	58-08016	0.65
MRF237	58-14237	3.20
MRF238	58-14238	16.50
MRF245	58-14245	40.00
MRF449A	58-14449	16.50
MRF472	58-14472	1.25
MRF475	58-14475	4.60
MRF629	58-14629	4.99
PT8811	58-18811	9.50
TP2320	58-12320	10.24
VN66AF	60-02066	0.95
ZTX3866	58-03866	0.45
2N3866	58-13866	1.20

SMALL SIGNAL FET

Type	Stock No.	Price
BF256	59-00256	0.38
BF960	60-06960	0.99
BF961	60-06961	0.70
BF963	60-06963	0.99
J310	59-02310	0.69
J176	59-02176	0.65
2SK55	59-01055	0.32
2SK168	59-01168	0.37
3SK45	60-04045	0.49
3SK51	60-04051	0.54
3SK60	60-04060	0.58
3SK88	60-04088	0.99
40673 see 3SK51		
40822 see 3SK51		
40823	60-03823	0.65
3SK112	60-04112	4.60

DIODES

Type	Stock No.	Price
AA112	12-01126	0.25
BA244	12-02447	0.17
BA379	12-03797	0.35
ND4981-7E	12-49817	0.51
OA91	12-00916	0.07
OA47	12-00476	0.10
PW02	12-62006	0.75
S04	12-24006	0.45
W005	12-10506	0.28
1N4001	12-40016	0.06
1N4002	12-40026	0.07
1N4004	12-40046	0.07
1N4148	12-41486	0.05
1N5404	12-54046	0.16
1N6263	12-62637	0.62

VARICAPS

Type	Stock No.	Price
BA102	12-01025	0.30
BA121	12-01215	0.30
BB105B	12-01055	0.30
BB109B	12-01095	0.27
BB204B	12-02045	0.38
BB212	12-02125	1.95
ITT210	12-02105	0.30
MVAM115 see KV1236		
MVAM125 see KV1225		
KV1210	12-12105	2.45
KV1211 see KV1236		
KV1225	12-12255	2.75
KV1235	12-12355	2.75
KV1236	12-12365	2.55
KV1310	12-13105	0.40
KV1310	12-13205	0.40

ZENER DIODES

BZY88C 400mW. 5%.

Type	Stock No	Price
2V7	12-00278	0.10
3V3	12-00338	0.10
3V9	12-00398	0.10
4V7	12-00478	0.10
5V1	12-00518	0.10
5V6	12-00568	0.10
8V8	12-00688	0.10
8V2	12-00828	0.10
9V1	12-00918	0.10
10	12-01008	0.10
11	12-01108	0.10
12	12-01208	0.10
15	12-01508	0.10
18	12-01808	0.10
22	12-02208	0.10
27	12-02708	0.10
33	12-03308	0.10

SCRS TRIACS

Type	Stock No	Price
BRY55-100	52-55100	0.50
C106D1	52-00106	0.70
C122D1	52-00122	1.45
2N6403	52-06403	2.22
2N6073A	58-06073	0.98

BALANCED MIXERS

Type	Stock No	Price
SBL1	12-00003	4.68
SBL1-8	12-00013	5.00
SBL1-X	12-00023	8.33
SRA1	12-00033	10.80
SRA1-1	12-00043	12.77
SRA1H	12-00053	16.34
SRA3	12-00063	15.35

LEDs

3mm round types

Type	Stock No	Price
CQX25-Red/Clr	15-20250	0.15
V178P-Red	15-01780	0.15
CQX26-Gr/Clr	15-20260	0.16
V179P-Green	15-01790	0.16
CQX27-Yel/Clr	15-20270	0.18
V180P-Yellow	15-01800	0.18
CQX41A-Or/Rd	15-20410	0.19

Standard 5mm DIA LEDs

Type	Stock No	Price
CQY40L Red	15-10400	0.12
CQY72L Green	15-10720	0.15
CQY74L Yellow	15-10740	0.15
CQX38A Or/rd	15-20380	0.20
CQX39B Or/cl	15-20390	0.29

Rectangular 2.5 x 5mm LEDs

Type	Stock No	Price
CQX10 Red	15-20100	0.17
CQX11 Green	15-20110	0.20
CQX12 Yellow	15-20150	0.20
CQX40 Or/Red	15-20400	0.24

Infra-Red LEDs

Type	Stock No	Price
CQY99 Emit	15-10990	0.56
BPW41 Det	15-30410	1.51

I-R Optocoupler

Type	Stock No	Price
BNY37	15-40370	1.44

FLAT DIFFUSED

Type	Stock No	Price
V320	15-03200	0.17
V321	15-03210	0.28
V322	15-03220	0.20
V323	15-03230	0.20
V330	15-03300	0.17
V331	15-03310	0.28
V332	15-03320	0.20
V333	15-03330	0.20
V340	15-03400	0.17
V341	15-03410	0.28
V342	15-03420	0.20
V343	15-03430	0.20
V510	15-05100	0.17
V511	15-05110	0.28
V512	15-05120	0.20
V513	15-05130	0.20
V520	15-05200	0.17
V521	15-05210	0.28
V522	15-05220	0.20
V523	15-05230	0.20
V530	15-05300	0.17
V531	15-05310	0.28
V532	15-05320	0.20
V533	15-05330	0.20
V540	15-05200	0.17
V541	15-05410	0.28
V542	15-05420	0.20
V543	15-05430	0.20
V550	15-05500	0.17
V551	15-05510	0.28
V552	15-05520	0.20
V553	15-05530	0.20

TRI COLOUR

Type	Stock No	Price
V518	15-05180	0.60

Ambit international

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CM14 4SG

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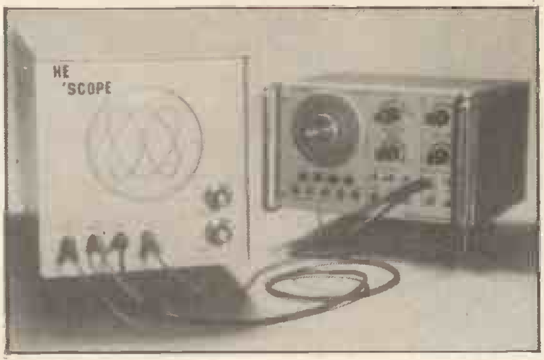
JUNE 1983
Vol 5 No 6

Hobby Electronics

PROJECTS

FEATURES

REGULARS



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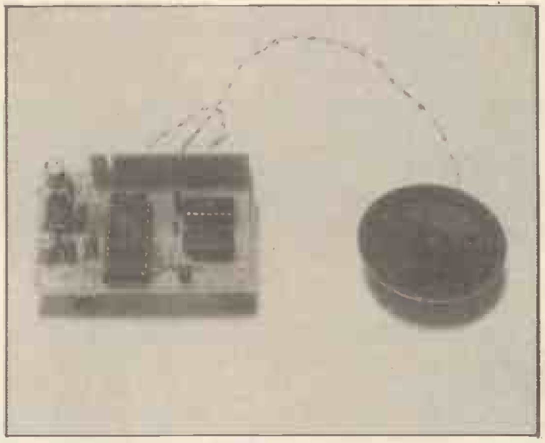
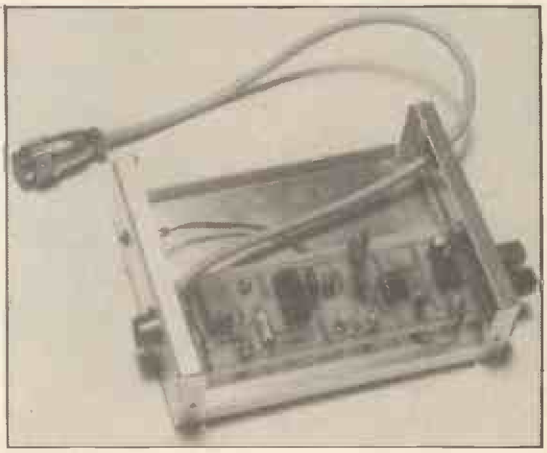


Sinclair Sound Board — page 20



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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 circuit, combining low loss components, glass fibre board and recessed loudspeaker terminals. SUPERB SOUNDS AT LOW COST. Kits supplied in polystyrene packs complete with instructions.

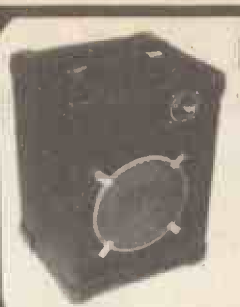
8" 40W system — recommended cabinet size 240 × 216 × 445mm
Price £14.90 each + £2.00 P & P.

5" 30W system — recommended cabinet size 160 × 175 × 295mm
Price £13.90 each + £1.50 P & P.

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 **£8.00 each + £2.50 P & P.**
5" system cabinet kit **£7.00 each + £2.00 P & P.**

OMP 80 LOUDSPEAKER



The very best in quality and value.

Ported tuned cabinet in hard-wearing black vynide with protective corners and carry handle. Built and tested, employing 10in British driver and Piezo tweeter. Spec: 80 watts RMS; 8 ohms; 45Hz-20Hz; Size: 20in x 15in x 12in; Weight: 30 pounds.

Price: **£49.00 each**
£90 per pair
Carriage: £5 each £7 per pair

BK ELECTRONICS

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VAT inclusive prices
Audio Equipment
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by
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and
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PANTEC

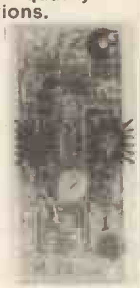
HOBBY KITS. Proven designs including glass fibre printed circuit board and high quality components complete with instructions.

FM MICROTRANSMITTER (BUG) 90/105MHz with very sensitive microphone. Range 100/300 metres. 5 x 46 x 14mm (9 volt) **Price: £6.58.**

DIGITAL THERMOMETER −9.9°C to +99.9°C. LED display. Complete with sensor. 70 x 70 mm (9 volt) **Price: £22.94**

3 WATT FM TRANSMITTER / WATT 85/115MHz varicap controlled professional performance. Range up to 3 miles 35 x 84 x 12 mm (12 volt) **Price: £10.64**

SINGLE CHANNEL RADIO CONTROLLED TRANSMITTER/RECEIVER 27MHZ Range up to 500 metres. Double coded modulation. Receiver output operates relay with 2amp/240 volt contacts. Ideal for many applications. Receiver 90 x 70 x 22 mm 9/12 volt) **Price: £14.38.** Transmitter 80 x 50 x 15 mm (9/12 volt) **Price £9.15. P&P All Kits +50p. S.A.E. for complete list.**



3 watt FM Transmitter

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 unit for 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 Sensitivity:** 100mV to 2V. **Input Impedance:** 68K. **Output level:** 400mV to both left and right hand channels. **Output Impedance:** 10K. **Signal to noise ratio:** 45dB. **Wow 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 5¼in × 11¼in. Clearance required under top panel 2¼in. Supplied complete with circuit diagram and connecting diagram. Attractive black and silver finish.

Price £26.70 + £2.50 postage and packing.

Supplementary parts for 18V D.C. power supply (transformer, bridge rectifier and smoothing capacitor) £3.50

BSR P256 TURNTABLE

P256 turntable chassis ● S shaped tone arm ● Belt driven ● Aluminium platter ● Precision calibrated counter balance ● Anti-skate (bias device) ● Damped cueing lever ● 240 volt AC operation (Hz) ● Cut-out template supplied ● Completely manual arm. This deck has a completely manual arm and is designed primarily for disco and studio use where all the advantages of a manual arm are required.

Price £31.35 each. £2.50 P&P

LOUDSPEAKERS

16" 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.

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.) 1½" 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 (LEAD GUITAR, KEYBOARD, DISCO) 2" aluminium voice coil, aluminium centre dome, 8 ohm imp., Res. Freq. 45Hz., Freq. Resp. to 6.5KHz., Sens. 98dB. **Price: £22.00 +** £3 carriage.

12" 85 watt 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 watt 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** carriage.

OMP POWER AMPLIFIER MODULE

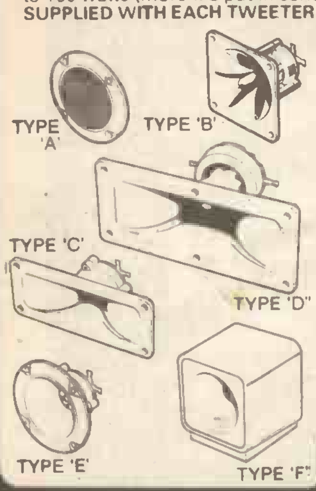
New model.
Improved specification

NEW OMP100 Mk.II POWER AMPLIFIER MODULE Power Amplifier Module **complete** with integral heat sink, toroidal transformer power supply and glass fibre p.c.b. assembly. Incorporates drive circuit to power a compatible LED Vu meter. New **improved** *specification makes this amplifier ideal for P.A., Instrumental and Hi-Fi applications.*

SPECIFICATION
Output Power:— 110 watts R.M.S.
Loads:— Open and short circuit proof 4/16 ohms.
Frequency Response:— 15Hz - 30KHz -3dB.
T.H.D.:— 0.01%.
S.N.R. (Unweighted):— -118dB ±3.5dB.
Sensitivity for Max. Output:— 500mV @ 10K.
Price:— £31.99 + £2.00 P&P.
Vu Meter Price:— £7.00 +P&P.

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 £4.29 each.**

TYPE 'B' (KSN1005A) 3½" super horn. For general purpose speakers, disco and P.A. systems etc. **Price £4.99 each.**

TYPE 'C' (KSN6016A) 2" × 5" wide dispersion horn. For quality Hi-fi systems and quality discos etc. **Price £5.99 each.**

TYPE 'D' (KSN1025A) 2" × 6" wide dispersion horn. Upper frequency response retained extending down to mid range (2KHz). Suitable for high quality Hi-fi systems and quality discos. **Price £7.99 each.**

TYPE 'E' (KSN1038A) 3¾" horn tweeter with attractive silver finish trim. Suitable for Hi-fi monitor systems etc. **Price £4.99 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).

HOME PROTECTION SYSTEM

Better to be 'Alarmed' then terrified.

Thandar's famous 'Minder' Burglar Alarm System. Superior microwave principle. Supplied as three units, complete with interconnection cable. **FULLY GUARANTEED.**

Control Unit — Houses microwave radar unit, range up to 15 metres adjustable by sensitivity control. Three position, key operated facia switch — off — test — armed. 30 second exit and entry delay.

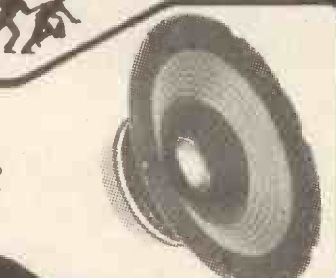
Indoor alarm — Electronic swept freq. siren. 104dB output.

Outdoor Alarm — Electronic swept freq. siren. 98dB output. Housed in a tamper-proof heavy duty metal case.

Both the control unit and outdoor alarm contain rechargeable batteries which provide full protection during mains failure. Power requirement 200/260 Volt AC 50/60Hz. Expandable with door sensors, panic buttons etc. Complete with instructions.

SAVE OVER £100 Usual price £228.85
— B.K.E.'s BARGAIN PRICE £128.00
+ £5.00 P&P.
S.A.E. for colour brochure.

12" 80 watt R.M.S. loudspeaker.
A superb general purpose **twin cone** loudspeaker. 50 oz. magnet. 2" aluminium voice coil. Rolled surround. Resonant frequency 25Hz. Frequency response to 13KHz. Sensitivity 95dB. Impedance 8ohm. **Attractive blue cone with aluminium centre dome.**
Price £18.49 each + £3.00 P&P



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MONITOR

New Hifi Amplifier

The AX30 is a new low-cost, high performance hifi amplifier from **JVC**. The amp boasts 50W per channel (RMS), and uses a system which JVC call 'Super A' to give the low distortion of a Class A amplifier with the efficiency of a Class B one. Switching (related to crossover) distortion is said to have been eliminated, and TIM distortion insignificant. The power supply is direct low impedance, and the power amp and phono equaliser stages are each direct-coupled to their own power supply stages, to minimise the likelihood of interference. Triple power protection ensures that there is very little danger of damaging speakers or output transistors if you overload the system with too much volume.

The AX30 has a fluorescent peak power display, for power monitoring and as a warning against clipping; two tape deck connections; a video/aux input for audio replaying of video or other sources; independent switches for two sets of speakers, and loudness control, amongst other more usual amp features.

The specification gives output power as 50W per channel min into 8R at 1KHz (DIN); total harmonic distortion at 0.001% at 42W output, 8R; Aux to speaker output 0.007% at 40W output, 8R 20Hz to 20kHz, with switching and transient distortion zero; frequency response 10Hz to 10kHz, +0.5 − 3db at 8R; weight six kilos, and dimensions 43.5 x 11.7 x 30.3cm (17.4 x 4.68 x 12.1in). Cost is £99.90. For more information contact your local hifi dealer or **JVC (UK) Ltd., Eldonwall Trading Estate, Staples Corner, 6-8 Priestley Way, London NW2 7AF. Tel: 01 450 2621.**

A Knip In The Air

Advertised as specially for the hobby electronics enthusiast, **Draper Tools** are producing the **Knipex** range of West German pliers and cutters in various formats.

Knipex electronic pliers in special tool steel have 20mm jaws with a smooth gripping surface and spring-loaded PVC-covered handles. They come in three patterns. Knipex Relay Adjusting Pliers come in oil-hardened chrome vanadium electric steel and have 34mm jaws with extra-thin tips; designed for adjusting relay springs and other very fine adjustments, they come in four patterns. Knipex Electronic Super Knips, in stainless steel, have full-flush cutting faces for use on soft wire down to 0.2mm thickness. They have zero-play joints and spring-loaded soft PVC handles.

The range can be obtained from most hardware and electronics shops, or contact **Draper Tools Ltd., Hursley Rd., Chandlers Ford, Eastleigh, Hants SO5 5YF.**

Computer Camp

Following a successful inauguration in 1982, **Camp Aldenham**, a Day Adventure and Computer camp for children is this year running five one-week sessions (Monday through Friday) from 25th July to 26th August.

The camp is non-residential and aims to introduce children from five to thirteen to a choice of sports and crafts during the summer holidays when they are often at a loss for anything interesting to do. Activities range from horseriding and sailing to judo and pottery, but of interest to Hobby readers and their families in particular is the Computer Camp and Microelectronics Centre.

This is for children from nine to thirteen and offers personal tuition for two hours a day as part of attendance at the Camp, and they assure us that everybody attending will actually get ten hours 'hands on' experience in the week. The computers used are Texas Instruments TI00/4A home computers, plus five full-spec equivalents. Anyone wishing to do the Micro-electronics Centre will get an additional two hours a day in electronics at an all-in supplementary charge, but will miss out on some non-electronic options — not a terrible hardship.

The Camp makes transport available to ferry children there and home again. For more details, contact **Camp Aldenham, Aldenham School, Elstree, Herts WD6 3AJ. Tel: Radlett 7553** or **6131**, for brochure.

Odd Components

Ambit International (who were nominated—along with Electroplan and Manhattan Skyline—for the title of AES/Electronic Times Distributor of the Year) is sole UK stockist for Alps and TOKO switches and components and has added the new Alps dual-in-line switches, designed to prevent flux ingress when soldering, and the entire range of TOKO F-series push switches, which can be built up from basic modules to various requirements including combined mains and DC switching capability.

Ambit's ever-increasing stock now includes a range of TOKO 20kHz low pass active filters for the digital audio market, the PAL 0900 series. These are thick-film low pass filters with a variety of terminating impedances with carefully optimised group delay and stopband attenuations up to -95dB. Ambit has its eye on the emgrance of the digital audio disk which is soon to come on the market, and the analogue to digital and digital to analogue designs required to complement it.

Requests for low cost DC-controllable cassette mechanisms have led to the launch of the AMBTN-3600 mechanism which can be supplied with a variety of heads. The standard version has a stereo record/replay, and an erase head and the motor is from 12VDC with less than 0.08% RMS wow and flutter.

Ambit, like Alps and most of the other manufacturers it supplies, is aimed primarily at the industrial market but is a source of unusual components and information.

Enquiries to **Ambit International, 200 North Service Rd., Brentwood, Essex CM14 4SG. Tel: (0277) 230909.**

Software Option

Elkan Electronics has prepared a free package of information sheets, called the Elkan File, on the publications, hardware and software they handle. This is mostly concerned with the Sharp pocket computers, the PC1251, PC1500 and OC1211 (plus the Tandy PC2 and Radio Shack TRS-80 PC), the Dragon 32, and the Apple II. They aim especially to provide information in a concise, easy-to-implement form.

This also includes a new quick-reference card designed by **Nanos Systems Corp.** in the USA for the Sinclair ZX80 and 81. The card comes in the form of an accordian-style fold-out with ten panels (twenty pages, in effect) and is said to "contain all the basic information necessary for programming the ZX80 and ZX81". Cards are also available for Apple, Tandy and other micros, from local computer dealers or from Elkan, at £3.50 each.

Elkan is also the UK and European agent for **Rainbow**, a monthly magazine for supporting the Dragon 32 and Tandy TRS-80 colour computers, with programs and information. A sample copy costs £1.95 plus a large self-addressed envelope stamped with 56p.

Send for your Elkan File and/or Rainbow to **Elkan Electronics, FREEPOST, 11 Bury New Road, Prestwich, Manchester M25 8JZ. Tel: 061 798 7613** (24 hour service).

Texas For Starters

A new computer console believed to be the first 16-bit computer for around £75 has been announced by **Texas Instruments**. Unlike most computers in this price range, the TI-99/2 basic computer can use software on solid state cartridges as well as on cassettes. In addition, Texas Instruments is introducing new low cost peripherals and software for the TI-99/2 that will also work with the TI-99/4A family computer. The TI-99/2 is designed to allow computer novices to learn to program a computer in TI BASIC and BASIC- supported assembly language.

The combination of the £75 computer and the new low-cost peripherals, says Texas, make this the lowest cost computer system on the market. The TI-99/2 will be targeted primarily at the technical enthusiast, engineer or student in the home. Additionally, they expect the computer to be purchased as the first computer in the home for those who are just beginning their experience with a computer system, or as a second computer in the home after the purchase of a TI-99/4A family computer.

The TI-99/2 console has an elastomeric typewriter-like keyboard with 48 raised moving keys in a staggered QWERTY arrangement similar to the TI-99/4A. The computer has 4K2 bytes of built-in random access memory (RAM), of which 4K Bytes is user accessible, and can be expanded to a total of 36K2 bytes of RAM. Most peripherals for the new system will plug into a "Hex-bus" peripheral-interface connector in the rear of the console. The Hex-bus port allows users to connect any peripheral developed for TI's Compact Computer family. Currently, these consist of the RS232 interface, HX-3000, the "Wafertape" digital tape drive unit, HX-2000, and the HX-1000 four colour printer/plotter.

Two "Solid State Software" cartridges, *Learn to Program* and *Learn to Program BASIC*, will be available initially for the unit. Other cartridges will be available later. Twenty software programs will be available on cassettes at the initial launch. Educational programs include: Picomath-80, Math I and II, Statistics I and II, Sunrise Time, Datetimer and Civil Engineering. Programs for personal management are: household formulas, chequebook manager, purchase decisions and general finance. Entertainment cassettes include: Lunar Landing Bioplot, The Minotaur, TI Trek, and Mind Games I, II, III and IV. These programs, as well as user-written programs, can also be run on the TI-99/4A family computer.

The TI-99/2 features monochrome display capability and contains a built-in RF modulator to allow connection to any television. A cassette interface cable is also included to interface directly to the new TI program recorder or many ordinary cassette tape players. In addition, the TI-99/2 comes with an AC adapter, a user's manual and a demonstration cassette, and measures 24 x 26 x 35cm. Availability in Europe is planned for late summer.

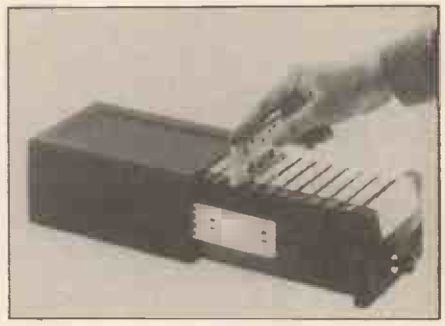
For more information contact **Texas Instruments Ltd., Manton Lane, Bedford MK41 7PA. Tel: (0234) 67466.**

Book For Boffins

Birmingham author Laurence Shaw's latest book *The Practical Guide for People With a New Idea*, puts the complex and offputting business of patenting into a nutshell. Three or four hours spent digesting this 98 page information packed paper back will turn a good inventor into a potentially rich inventor.

The aim of the book, with a forword by Sir Eric Weiss, President of Foseco Minsep, is to instruct people with an orginal, potentially lucrative idea, how to protect an invention, product or scheme and exploit it to the full. Market research, approaching the manufacturer, telling the world about an idea, patenting an invention, secret patents, checking if the idea is original, patent costs and life span, are all covered, along with copyrights, designs, licences and how to trademark a product effectively without copying an existing one.

The book costs £5.95, post paid, from **Laurence Shaw, George House, George Road, Edgbaston, Birmingham B15 1PG,** and is bound to be interesting to the ingenious mind which wants to turn ideas into hard cash.



Data Store

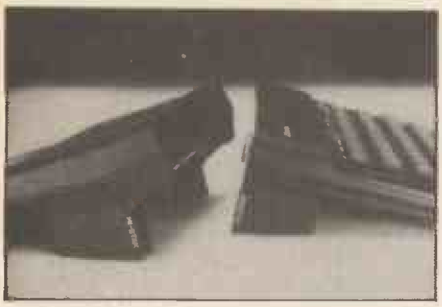
Fed up with losing your software cassettes, or finding them under the armchair, jammed up with fluff? **Arthur Fischer (UK) Ltd.** have introduced their CBox Drawer Unit to the UK, designed specially to store software cassettes in a safe and accessible form.

Each cassette is stored in a 'CBox', a cassette-sized, spring-loaded frame which clicks into place in a drawer unit, and lifts out again at the touch of a button. Each drawer unit has ten CBoxes, and the labelling system is designed to be easily altered as necessary.

There are two standards of drawer unit, the standard at £17.50 and the de luxe (lockable) at £19.50, including VAT and p&p. Of course, the system could be used by audiophiles as well as computer operators. Orders and enquiries to **Arthur Fischer (UK) Ltd., 25 Newton Rd., Marlow, Bucks SL7 1JY. Tel: (06284) 72882.**

Hey, Stack!

For those who find the totally flat keyboards of many micros, especially the very small ones, tiring to read and easy to misread, **Warp Factor Eight** are marketing an extremely simple device — or devices — to alleviate (or elevate) the problem somewhat. It's a set of custom-designed self-adhesive plastic legs to raise your micro to the point (taking the Spectrum as an example) where you can actually see the top row of print over the tops of the keys without having to place yourself vertically above the machine.



Called Hi-Stack, this set of legs seems a little bit pricy at £3.95 (including p&p and VAT, however) but in their favour they are extremely smart, solid and well-made and my sample pair has been doing a great job on my telephone and shows no sign of toppling or coming adrift.

The pack comes with a very comprehensive set of instructions. Orders and enquiries to **Warp Factor Eight, 6 Pelham Rd., Braughing, Ware, Herts SG11 2QU. Tel: (0920) 821841.**

Join The Club

The **British Amateur Electronics Club (BAEC)** has announced price rises for 1983 from 1st July, when the subscription for UK and Eire members will go up to £5.50, £8.00 for overseas airmail members and £7.00 for surface mail and all European subscriptions. That still leaves plenty of time to join or re-join at the 1982 rates of £4.00, £7.00 and £6.00 respectively. Payments in sterling only, please.

The BAEC have announced that their **18th Amateur Electronics Exhibition 1983** will be held at The Shelter, centre of the Esplanade, Penarth, South Glamorgan, Wales, from Saturday 16th July to Sunday 24th July 1983, opening from 7.30pm during the week and including the afternoons at weekends.

For those new to BAEC, it is the only national amateur electronics club in the UK and is open to everyone interested in electronics, here and abroad. It was founded in 1966 and aims to provide the means for amateur enthusiasts to give and receive help with electronics problems.

The heart of the organization is the BAEC Newsletter, which comes out quarterly (but, since the BAEC runs its year from 1st January to 1st January, members will receive all the bulletins for the year they join, regardless of when they join). As well as practical and theoretical articles on all aspects of electronics, it runs Help Wanted, Sales, Exchanges and Requirements sections.

One section of the club, with its own organiser, is devoted to beginners, with advice and equipment offers to get them started, and beginners' articles appear regularly in the newsletter.

Members also receive a library list which is updated from time to time and contains many technical books and magazines, including USA publications. This is run postally. A list of club members is circulated so that members can contact each other locally and correspond.

A final carrot is a number of special price concessions.

To give you an idea, the January newsletter contains the first part of an article on Basic Semiconductor Theory and Putting it into Practice, thoughtful reports on the Breadboard and Electronic Hobbies Fairs, letters and book reviews, a list of thirty or so well known suppliers offering discounts to members, part one of a series on basic electronics (with a highly practical bias concentrating on resistors), and other general information, A4, card cover, 34 clearly duplicated pages. Good value.

For application forms or further information contact the **Hon. Secretary, Mr. J. G. Margetts, 113 South Road, Horndean, Hampshire PO8 0ER.**

Oric On The Horizon

The 16K version of the Oric 1 micro should be available in late May/early June, after a delay of several months. **Oric** say that technical problems due to the specification of a chip changing late in the day, and also the overwhelming demand for the 48K version (four times that for the 16K), have led to the 16K machine being held up. The micro will be delivered to all existing mail order customers when available, and they will be offered the option of returning the 48K machines loaned in replacement or keeping these and paying the price difference.

Oric is no longer taking orders by mail, and is instead relying on its extensive network of distributors, including W H Smith, Dixons, Greens, Laskys, Micro C and specialist outlets all over the country, so there should be no problem for anyone in finding a supplier, in fact . . . by this time you probably won't be able to move for the things, sitting in smug rows on their shelves, murmuring alluringly "touch my keys, program me, examine my software, take me home". Before you know where you are, even the budgie'll be into Froglets. Don't say I didn't warn you! (Quick, nurse, pass the teabags, she's having one of her paranoia attacks.)

Please address enquiries, if necessary to **Judith Pattern Public Relations, 24 Easton Drive, Kingston upon Thames, KT2 7QT. Tel: 01 546 5144.** However, we advise that you speak to your local dealer first, as the PR company are being kept very busy.

Going Out For A Spin

How many of our more youthful readers recall playing 45s and long players and possibly even the odd 78 on one of those tichy little Phillips (or whoever) portable record-players? The ones with the single speaker (you couldn't call it a *loud*speaker) built into a jolly red or blue plastic lid, which lifted off to reveal a five-inch turntable, stout little plastic arm and a foot or two of straggly wire so that you could prop the speaker up just far enough away from the 'player to get an LP on it, and every gust of wind threatened to lift your precious singles off the turntable and send them bowling into a corner . . . sweet memories.

Audio Technical's new AT-727 Soundburger is one of those. The space-age design, the obligatory connections for two sets of mini headphones, the 110mV line outputs for connection to a full stereo system, the 30 to 25,000Hz frequency response, the DC servo motor and double belt, the signal-to-noise ratio of more than 50dB, the dynamically balanced tonearm giving superb tracking on any reasonably level surface (can you use it on your knee in the back of a car?) and the optional mains adaptor, its very stereoness, undreamed-of in 1962, cannot mask the immutable truth that what we have here is one of those marvellous take-it-anywhere, won't-do-your-singles-any-harm-if-you're-careful-with-it RECORD PLAYERS. And about time too. It even has a carrying strap.

At £89.95, it's not rock-bottom cheap, but it's bound to catch the eye of itinerant record freaks, or those moving away from the family stereo to the

independence of a bedsit or student room.

But alas, I can't see the Soundburger bringing back the days of twisting by the pool. For one thing, there is no output to external speakers without an additional amplifier, and for another thing, there's no 78rpm. And as Tony Benyon said many years ago, Leonard Cohen is much more fun at 78, and I suspect the same goes for Culture Club and Ultravox . . . I wonder where I put my Phillips plastic portable?

For more information and specification, see your hifi dealer or contact **Audio Technicia Ltd., Hunslet Trading Estate, Low Road, Leeds 10. Tel: (0532) 771441.**

Sound With Sinclair

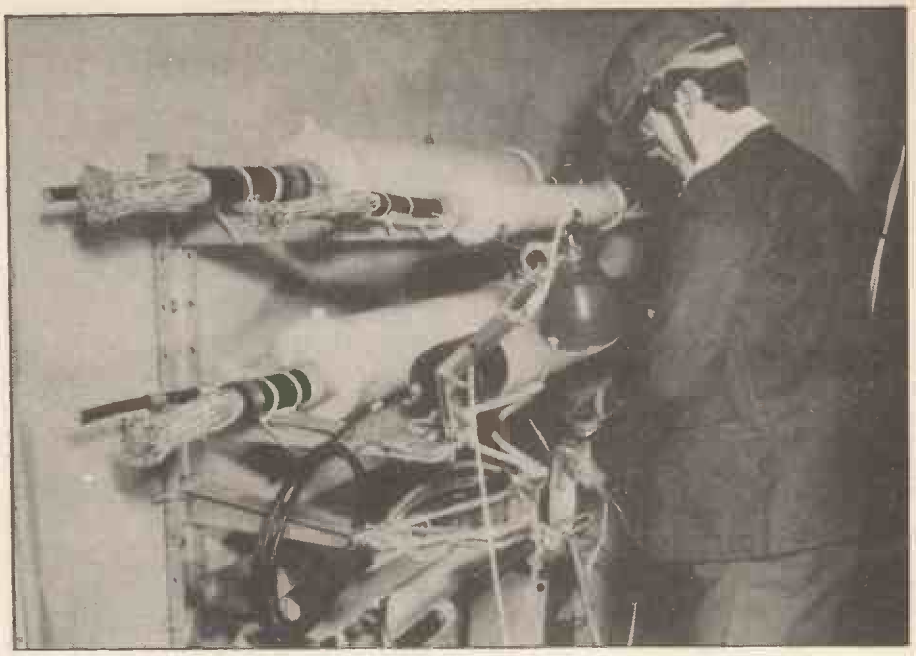
Just three months ago, **Bi-Pak Semiconductors** published details of their first sound generator for use with the Sinclair ZX81 computer, adding much-needed sound to an otherwise silent computer. So successful has this proved with Sinclair users that Bi-Pak have now introduced a new modified version for use with all Sinclair computers, ie ZX81, Sinclair Timex 1000 and the Sinclair Spectrum.

Designated ZON X, the unit is self-contained in a black plastic case with a loudspeaker and manual volume control. No power supply or batteries are required to power the unit — it simply plugs into the rear of the Sinclair computer.

The new unit offers a wide range of sound effects. These are obtained using the three-channel-plus-noise sound chip, and is designed so that the pitches and volumes of the three channels and overall attach/decay envelope can be controlled by simple basic statements. This means that pianos, organs, bells, helicopters, lasers, explosions etc. can be simulated and added to existing program.

For use with the Spectrum there is a further plug-in adaptor which houses a crystal and other electronic devices needed to give unlimited sound facilities.

The ZON X unit is available from **Bi-Pak Semiconductors, PO Box 6, Ware, Herts. Tel: (0920) 3442/3182.** The ZON X for use with the Sinclair Timex 1000 is £25.95; with special adaptor for Sinclair Spectrum: £32.75; the Spectrum adaptor only £6.80. All the above prices include VAT and postage.



Newseum

A new gallery devoted to telecommunications has been opened by the Prince of Wales at the **Science Museum** in London.

The gallery is titled "Telecommunications — A Technology For Change" and is sponsored by Standard Telephone and Cables (STC) to mark that company's centenary. Its opening also marks World Communications Year, a prime objective of which is to bring the subject more into the public eye. The story of telecommunications over the last hundred years is told in two sections in adjoining galleries, one arranged chronologically while the other displays the technologies which make distance communication possible.

The first section concentrates on the way telecommunications have altered out our lives, and include mock-ups of the telegraph office at Tonbridge Railway Station in 1895, a ship's radio cabin in 1910 and the radio operator's position in a Lancaster bomber from the Second World War. There are also taped remniscences of life with cable companies between the 1920s and 1950s.

The second part of the exhibition is more technical, and is introduced at the entrance with a display of telephone engineers maintaining the thousands of underground telephone wires concealed beneath our feet, and the giant 'H' poles that used to follow the roads and railways and are now hardly ever to be seen. Telecommunications terminals, land, sea and space links, and switching systems are covered in separate displays, and there are working demonstrations and computer graphics displays illustrating aspects of communications systems in a memorable and easy-to-follow way. There is a built-in cinema which shows a short film by STC, called "Echoes", which assesses just where we stand at the moment and where communications may go in the future.

Sounds like a good venue for a school or club outing, for those who don't see themselves getting to London under their own steam. Enquiries to **The Science Museum, South Kensington, London SW7 2DD. Tel: 01 589 3456.**

Everything's OK

New from **OK Industries (UK) Ltd.**: a battery-powered wire-wrapping tool, the Just Wrap BJW-3, which uses spooled wire and wire-wrapping posts, together with a wire gun, to make a continuous series of connections without wire stripping, cutting or soldering. The batteries are rechargeable.

Also new are two component-handling tools. The LB-100 lead bender and crimper is designed for all common axial components such as resistors, diodes and capacitors, and also for many radial and 'TO' packages. The LB-100 will do a variety of angles and bends (see illustration). The TP-1 cutter and crimper, is a high carbon steel tool which is designed to handle up to 20 AWG (0.8mm) soft wire leads and to trim and crimp component leads flush to the PCB prior to soldering.

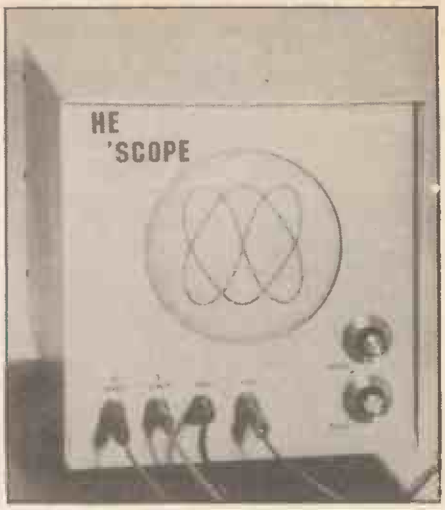
More specialised are the BB1-1416 and BB1-2428 IC insertion tools, for 14 and 16 pin and 24 and 28 pin ICs respectively (I bet you're wondering how we worked that one out, aren't you?). The tools are nickel-plated steel for durability and protection from static, important for MOS and CMOS.

OK's Electroware division specialises in the supply of tools and accessories for electronics building, and produce a catalogue which features many of OK's lines most likely to be of interest to hobbyists. That, and information about new projects, can be obtained from **OK Industries UK Ltd., Dutton Lane, Eastleigh, Hants SO5 4AA. Tel: (0703) 610944.**

HE

The Hobby 'Scope

Christopher Murphy



The first part of HE's learn-as-you-build oscilloscope, at the hobbyist's price.

MOST PEOPLE involved with electronics are aware of the enormous value of an oscilloscope in circuit testing, yet how many hobbyists are affluent enough to own one? Hobby Electronics, in co-operation with a leading London component retailer, have designed a low cost modular oscilloscope (the Hobby 'Scope) which, at under £80, is within the grasp of most hobbyists. Obviously, at this price it would be unreasonable to expect the facilities of a £200 instrument, yet this simple design should prove to be an invaluable tool to anyone who, until now, has struggled with nothing but a multimeter.

For maximum flexibility, the 'Scope has been divided into separate functional units or modules; for under £40 there is an X-Y plotter (display unit) which will operate with either the scope add-on, to provide a full single trace oscilloscope, or the curve tracer add-on, which is a useful tool for component testing and identification.

We will be presenting these projects over four issues, beginning this month with an overview and then, in the three subsequent issues, we will give the full circuit and constructional details of the three units described above.

The Oscilloscope

An oscilloscope is a piece of test equipment based around the cathode ray tube (CRT), a device similar to that found in a television, which enables voltage waveforms to be displayed as they vary with time. This is illustrated in **Figure 1**. The oscilloscope has two terminals referred to as the 'Y Input' for connection to the circuit under test; the Y Input consists of the signal terminal and the ground or return terminal. The waveform shown, in this case a sine wave, is representative of the type of signal to which the Y input is normally connected; it has two important attributes, namely Amplitude and Frequency. The Y amplifier within the scope has a variable or switched gain (amplification factor) normally controlled by a potentiometer and/or multi-gang switch on the front panel of the instrument; the Y gain has to be adjusted by the user so that the physical height of the displayed waveform falls comfortably on the screen. Similarly there is a Timebase control which must be adjusted to suit the frequency of the incoming waveform. The timebase circuit within the scope controls the period of time over which the waveform is displayed from left to right across the screen; if this period is too long then too much information (too many cycles) become compressed onto the screen width; if too short, only a fraction of the waveform will be seen. An oscilloscope does not, as you might expect, capture a single sample of the waveform and freeze it on the screen (storage oscilloscopes are able to do this—at much expense!), but repeatedly updates the screen with identical portions of the waveform—this is a necessity imposed by the working principles of the CRT as we shall see, and the consequences are that oscilloscopes are really only useful for displaying waveforms that are repetitive, such as sine waves or square waves. Now, in order that the waveform can be viewed as a stable display there is the additional requirement of a Trigger circuit, whose purpose is to ensure that each time the waveform is drawn on the screen, the starting point is the same 'place' on the incoming waveform. The starting Trigger point is referenced to a particular voltage level on the incoming waveform, and usually can be varied by means of a

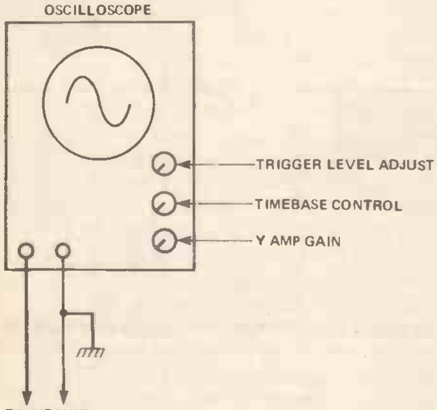


Figure 1. The basic functions of an oscilloscope (see text).

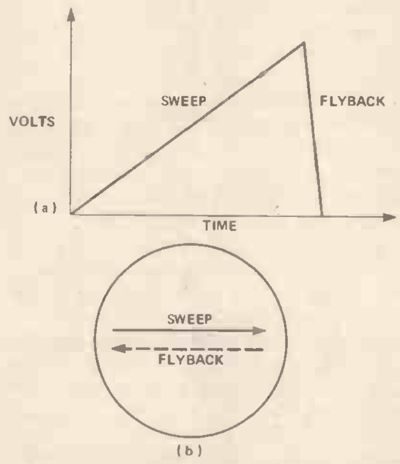


Figure 2. The sweep moves steadily across the screen, returning rapidly.

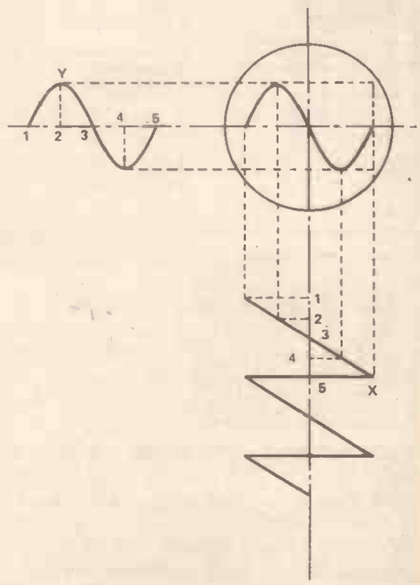


Figure 3. The electron beam sweeps an accurate replica of the Y-input.

control on the front of the instrument; the effect of varying this control is to alter the starting point of the display, which therefore appears to travel left-right across the screen.

The Cathode Ray Tube

A major part of understanding the workings of an oscilloscope lies with the cathode ray tube itself. Physically, a CRT is an evacuated glass envelope (vacuum tube), shaped with a long narrow tube at one end tapering out to form a wide flat round screen at the other end (more expensive tubes taper to a rectangular screen). At the narrow end there are a number of pins which are the electrical connections to the inner works; these lie mainly within this narrow tubular section. On the inside surface of the glass screen there is a coating of phosphor which is electro-fluorescent. The basic principle by which a display is produced is that a fine beam of electrons is produced within the far end of the tube and accelerated towards the phosphor screen, which emits light over the area that is being bombarded with electrons. By means yet to be revealed, the electron beam is brought to a focus and can be made to strike any given point of the screen, producing a small spot of light. If this electron beam is scanned about the screen, it traces out a thin line of light because the phosphor persists in its emission for some tens of milliseconds; providing that the line is retraced by the beam of electrons every few milliseconds or so, a stable display of the line will be seen, without flickering.

The actual geometry of the CRT internal electrodes is fairly complex in a modern high performance tube, howeve the schematic of **Figure 2** is an adequate representation of the various internal components, at least for our purposes. The principle by which an electron beam is generated is called thermionic emission. A cylindrical plate of metal, the cathode, is heated indirectly by a tungsten filament inside the cathode. The cathode, like all metals, produces a cloud of electrons around the surface when it is heated, but in great quantity at a temperature that can be practically realised. The electrons thus emitted from the surface of the cathode can easily be persuaded to leave the area by the high positive potential present on the series of electrodes Anode 1 to Anode 3. These three anodes can for the moment be considered as one, held at a high positive voltage of about 2kV, and consisting of a metal plate with a small hole centered on the axis of the tube. Electrons accelerate from the cathode towards this anode and most of them fly straight through the center hole, eventually to strike the screen. However there is a further obstacle in the path of the electrons, in the form of a grid or mesh electrode, surrounding the cathode and thus between the cathode and anode. The grid is always biassed negative, relative to the cathode, and acts as a

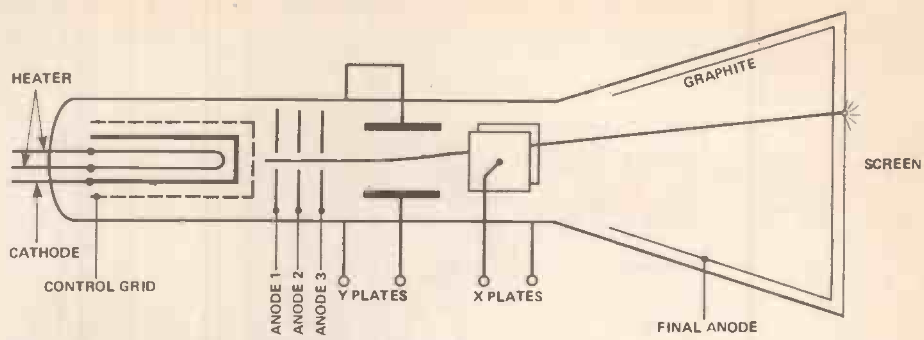


Figure 4. A simplified representation of the internal workings of the cathode ray tube.

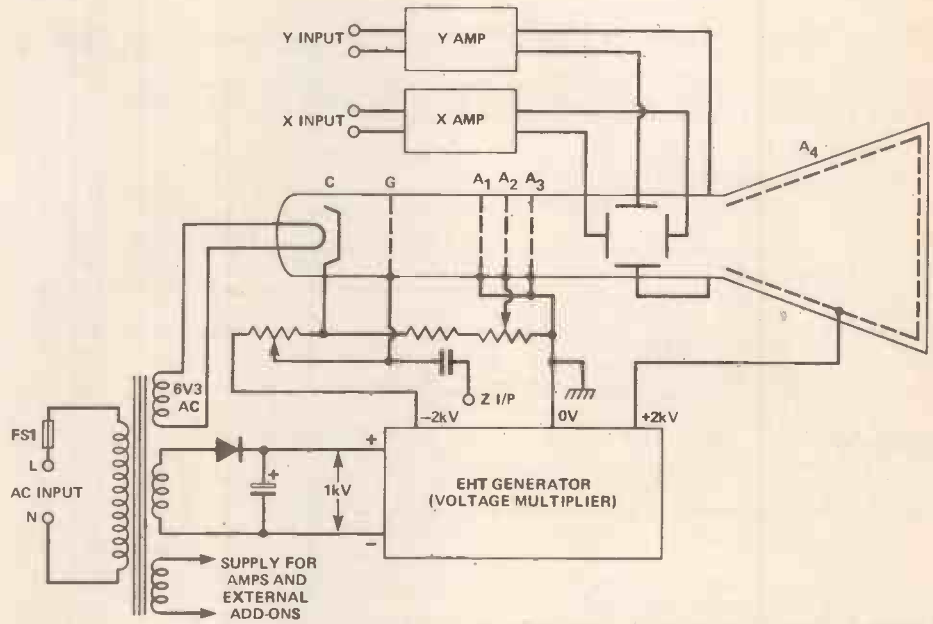


Figure 5. Block diagram of the X-Y plotter.

control over the number of electrons able to leave the cathode. By varying the negative potential applied to this grid, the brightness of the display can be indirectly varied from maximum down to complete darkness (electron beam turned off).

Shaped Fields

As can be seen in **Figure 4** there are three anodes in a practical CRT, the purpose of which is to focus the electron beam. Anodes 1 and 3 are held at the same high positive potential whilst Anode 2 is a few hundred volts more negative than the other two (but still highly positive relative to the cathode). The geometry of these anodes is arranged so that electrons travelling through the system, but which are off-axis, experience a small accelerating force (electric field) which tends to move them towards the centre of the tube. The potential of Anode 2 is made variable, and on every oscilloscope there is a Focus potentiometer which the user must adjust to produce the finest possible spot size. The physics of the focussing system is too complex for a complete explanation, however a useful analogy is to consider the electrons moving in electric fields in terms of balls rolling down a hillside (ie in a gravitational field); by shaping the profile of the hillside into a U-shaped channel, it is obvious that any ball initially launched at the side of the channel (ie off-axis) will roll towards the centre as well as down the hillside, and by choosing the exact profile of the channel all balls, no matter where released, can be made to pass through the same point on the axis. This is what, in electric, terms happens as electrons pass through the anodes and 'meet' at a point on the CRT screen.

The remaining system in a CRT to be described is the electrostatic deflection plates — the means by which the illuminated spot can be moved to a given part of the screen. Beyond the three anodes are two sets of parallel plates at right angles to one another and referred to as the X-plates (vertically aligned) and the Y-plates (horizontally aligned). By applying a voltage to any pair of plates, an electric field is established at right angles to the electron beam and will deflect it in the direction of the field. The X-plates will produce a horizontal deflection and the Y-plates a vertical deflection. In practice the deflection plates are not parallel but

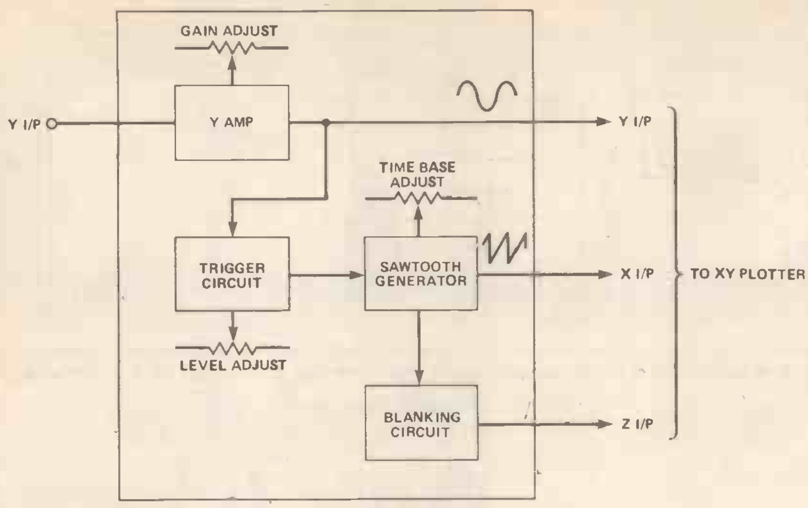


Figure 6. Block diagram of the X-Y processing unit.

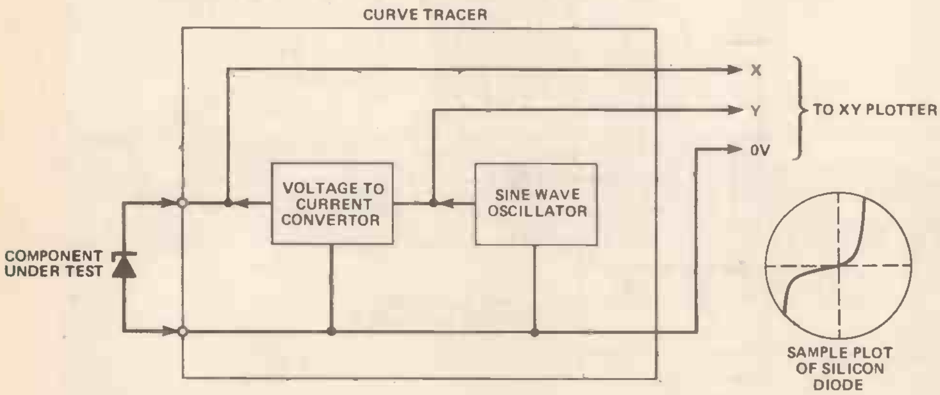


Figure 7. Block diagram of the curve tracer unit.

diverge towards the screen. This is partly to allow for the divergence of the electron beam when deflected, and partly to improve the linearity of the deflection voltage.

A final point to note is that the electrons, having struck the screen, must have some means of returning to their source — otherwise a charge would build up on the screen, repelling the electron beam. This is provided by coating the inner surface of most of the tube, beyond the deflection plates, with a thin layer of graphite and making a connection to it on the side of the tube. This coating, the 'Final anode' is sufficiently thin so that the electrons are not prevented from striking the phosphor.

X-Y Plotter

The X-Y Plotter is the most important module of the Hobby 'Scope. It contains a CRT and all the electronics required to convert the CRT into an easily used display unit, namely the power supplies for the tube and the deflection amplifiers. Physically, the X-Y Plotter is a self-contained unit with a lead at the rear to connect to the mains supply; on the front panel, the CRT screen is viewed through a circular hole and there are two rotary controls for brightness and focus. All connections to the scope are made to terminal posts on the front panel (X-input, Y-input, Ground and external supply) with the exception of the Z input (see later), which is at the rear.

A block diagram of the X-Y Plotter, **Figure 5**, reveals its simplicity, A transformer isolates the unit from the mains and provides several secondary voltages for the circuit; a 6V3 AC winding supplies the CRT heater filament, another winding of 800V AC provides the supply for the EHT accelerator voltages, and the remaining winding provides for the X and Y Amplifiers. The 700V AC is rectified to produce lkV DC, which is then stepped-up to 2kV and 4kV in a four stage multiplier circuit; this is prefered to providing 4kV direct from a transformer secondary, which would be very expensive because of the heavy insulation requirements. The EHT supply directly feeds the CRT anode voltages and, by means of a resistor potential divider chain, the voltages for the other electrodes. The potentials of the grid and second anode are made variable with potentiometers to allow the brightness and focus, respectively, to be adjusted. The X and Y Amplifiers essentially amplify convenient input voltage levels of ±2V (full scale deflection) to the necessary ±150V needed to drive the deflection plates of the CRT.

A further input, called the Z-input, is AC coupled into the control grid to allow the brightness to be controlled dynamically by an external signal, as is necessary for the 'Scope Add-on.

'Scope Module

A block diagram of the unit that turns the X-Y Plotter into an oscilloscope is shown in **Figure 6**. An oscillator generates a 'sawtooth' waveform which must be applied to the X-input of the X-Y Plotter; this causes the electron beam to sweep smoothly across the screen from the far left to the far right, and then rapidly fly back to the starting point to repeat the sweep. In the absence of any Y input this would cause the display of a horizontal line in the centre of the screen. When a signal is applied to the X-Y Plotter Y-input, however, the beam is displayed so as to display the input waveform plotted against time. The display will also show, albeit faintly, the signal during the rapid flyback of the X deflection. This flyback is undesirable and so is suppressed by a negative going pulse applied to the Z-input of the plotter; it coincides with the flyback period and therefore blanks the beam at this time. An extra Y Amplifier, provided within the 'Scope Module, has switchable gain so allowing a wide range of input voltage amplitudes to be displayed on the scope.

As mentioned earlier, the timebase waveform has to be synchronised with the incoming signal to obtain a steady display; this is achieved with a Trigger circuit, which compares the input signal with the level control potential and forces the sawtooth oscillator to flyback when it detects a coincidence.

Curve Tracer

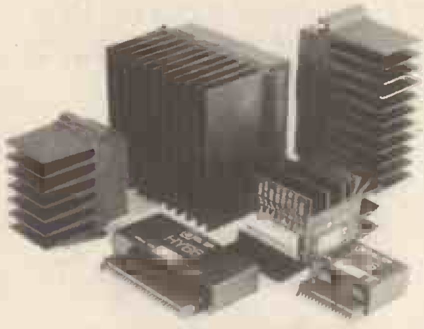
A curve tracer is a device that allows a plot of a component's voltage versus current characteristic, plotting current on the vertical (Y) axis and voltage on the horizontal (X) axis. This is useful for checking or identifying components such as diodes or transistors, as each device has a characteristic curve (that of a PN junction diode is shown in **Figure 7**). An oscillator periodically sweeps the required range of current by generating a representative voltage — this is applied to the Y input of the plotter. The voltage (which actually represents a current) is converted to a current in a proportional voltage to current convertor and is made to pass through the component being tested. The voltage which then develops across the component is fed to the X input of the plotter.

The oscillator need not be sinusoidal; in fact a symmetrical triangular wave would produce a more evenly bright trace.

The Hobby 'Scope project continues next month.

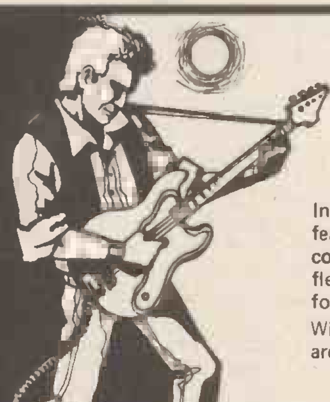
HE

GET BIG POWER



ILP 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.

BIPOLAR MODULES

Module Number	Output Power Watts rms	Load Impedance Ω	DISTORTION T.H.D. Typ at 1KHz	I.M.D. 60Hz/ 7KHz 4:1	Supply Voltage Typ	Size mm	WT gms	Price inc. VAT
HY30	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
HY6060	30 + 30	4-8	0.015%	<0.006%	± 25	120 x 78 x 40	420	£18.69
HY124	60	4	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	4	0.01%	<0.006%	± 45	120 x 78 x 100	1030	£38.41
HY368	180	8	0.01%	<0.006%	± 60	120 x 78 x 100	1030	£38.41

Protection: Full load line. Slew Rate: 15v/μs. Risetime: 5μs. S/N ratio: 100db.
Frequency response (−3dB) 15Hz − 50KHz. Input sensitivity: 500mV rms.
Input Impedance: 100K Ω. 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 B6 for modules HY6–HY13 £1.05 (Inc. VAT) and the B66 for modules HY66–HY78 £1.29 (Inc. VAT).

MOSFET MODULES

Module Number	Output Power Watts rms	Load Impedance Ω	DISTORTION T.H.D. Typ at 1KHz	I.M.D. 60Hz/ 7KHz 4:1	Supply Voltage Typ	Size mm	WT gms	Price inc. VAT
MOS 128	60	4-8	<0.005%	<0.006%	± 45	120 x 78 x 40	420	£30.41
MOS 248	120	4-8	<0.005%	<0.006%	± 55	120 x 78 x 80	850	£39.86
MOS 364	180	4	<0.005%	<0.006%	± 55	120 x 78 x 100	1025	£45.54

Protection: Able to cope with complex loads without the need for very special protection circuitry (fuses will suffice).
Slew rate: 20v/μs. Rise time: 3μs. S/N ratio: 100db
Frequency response (−3dB): 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 4Ω.
Frequency response (−3dB) 15Hz to 30KHz, T.H.D. 0.1% at 10w 1KHz
S/N ratio (DIN AUDIO) 80dB, Load Impedance 3Ω.
Input Sensitivity and impedance (selectable) 700mV rms into 15KΩ 3V rms into 8Ω.
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 gms.

POWER SUPPLY UNITS (Incorporating our own toroidal transformers)

Model Number	For Use With	Price inc. VAT
PSU 21X	1 or 2 HY30	£11.93
PSU 41X	1 or 2 HY60, 1 x HY6060, 1 x HY124	£13.83
PSU 42X	1 x HY128	£15.90
PSU 43X	1 x MOS128	£16.70
PSU 51X	2 x HY128, 1 x HY244	£17.07

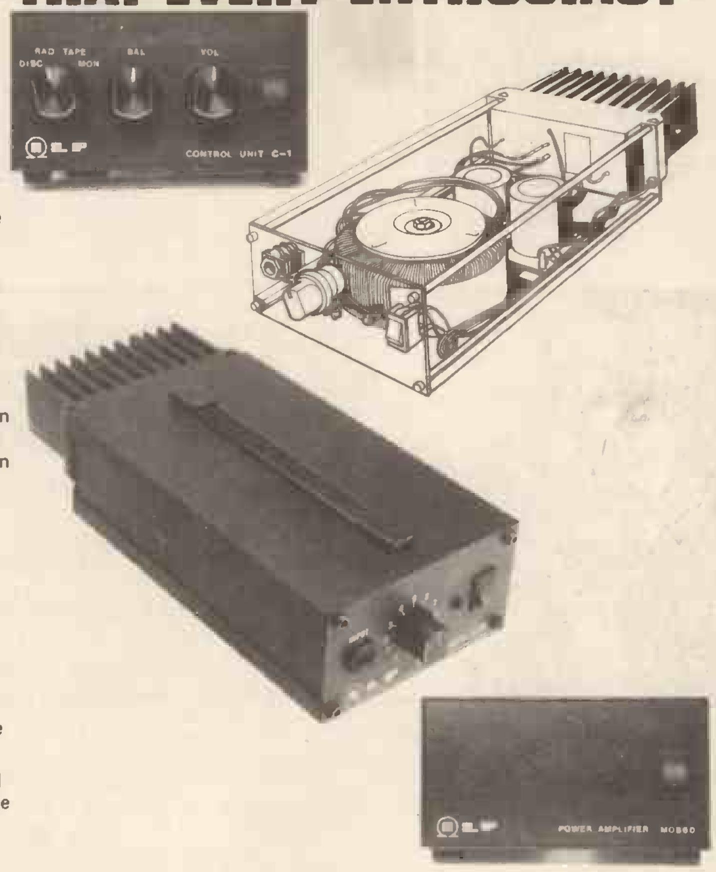
Model Number	For Use With	Price inc. VAT
PSU 52X	2 x HY124	£17.07
PSU 53X	2 x MOS128	£17.86
PSU 54X	1 x HY248	£17.86
PSU 55X	1 x MOS248	£19.52
PSU 71X	2 x HY244	£21.75

Model Number	For Use With	Price inc. VAT
PSU 72X	2 x HY248	£22.54
PSU 73X	1 x HY364	£22.54
PSU 74X	1 x HY368	£24.20
PSU 75X	2 x MOS248, 1 x MOS368	£24.20

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 ILP 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

HIFI Separates					Price inc. VAT
UC1	Preamp				£29.95
UP1X	30 + 30W/4–8Ω	Bipolar	Stereo	HiFi	£54.95
UP2X	60W/4Ω	Bipolar	Mono	HiFi	£54.95
UP3X	60W/8Ω	Bipolar	Mono	HiFi	£54.95
UP4X	120W/4Ω	Bipolar	Mono	HiFi	£74.95
UP5X	120W/8Ω	Bipolar	Mono	HiFi	£74.95
UP6X	60W/4–8Ω	MOS	Mono	HiFi	£64.95
UP7X	120W/4–8Ω	MOS	Mono	HiFi	£84.95
Power Slaves					
US1X	60W/4Ω	Bipolar	Power	Slave	£59.95
US2X	120W/4Ω	Bipolar	Power	Slave	£79.95
US3X	60W/4–8Ω	MOS	Power	Slave	£69.96
US4X	120W/4–8Ω	MOS	Power	Slave	£89.95

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

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

ILP ELECTRONICS LTD

Post to: ILP Electronics Ltd., Freepost 4,
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 ____________

I enclose Cheque ☐ Postal Orders ☐ Int. Money Order ☐

Please debit my Access/Barclaycard No. ____________

Name ____________

Address ____________

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Signature ____________

POINTS OF VIEW

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

HEBOT Rides Again

Dear Sir,
I have just read the HEBOT II article in the November '82 issue of your magazine, where you ask for submissions on the subject of other interfaces.

I own a PET computer by Commodore and would like to know the details of how to control HEBOT II with it, therefore I would be pleased if you could work this out for me as I am not very good at electronics.
P R Brown,
Stevenage,
Herts.

Coming soon in Hobby Electronics!

You Don't Ohm Me

Dear Sir,
As an enthusiastic hobbyist in hifi, I want to build your Audio Signal Generator (HE May '82), the relatively simple design of which appeals to me. Unfortunately I cannot obtain locally the prescribed thermistor RA53 (or R53 alternatively). Stockists of electronic components always request the ohmic value of such a thermistor, which is not given in your article. Simply referring RA53 or R53 means nothing to them. To order just one piece from England (Maplin or Watford) is not very convenient.

Physically similar thermistors are available locally (Philips?) as long as I know the correct ohmic value. Another alternative available is to use the slightly cheaper glass-bead type thermistor. I shall be pleased to know if this can be used instead.
Yours faithfully,
J F Bednarik,
Pretoria,
S. Africa.

The RA53 is, in fact, a glass bead thermistor. It is rated at 3mW at 20°C with a resistance of 5k at that temperature, and has a minimum resistance of 80R. Hope that helps. PS. You forgot to put your SAE in. Actually about 5% of our enquiries forget to include their SAEs (not counting the ones who don't think of sending one in the first place) — which is why they end up here!

But then, if you have something especially pertinent or fascinating to ask or say, and send an SAE, you may have the double honour of a personal reply and a letter on the POV page as well.

Calling All Cars

Dear Sir,
I am a new reader to HE and find it very interesting reading, and will be subscribing to the magazine on a regular basis.

I would gratefully appreciate your experience and knowledge to help me to make my own small alarm paging system with the best possible range. My intention is to install a small transmitter unit in my car which would transmit a signal independently or through the car aerial, activated by vibration sensors, and door switches which would be received by a small pocket bleeper, either carried or in the home.

Being a newcomer to electronics I thought this was a very good idea of mine but like all good ideas I now see something like it is already on the market, but very expensive.

I will be happy to forward any remittance for plans, literature etc. Would you make it as straightforward as possible, me being a newcomer to electronics, and include information of my nearest electronics agent for the best stock of components?

I hope to make this alarm and lots of other items in the near future and look forward to hearing from you.
Yours sincerely,
David Knowles,
Barton,
Eccles.

After having thought about this for a bit, we have some ideas on this type of project and, subject to checking the legality of the suggestion as it stands, we hope to be producing one or more projects along these lines.

Does anyone else have any comments or suggestions?

When looking for components stockists, consult our Directory of Electronics Components and Hardware Suppliers (HE October '82) and the update which appeared last month, and also consult our advertisers — don't overlook mail order. It's an extremely reliable way of gaining access to large stocks of components.

Let There Be Lights

Sir,
I have just ordered Counter Driver and Numeral Display Projects *from your Bookshelf but I urgently need assistance and direction. You see I'm an amateur and without boring you I will be grateful if you will be able to tell me how I could construct the words JESUS SAVES to glow permanently and if need be the power supply to go with them to ensure non-interference. If I can be assisted by way of a circuit diagram and list of components I will very much appreciate it. If not, I won't be discouraged from buying HE, it's a great magazine.*
Yours sincerely,
David Amakiri,
Crystal Palace,
London.

Dear Sir,
I'm trying to create a waterproof, battery operated clock with an LED display and I was wondering if you could help or put me in touch with somebody who could. The idea is to have the readout on one side of a piece of fabric with the circuit board and battery on the inside.
Yours,
J. Johns,
Kingwood,
Herts.

Firstly, sorry, chaps, but we cannot design circuits to specifications. If the Lord had intended the staff of HE to design circuits to order, He wouldn't have given us a magazine to publish. We don't have an infinite number of hands!

To get a light to glow permanently all you have to do is wire up enough light bulbs, Christmas tree lights, LEDs etc. to create the display you want. I wouldn't recommend domestic bulbs, as they get hot and burn out, but for any other kind of small light source you would need a suitable power supply circuit. That's a basic aspect of electronics, so if you want to get into that, try *Power Supply Projects*, £1.75 from the HE Bookshelf service (see page 29), As for Mr. Johns, can anybody help? I must confess, my mind boggles to know what it's for. A digital alarm umbrella? Upholstery for your goldfish bowl? Could there be a new project in this somewhere??

Low Resistance

Dear Sirs,
I will firstly say that I qualify as a devoted HE reader and that I have collected every single issue since November '78.

Since you seem to be in the know about electronics suppliers I wonder if you could give me some advice on where I can obtain some miniature resistors of power rating 0W125 or below. These seem to be extremely

difficult to get hold of for some reason.
Yours faithfully,
N.S. Jones,
Stratford-upon-Avon,
Warks.

The resistors you want are in the RS Components catalogue. RS itself only deals with the trade, but any component in its stock can be ordered from your regular retail supplier (most of them deal with RS), although you will naturally have to pay for the service. And then there is our Components Directory in HE October '82 and April '82, and our gallant army of advertisers — a handful of phone calls can unmask wonders, if you know what you're asking for.

Teletext Kits

Dear Sir,
I am interested in Teletext/Prestel kits, could you please advise me of any manufacturers or agents other than Bradley Marshall Ltd?
Yours faithfully,
C.V. Parker,
Bildeston,
Ipswich.

Bradley Marshall Ltd. is the only Teletext/Prestel kits supplier known to us — does anyone out there know of another?

We Can't Amplify

Dear Sirs,
Project: Power Amplifier (HE June '81).
While going through some old HEs I came across this interesting project, but to my surprise the parts list which was provided with the article was incomplete. For example, values of resistors are not always given in the PCB diagram. As I am interested in making one, I would be very grateful if you could send the complete parts list since getting the kit would mean I have to pay more for the postage than the kit.
Thanking you,
V. Alexander,
Selangor,
Malaysia.

Sorry, but this circuit was provided by Capricorn Electronics, and to protect their design the Parts List was not completely described. You'll have to write to the address given to see if they're still supplying the kit or would be prepared to help you with some of the parts.

Out Of Data

Dear Hobby Electronics,
I am desperately begging for your help. I am involved in a college project where there are a few integrated circuits needed. I require data on these ICs to adapt my project to them. This is where the help comes in.

It would be very time consuming to write to each manufacturer for their data. The datas that I require are as follows:

IC8038, IC7400, IC4093, IC555, IC4534, IC4511, IC4081, IC4011, IC4001, ICULN2803A, seven segment LED FND500, seven segment LED HP 5082-7730.

Are the seven segment displays compatible?

If there are any charges for your service, please send me the bill and I would gratefully pay for the charges.

I do hope that you can help me. I am an HE addict, I have every issue since it was launched on November 1978. A great magazine, keep it up.
Yours waiting patiently,
S. Ferrol,
Dagenham,
Essex.

Every now and then somebody asks us for data on one particular device and we happen to have it at arm's length and can provide it — but if we guaranteed this service, and charged for it, well, you the reader would probably not be able to afford the service. There are electronics consultancies in every reasonable-sized town in the country, but their services don't come cheap.

Surely your college, either the library or one of your lecturers, keeps data sheets for these devices? That is their job, after all! I would try asking them, first.

Otherwise, you will have to contact the manufacturers, the same as we do when we get stuck, either by letter or by phone. It will help speed up the response you get to do three things: i) find out by phone first of all which department at which address you need to contact to get data on ICs; ii) send an SAE; iii) if you don't hear within a fortnight, phone the department you wrote to and ask if they have your letter.

If you are really stuck, I seem to recall Ilford Central Reference Library was good on science and technology, although data sheets might be stretching their resources a bit. Their number will be in your phone book.

Sorry we can't help with lists like this. Anyway, you wouldn't get much credit if we did all the research!

Games People Play

Dear Sir,
I have read your magazine with interest since its introduction and have enjoyed constructing many of the projects. I appreciate your encouragement of worthwhile community projects, for example, in the Year for the Disabled.

I would like to suggest a competition to design an original and attractive electronic game which could be used for raising money at various charity fetes, church fairs, etc. The wire loop game surely has been played out and I think there is a good opening for an alternative game which could be played by one or more players and which offered a challenge and value for money.

I would like to see a worthwhile and practical project to enhance still further the reputation of your excellent magazine.
Yours faithfully,
J. Dakes,
Stone-on-Trent,
Staffs.

As it happens, we have several ideas for electronic games in the pipeline. We don't actually want to reveal our plans at this stage, but keep looking in HE. And thanks for the kind words.

Mail Order Maestros

Dear Sir,
On Tuesday 7th February, I sent by post orders to three of your advertisers, namely Rapid Electronics, John Bull and Bi-Pak.

I received delivery of the goods ordered, by post, on Friday, Saturday and finally today.

Congratulations to the efficiency of the firms concerned and the Post Office.
Yours faithfully,
M J Turner,
Whitstable,
Kent.

Nice to hear about the good things instead of the grollies for once! And living proof that mail order really does work, for anyone thinking of taking the plunge. Thank you, M.J.

Wah's That Again?

Dear Hobby Electronics,
I would like to enquire about a project which appeared in HE June '82, the Auto Wah. I wondered if a kit is available and how much it is including case and all the necessary bits. Please send me an answer quickly since I want to make it for a friend of mine who has an electric guitar.

Thank you.
Ali Modjdehian,
Sussex University.

The kit for the Auto Wah, with or without case, is available from Magenta Electronics — see their advertisement in this (and every) issue of HE. The produce kits for many HE projects old and new, so they are usually the first people to check.

PS Has your friend warned his neighbours?!!

While offering help and advice about projects and general electronics subjects tends to be priority number one in Points of View, not omitting to mention my colleague C. Dick across the way, we would also like to hear the odd Point of View from time to time, so if you have anything you want to praise, speculate on, comment on or sound off about in the world of electronics, let us know. Its your voice as well as ours. Of course if you don't need a reply you don't need to enclose an SAE either — it gives a wonderful sense of freedom! **HE**

COMING SOON TO . . .

Hobby Electronics

ZX81 HIGH RESOLUTION GRAPHICS BOARD

User-definable, high resolution graphics for the Sinclair ZX81 computer — without fuss! This is a simple add-on PCB that plugs into the ZX81 ROM socket; no modifications to the computer hardware are needed in this project! The ZX HRG is completely software controlled and allows you to program high resolution graphic characters for, say, a Space Invader game, graph plotting or anything else.

Software control allows the high resolution characters, once set up, to be saved on cassette then loaded and re-used at any time, and switching between either HRG user-graphics or the standard Sinclair character set is easy, under software control. Any single element of an 8x8-pixel character can be individually controlled, giving a screen resolution of 256x176, allowing finely details graphics programming.

The ZX HRG Board is the first half of a Sinclair Graphics Package. The second project is a user-programmable joystick controller — the first of its kind! Unlike all others it can be instructed to operate with any commercially available games programme, and will appear in the August issue of Hobby Electronics. A slightly different version for the Sinclair Spectrum will also be out shortly.

SATELLITE AND CABLE TELEVISION EXPLAINED

The communications revolution is nearly upon us! Find out about the technology of tomorrow's entertainment world in our July issue.

ALL ABOUT ELECTRONICS

Commencing a new series, especially written for the novice. All aspects of electronics will be covered in 12 separate parts, leading from basic theory through to descriptions of complete electronic systems.

COMPONENTS FOR COMPUTING

The second part of the article looking at computer display systems, leading up to a simple video display project in a future issue.

THE HOBBY 'SCOPE

Continuing with the circuit details of the X-Y Plotter unit of our super low-cost oscilloscope project.

Please reserve .... copies of the July issue of

Hobby Electronics

for

Name ....

Address ....

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....

Hobby Electronics

July issue on sale at your newsagent from 10th June. Place your order now!

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

BI-PAK

"IRRESISTABLE RESISTOR BARGAINS"

Pak No.	Qty.*	Description	Price
SX10	400	Mixed "All Type" Resistors	£1
SX11	400	Pre-formed ¼-½ watt Carbon Resistors	£1
SX12	200	⅛ watt Carbon Resistors	£1
SX13	200	¼ watt Carbon Resistors	£1
SX14	150	½ watt Resistors 22 ohm-2m2 Mixed	£1
SX15	100	1 and 2 watt Resistors 22 ohm 2m2 Mixed	£1

Paks SX12-15 contain a range of Carbon Film Resistors of assorted values from 22 ohms to 2 2 meg. Save pounds on these resistor paks and have a full range to cover your projects

*Quantities approximate, count by weight

"CAPABLE CAPACITOR PAKS"

Pak No.	Qty.*	Description	Price
SX16	250	Capacitors Mixed Types	£1
SX17	.200	Ceramic Capacitors Miniature Mixed	£1
SX18	100	Mixed Ceramics 1pf-56pf	£1
SX19	100	Mixed Ceramics 68pf-0.5mf	£1
SX20	100	Assorted Polyester/Polystyrene Capacitors	£1
SX21	60	Mixed C280 type capacitors metal foil	£1
SX22	100	Electrolytics, all sorts	£1
SX23	50	Quality Electrolytics 50-1000mf	£1
SX24	20	Tantalum Beads, mixed	£1

*Quantities approximate count by weight

SX52 6 Black Heatsink will fit TO-3 and TO-220 Ready drilled Half price value £1

SX53 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 square x 20mm high 40p

SX54 TO 66 size 35mm x 30mm x 12mm 35p

SX55 1 Heat Efficiency Power Finned Heatsink 90mm x 80mm x ..mm High Drilled to take up to 4 x TO 3 devices £1.50 each

BARGAINS

SX42	20 small 125 Red LED s	£1
SX43	10 Rectangular Green LED s 2	£1
SX46	30 Assorted Zener Diodes 250mw-2 watt mixed voltages, all coded New	£1
SX47	4 Black Instrument Knobs—winged with pointer ¼" Standard screw Fit size 29 x 20mm	50p
SX49	20 Assorted Slider Knobs Black/Chrome etc	£1
SK80	12 Neons and Filament Lamps. Low voltage and mains — various types and colours — some panel mounting	£1

SEMICONDUCTORS FROM AROUND THE WORLD

100 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 100

Guaranteed Value over £10 at Normal Retail Price

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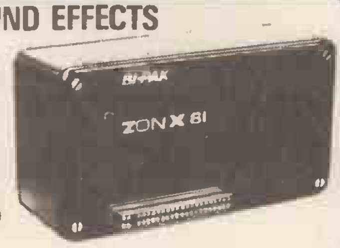

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Sinclair Sound Board

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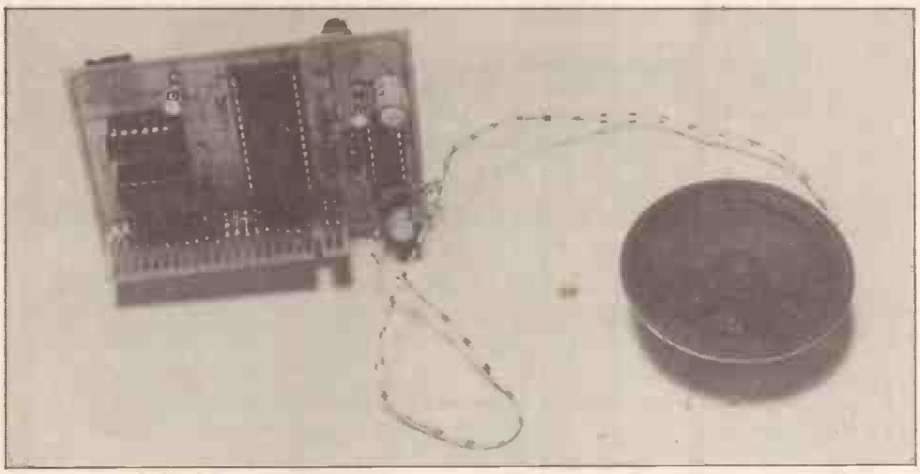
Development by Mike Lord



Do your ZX81 or Spectrum programs seem dull and lifeless? Do they lack that Snap, Crackle or Pop? If so then our Sound Board may be the answer!

Our ZX Sound Board is based on the General Instruments' 8912 sound generator chip, which gives you three programmable tones or noise with the option of automatic enevelope control, so your computer can carry on with other things while the sound is being produced. The board has been designed to work on both the Spectrum and the ZX 81 (1K or more RAM) without modification, and features a built-in amplifier to drive an 8 or 16 ohm speaker as well as a volume control (for work in the early hours!) and a 'Reset' button for turning it off quickly when the neighbours start knocking!

The unit is designed to plug into the rear connector of the computer; a matching edge connector plug is fitted to the rear of the sound board to allow for other add-ons such as the ZX81 RAM Pack or printer.

Circuit Description

The heart of the board is the sound generator chip, IC3. The data needed to program its operation comes in from the computer's data bus, on leads D0-D7, while the IC itself is under control of the signals on the BC1 and BDIR chip inputs. These are improved by ICs 1 and 2 whenever the computer performs an 1/0 operation with address line A5 or A6 low. These two address lines have been chosen because they do not conflict with any of the 1/0 addresses used by Sinclair add-ons such as the ZX printer. Putting the board in the computer's '1/0 Map' rather than the 'Memory Map' means that we can use the same board for both the ZX81 and the Spectrum without modification, although it does make use with the ZX81 slightly more complicated.

R2 and C3 reset the 8912 chip when power is applied to the board, or it can be reset any time by operating SW1; R3 limits the current flowing through the switch from C3 to a sensible level.

IC3 needs a clock signal of somewhere between 1 and 2MHz, and this is provided by using part of IC2, (which is a quad 2-input NAND with Schmitt Trigger inputs), R1 and C1 as an oscillator. The output of the oscillator is buffered by a spare gate from ICl.

The three sound outputs of IC3 are connected togther and to the load resistor R5, then the resulting signal is fed through the low-pass filter R4/C4 to round off the edges of the square waves produced by IC3 before being amplified in IC4 to drive the loudspeaker. R6 and C7 guard against ringing and possible oscillation in IC4.

Construction

A single-sided PCB has been used to keep the cost down, so two wires have to be soldered in, as shown in **Figure 2**. Once this has been done, the resistors, capacitors and IC sockets can be fitted, care being taken to ensure that the electrolytic capacitors are fitted the right way round. Do not fit the ICs themselves yet.

The termination pins of the 23+23 way socket should now be fed through the board, so that they project out of the component side, the body of the socket being on the track side of the PCB. Position the connector so that it is square onto the PCB, with about half of the length of the termination pins on each side of the board. Solder two of the corner pins to the copper pads first, then check again that the connector is mounted squarely before soldering the other pins to the square pads on the board (some of the pins don't go through square pads, and so don't need to be soldered). Take great care not to create accidental short-circuits to adjacent pads or track when you are making the soldered joints!

The 23+23 way plug, which is a double-sided PCB, should now be fitted. Again, it must be mounted square onto the main PCB, the contact tails from the socket being bent down and soldered onto it on both sides.

The switch and volume control are

Parts List

RESISTORS
(All ¼W, 5% carbon)
R1 .... 470R
R2, 4 .... 33k
R3, 5 .... 1k
R6 .... 3R3

POTENTIOMETERS
RV1 .... 10K preset
(see Buylines)

CAPACITORS
(Disc ceramic unless noted)
C1 .... 1n
C2, 5, 7 .... 100n
C3, 8 .... 4u7
16V electrolytic
C4 .... 10n
C6, 9 .... 100u
16V electrolytic

SEMICONDUCTORS
ICI 74LS02
Quad NOR gate
IC2 .... 74LS132
Quad NAND Schmitt trigger
IC3 .... AY-3-8912
Sound generator
IC4 .... LM380N
Audio amplifier

MISCELLANEOUS
SK1 .... ZX edge connector
23 + 23 way 0.1in socket with
polarising pin in position 3,
wire/wrap contact terminations.
PL1 ....23+23 way plug
SW1 .... push switch
Single pole momentary
PCB; 3 x 14-pin, 1 x 28-pin DIL IC sockets; loudspeaker, 8 or 16 ohm; connecting wire, solder etc.

BUYLINES ....page 34

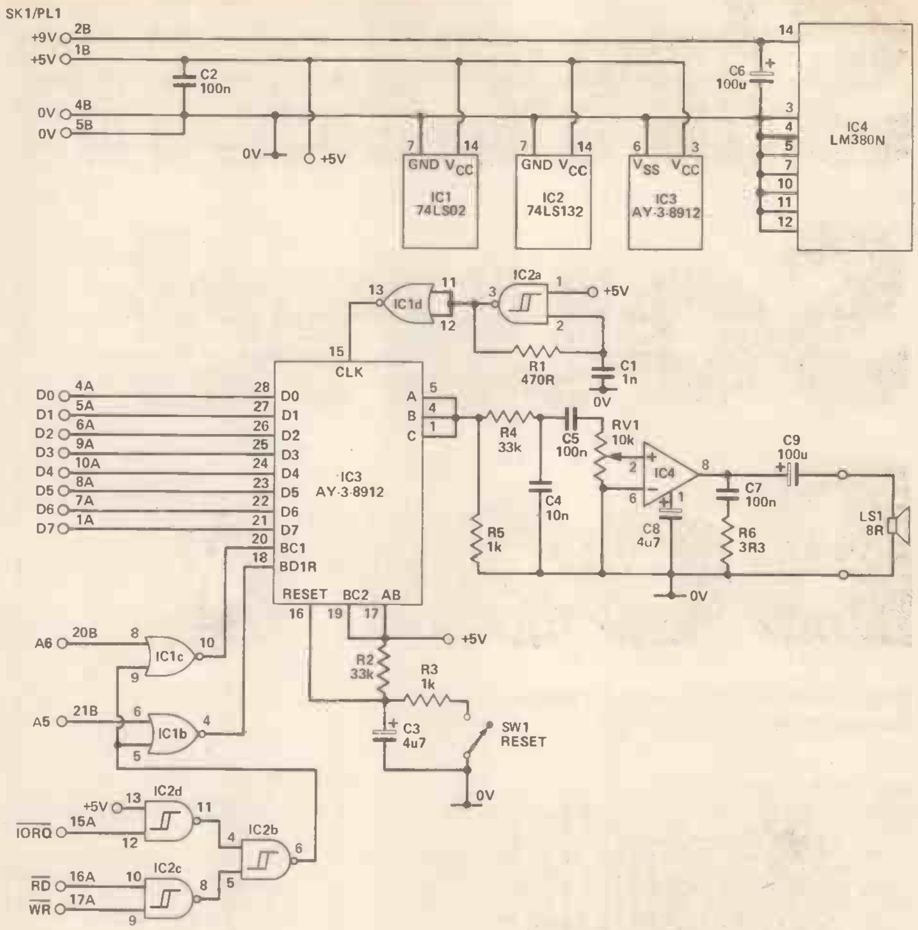
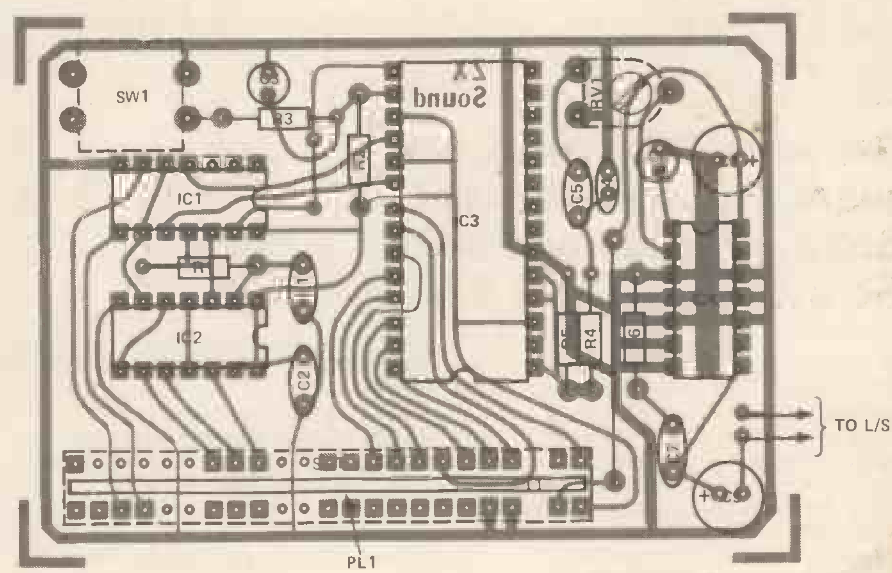


Figure 1. The circuit.

Figure 2: PCB Overlay. Note that SK1, SW1 and RV1 (dotted) are mounted on the track side of the board.



to be soldered onto the *track side* of the main PCB, which has been laid out to accommodate the types given in the parts list.

Finally, a pair of wires should be soldered into the two holes indicated in **Figure 2**, to connect with the loudspeaker, then the ICs plugged in.

Preliminary Tests

Before doing anything you might regret, check the board very carefully for possible short-circuits between tracks or connector pins. Then check again that the correct components have been inserted in the correct places, and the right way round. If you are very unlucky, a fault which is overlooked at this stage could damage your computer!

Now, plug the board into the back of your computer, REMEMBERING TO TURN THE POWER OFF FIRST!! Restore power to the computer, and check it works exactly as before.

Turn the volume control fully clockwise. You should be able to hear a slight buzzing sound from the loudspeaker, which will increase if you touch the left-hand terminal of RV1 with the tip of your finger.

If you are using it with a Spectrum, then you can check that the sound generator is working by entering the line:

(OUT 159,8: OUT 223,15)

which should result in a hissing noise. If you have a ZX81, you will have to load the 'Demo' program and use that to test the board as described in the next few sections.

SPECTRUM			ZX SOUND BOARD			ZX81		
PIN	A	B	PIN	A	B	PIN	A	B
1	A15	A14						
2	A13	A12						
3	D7	+5V	1	D7	+5V	1	D7	†5V
4		+9V	2		+9V	2	$\overline{RAMCS}$	+9V
5	KEY		3	KEY		3	KEY	
6	D0	0V	4	D0	0V	4	D0	0V
7	D1	0V	5	D1	0V	5	D1	0V
8	D2	CK	6	D2		6	D2	Ø
9	D6	A0	7	D6		7	D6	A0
10	D5	A1	8	D5		8	D5	A1
11	D3	A2	9	D3		9	D3	A2
12	D4	A3	10	D4		10	D4	A3
13	$\overline{INT}$	$\overline{IORQGE}$	11			11	$\overline{INT}$	A15
14	$\overline{NMI}$	0V	12			12	$\overline{NMI}$	A14
15	$\overline{HALT}$	VIDEO	13			13	$\overline{HALT}$	A13
16	$\overline{MREQ}$	Y	14			14	$\overline{MREQ}$	A12
17	$\overline{IORQ}$	V	15	$\overline{IOREQ}$		15	$\overline{IOREQ}$	A11
18	$\overline{RD}$	U	16	$\overline{RD}$		16	$\overline{RD}$	A10
19	$\overline{WR}$	$\overline{BUSRQ}$	17	$\overline{WR}$		17	$\overline{WR}$	A9
20	-5V	$\overline{RESET}$	18			18	$\overline{BUSAK}$	A8
21	$\overline{WAIT}$	A7	19			19	$\overline{WAIT}$	A7
22	+12V	A6	20		A6	20	$\overline{BUSRQ}$	A6
23	-12V	A5	21		A5	21	$\overline{RESET}$	A5
24	$\overline{MI}$	A4	22			22	$\overline{MI}$	A4
25	$\overline{RFSH}$	$\overline{ROMCS}$	23			23	$\overline{RFSH}$	$\overline{ROMCS}$
26	A8	$\overline{BUSAK}$						
27	A10	A9						
28		A11						

Table 1. The three columns give the edge connector pin signals for the Spectrum, the ZX Sound Board and the ZX81, from left to right.

This table covers the same ground as the ones published with "ZX Interfaces Explained" (HE August '82, page 12), with some corrections, and can be kept as a handy reference guide to Sinclair micro connections.

Inside The 8912 Sound Chip

The 8912 is basically a 'three-channel device', although in this circuit all three outputs have been connected to the single audio amplifier.

It contains a variable frequency tone source and a programmable amplitude control for each of the three channels A, B and C. A single — common — noise generator is also included, and its output can be added to or replace the output of any of the tone sources. The programmable amplitude control for any of the channels can be controlled by the computer or by an 'Envelope Generator' in the chip itself. This generator can be programmed to provide a variety of envelope shapes, automatically controlling the output level of the sound channel or channels. The values to be put into R7 selected.

Fourteen registers in the 8912 control the various sound generation functions. They are referred to as R0 to R13. R0 and R1 control the frequency of the tone produced for channel A. The larger the number entered into these registers, the lower the resulting note frequency. R0 is the 'Fine Tune' register, and can be programmed with any value between 0 to 255. R1 provides 'Coarse' tuning, and can take any value from 0 to 15. R2 and R3 are similar Fine and Coarse tuning registers for channel B, and R4, R5 for channel C.

The frequency of the noise

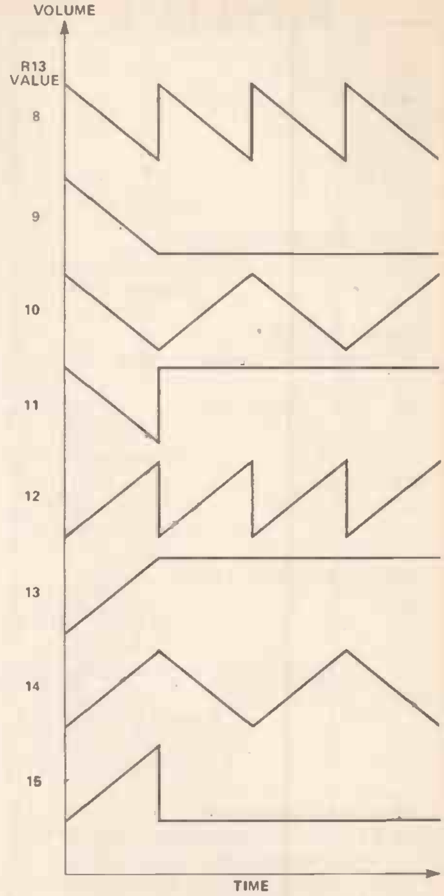


Figure 3. Envelope shapes available from the Sound Board's Envelope Generator.

generator can be controlled by entering a value from 0 to 31 into R6; the larger the value the lower the basic frequencies of the 'noise' produced.

R7 lets you select noise or tone output (or both) for each of the three channels. The values to be put into R7 should be between 0 and 63, calculated as the sum of:

1 to turn OFF tone from channel A
2 to turn OFF tone from channel B
4 to turn OFF tone from channel C
8 to turn OFF tone from channel A
16 to turn OFF tone from channel B
32 to turn OFF tone from channel C

R8, 9, and 10 control the output levels of channels A, B and C respectively. If they are loaded with a value between 0 and 15, then the output level for that channel will be determined by the value, 15 being the loudest. If, on the other hand, you enter the value 16, then the output level for the channel will be controlled by the Envelope Generator.

The Envelope Generator can vary the amplitude of any selected channel(s) to impose any of eight envelope shapes on the sound output, according to the value loaded into the register R13. Details of these envelope shapes are given in **Figure 3**. Note that some give a continuous (or continuously varying) output, while others give only a burst of sound every time R13 is loaded.

The duration of envelope shapes is controlled by values put into R11 and

Sounds

Dissonance

REG	*VALUE*
7	56
8	8
9	8
10	8
0	200
2	133
4	103

Choo-Choo

REG	*VALUE*
6	30
7	55
8	16
11	200
13	14

Chimes

REG	*VALUE*
1	1
2	130
4	60
7	56
8	16
9	16
10	16
12	50
13	8

Shot

REG	*VALUE*
7	55
8	16
12	5
13	9

(You'll get a 'shot' everytime you enter 9 into register 13.)

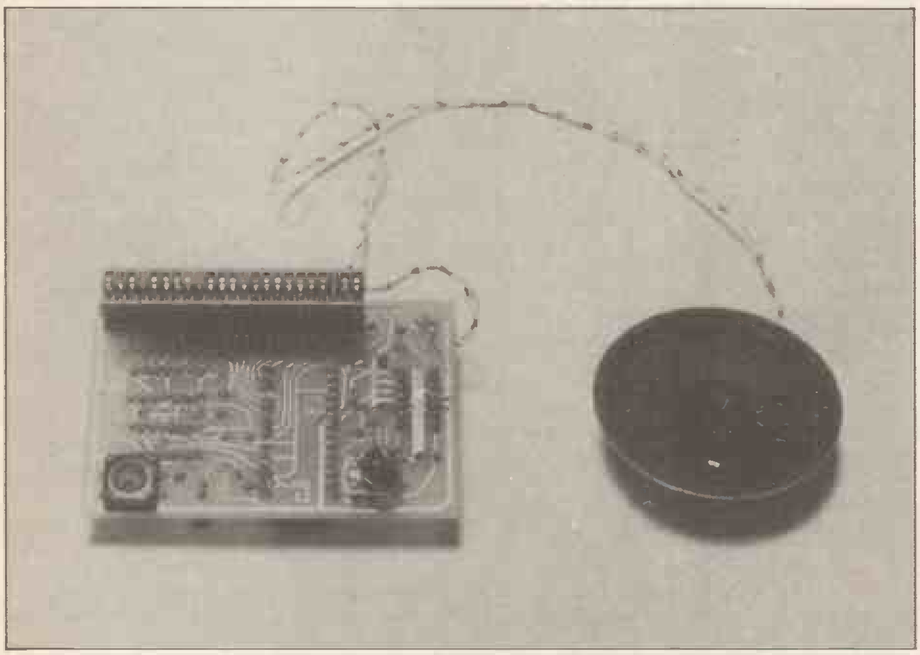
Demo Routines

```
   1  REM 123456789ABCD
   2  LET A$="110000019FFFED590EDFED51C9"
   3  LET A=16514
   4  FOR B=1 TO 25 STEP 2
   5  POKE A,16*CODE A$(B)+CODE A$(B+1)-476
   6  LET A=A+1
   7  NEXT B
 100  PRINT "REG VAL"
 110  INPUT R
 120  PRINT R:"
 130  INPUT V
 140  PRINT V
 150  GOSUB 990
 160  GOTO 110
9990  POKE 16515,R
9991  POKE 16516,V
9992  LET A=USR 16514
9994  RETURN
```

Note: characters '0' in line 2 are Zeroes, not the letter 'O'

SOUND BOARD DEMO PROGRAM FOR SPECTRUM

```
100  PRINT "Reg Val"
110  INPUT "Reg ";R'"Val ";V
120  PRINT R;TAB 6;V
130  OUT 159,R: OUT 223,V
140  GO TO 110
```



R12; larger values giving longer times. R11 is the 'Fine Tune' register, and R12 provides 'Coarse Tune'; both registers can take values from 0 to 255.

There are two further registers in the 8912, known as the 'Address Register' and the 'Data Register'. To put a value into any of the registers R0 to R13 you have to put the number of the register into the Address Register, then load the value into the Data Register. Reading the Data Register will give you the content of the register whose number is in the Address Register.

Programming It

As the board is I/O mapped, Spectrum owners should use the IN and OUT commands, the appropriate addresses being:

159 to write to the Address Register
223 to write to the Data Register
191 to read from the Data Register

So, to load the value 11 into the envelope shape register R13, we would use the two statements:

```
OUT 159,13
OUT 223,11
```

The 'DEMO' program given later simplifies things a little by letting you enter just the register number and contents.

The ZX81, however, lacks the IN and OUT instructions of the Spectrum; this means that a small machine code routine has to be loaded first to access the I/O map.

Lines 2-7 of the ZX81 'DEMO' program load this M/C program into the memory space reserved by the REM statement of line 1; once you have run this once then the characters in line 1 will change, and you can delete lines 2 to 7 if you wish. Lines 9990-9994 are a subroutine which calls the M/C routine, putting the value V into the 8912 register number R. Lines 100-160 are a short routine which uses the subroutine at 9990 and lets you experiment with the board by just entering the 8912 register numbers and the values you want stored there.

Sounding Out

Some interesting sounds to try out are listed under the heading 'Sounds to Try'. Remember that all of the 8912's registers that are not mentioned should contain '0' (pressing the board Reset button puts zero into all of the registers). These examples should get you started, then you can make a splash or any other sound you fancy! **HE**

74 SERIES	
7400	11p
7401	11p
7402	11p
7403	12p
7404	12p
7405	15p
7406	18p
7407	18p
7408	14p
7409	14p
7410	14p
7411	16p
7412	14p
7413	16p
7414	18p
7416	18pp
7417	18p
7420	14p
7421	18p
7422	20p
7423	18p
7425	18p
7426	18p
7427	18p
7428	18p
7430	14p
7432	18p
7433	22p
7437	22p
7438	22p
7440	15p
7441	55p
7442A	30p
7443	70p
7445	50p
7446A	50p
7447A	36p
7448	45p
7451	15p
7453	15p
7454	15p
7460	15p
7470	30p
7472	25p
7473	25p
7474	18p
7475	22p
7476	25p
7480	48p
7481	120p
7482	65p
7483A	38p
7484	65p
7485	60p
7486	18p
7489	170p
7490A	20p
7491	35p
7492A	25p
7493A	24p
7494	36p
7495A	35p
7496	35p
7497	90p
74100	80p
74107	22p
74109	25p
74112	170p
74116	50p
74118	55p
74119	60p
74120	60p
74121	25p
74122	30p
74123	36p
74125	30p
74126	30p
74128	36p
74132	30p
74136	28p
74141	55p
74142	175p
74143	200p
74144	200p
74145	40p
74147	75p
74148	60p
74150	50p
74151A	36p
74153	36p
74154	50p
74155	35p
74156	40p
74157	30p
74159	75p
74160	40p
74161	40p
74162	40p
74163	40p
74164	45p
74165	45p
74166	48p
74167	150p
74170	120p
74172	250p
74173	50p
74174	55p
74175	50p
74176	40p
74177	45p
74178	70p
74180	40p
74181	115p
74182	40p
74184A	90p
74185	90p
74186	470p
74188	250p
74190	45p
74191	45p
74192	45p
74193	45p
74194	40p
74195	40p
74196	40p
74197	40p
74198	80p
74199	80p
74221	55p
74251	45p
74273	120p
74278	140p
74279	40p
74283	50p
74284	160p
74290	75p
74293	80p
74298	100p
74351	150p
74365	30p
74366	35p
74367	35p
74368	30p
74376	100p
74390	75p
74393	90p
74490	95p

74LS SERIES	
74LS00	11p
74LS01	11p
74LS02	11p
74LS03	12p
74LS04	12p
74LS05	12p
74LS06	12p
74LS07	12p
74LS08	12p
74LS09	12p
74LS10	13p
74LS11	13p
74LS12	13p
74LS13	15p
74LS14	25p
74LS15	12p
74LS20	13p
74LS21	13p
74LS22	13p
74LS26	14p
74LS27	13p
74LS28	14p
74LS30	13p
74LS32	13p
74LS37	14p
74LS38	14p
74LS40	12p
74LS42	30p
74LS47	36p
74LS51	14p
74LS55	14p
74LS73	18p
74LS74	16p
74LS75	18p
74LS76	18p
74LS83	36p
74LS85	40p
74LS86	16p
74LS90	22p
74LS92	30p
74LS93	22p
74LS95	40p
74LS96	50p
74LS107	20p
74LS109	27p
74LS112	20p
74LS113	20p
74LS114	22p
74LS122	25p
74LS123	34p
74LS124	90p
74LS125	24p
74LS126	25p
74LS132	34p
74LS133	25p
74LS136	25p
74LS138	27p
74LS139	27p
74LS145	70p
74LS147	100p
74LS148	75p
74LS151	40p
74LS153	40p
74LS154	80p
74LS155	30p
74LS156	36p
74LS157	25p
74LS158	30p
74LS160	38p
74LS161	38p
74LS162	38p
74LS163	38p
74LS164	40p
74LS165	50p
74LS166	55p
74LS170	70p
74LS173	55p
74LS174	40p
74LS175	40p
74LS181	90p
74LS190	36p
74LS191	35p
74LS192	36p
74LS193	36p
74LS194	35p
74LS195	35p
74LS196	45p
74LS197	45p
74LS221	50p
74LS240	55p
74LS241	55p
74LS242	55p
74LS243	55p
74LS244	50p
74LS245	70p
74LS251	30p
74LS253	30p
74LS256	150p
74LS257	30p
74LS258	35p
74LS259	55p
74LS260	22p
74LS261	50p
74LS266	20p
74LS273	55p
74LS279	30p
74LS283	40p
74LS298	90p
74LS299	150p
74LS321	150p
74LS323	160p
74LS324	150p
74LS348	90p
74LS352	60p
74LS353	60p
74LS363	140p
74LS364	140p
74LS365	30p
74LS367	30p
74LS368	30p
74LS373	55p
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74LS399	160p
74LS467	£19
74LS540	90p
74LS541	80p
74LS610	£19
74LS626	150p
74LS628	150p
74LS670	120p
74LS687	400p

4000 SERIES	
4000	10p
4001	10p
4002	12p
4006	50p
4007	14p
4008	36p
4009	24p
4010	24p
4011	11p
4012	16p
4013	20p
4014	48p
4015	40p
4016	20p
4017	32p
4018	45p
4019	25p
4020	48p
4021	40p
4022	45p
4023	13p
4024	32p
4025	13p
4026	80p
4027	20p
4028	40p
4029	45p
4030	15p
4031	125p
4033	125p
4034	140p
4035	45p
4036	275p
4037	110p
4039	290p
4040	40p
4041	40p
4042	40p
4043	40p
4044	40p
4076	48p
4077	18p
4078	16p
4081	14p
4082	15p
4086	40p
4089	125p
4093	24p
4094	90p
4095	75p
4096	70p
4097	290p
4098	90p
4099	100p
4500	575p
4502	60p
4503	45p
4505	400p
4507	35p
4508	130p
4510	45p
4511	45p
4512	48p
4514	110p
4515	110p
4516	55p
4518	40p
4520	50p
4521	90p
4526	60p
4527	60p
4528	50p
4532	70p
4534	400p
4536	270p
4538	90p
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4543	75p
4553	245p
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4556	35p
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4568	250p
4569	170p
4572	30p
4583	90p
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LM334Z	90p
LM335Z	140p
LM339	50p
LM348	66p
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LM380	75p
LM381AN	180p
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MPSA56	25p
MPSA70	50p
MPSA93	50p
MPSU06	55p
MPSU07	60p
MPSU45	90p
MPSU65	78p
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TIP31C	50p
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TIP33A	90p
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2SC2078	160p
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Sir John Turton Randall

Not well known to the public, his experiments with the magnetron effect brought about a breakthrough in the generation of microwaves.

Ian Sinclair

This is no exotic mid-European name, and yet Sir John Turton Randall's fame is of a distinctly select variety. Like many distinguished academics, Sir John Randall is famous to a fairly small number of people who know of his achievements.

That is by no means to say that the achievements themselves are obscure — his work on microwaves enabled radar to play a crucial part in Britain's defences during the Second World War, quite apart from opening the way for the many roles radar has played since that time. In a very different context, it has given rise at some removes to that increasingly familiar phenomenon of our time, the microwave oven. Behind the headlines and high-street familiarity of winning wars and microwave cookery there are always the back-room boffins, rewarded perhaps but rarely renowned.

Sir John Randall was (and still is) one of these. Born in 1905, he pursued a brilliant academic career, and gained his MSc degree from the University of Manchester in 1926, at an age when most students are struggling with a lower degree. He worked in electrical research in the laboratories of GEC between 1927 and 1937, but then returned to academic life as a Warren Research Fellow of the Royal Society in the years 1937 to 1943.

Microwave Generation

This was no return to ivory towers or dreaming spires. His research in those years was very strongly connected with his work at GEC, and centred on the generation of microwaves. At that time, "microwave" was the term loosely applied to any frequency of more than about 1GHz (1000 MHz), and there was at that time no satisfactory way of generating these frequencies at high power. The first radar experiments were, in fact, conducted using frequencies around 50MHz.

To see why such difficulties existed, we have to think of the methods that were used for constructing oscillators. A conventional high-power oscillator of the mid-30s would use a triode valve, not so very different from the type we still use for the same purpose, with the cross-section shown in **Figure 1**. Electrons are emitted from the hot tungsten filament which, for a large transmitting valve, would typically use 115V 200A just in heating. These electrons are then attracted by the high positive voltage of the anode, a metal cylinder which forms the outside of the valve and which is water or air cooled.

The flow of electrons between cathode and anode is controlled by a "grid", a coil of wire or a wire-mesh cylinder placed between anode and cathode, whose voltage can be varied. With a high negative voltage on the grid, electrons will be repelled back to the cathode, none reaching the anode; with a positive voltage on the grid, a few electrons land on the grid but most travel on to the anode. The voltage on the grid controlled is the anode current, just as the voltage on the gate of a FET controls the drain current.

Oscillation Limitations

Triode valves of this sort were used and still are produced for radio transmitters, and they could be used as high power oscillators by adding some positive feedback, using circuits such as the one in **Figure 2**. Such oscillators could

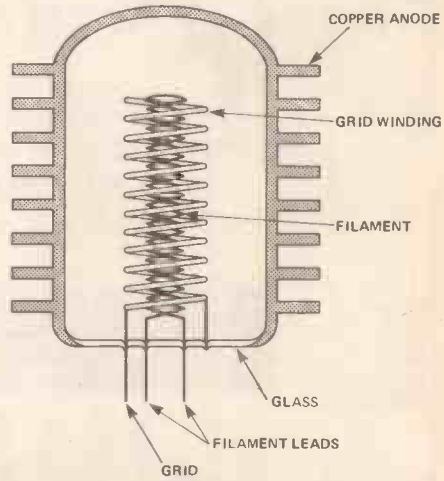

Figure 1. Cross-section of a typical triode transmitting valve.

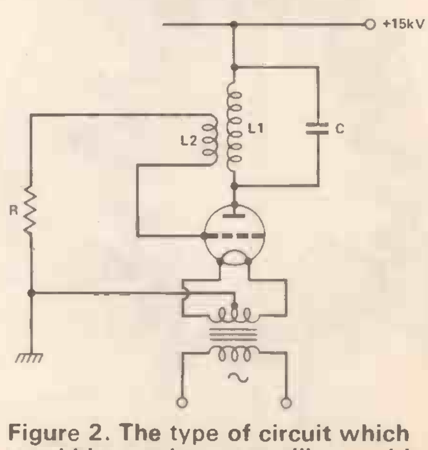

Figure 2. The type of circuit which would be used as an oscillator with a triode valve.

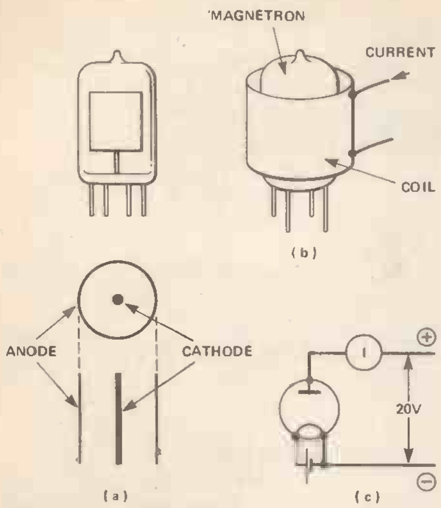

Figure 3. The magnetron. (a) Views of the structure. (b) The valve, which is a simple diode, is used inside a magnetic field provided by a large coil. (c) The circuit connection to the valve — the current drops suddenly as the magnetic field is increased.

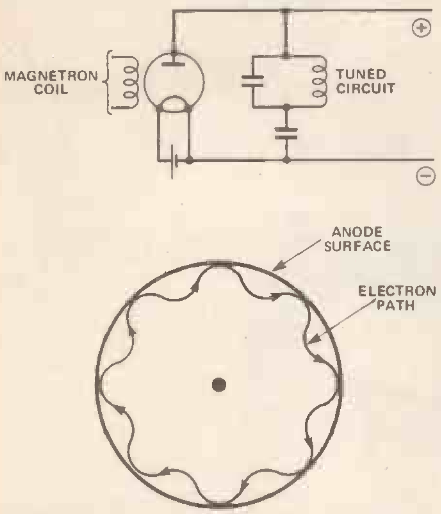

Figure 4. Using the magnetron valve with a tuned circuit. This causes the electron path inside the valve to be corrugated as the anode voltage oscillates.

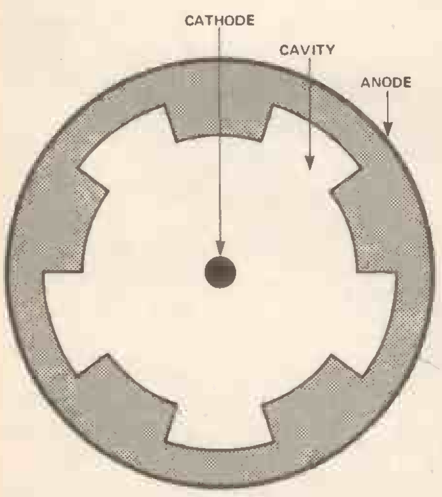

Figure 5. Cross-section of a cavity magnetron. The cavities act as tuned circuits for a microwave frequency.

produce an output whose frequency is controlled by the inductance of the tank coil and the value of capacitance connected across it, but there was a limit to the frequency that could be obtained. One limitation was simply that it's difficult to make a "coil" of less than one turn, but the more serious limitation was due to the valve itself.

The action of the oscillator depends on the positive feedback from the anode to the grid so that as the anode current increases, and its voltage decreases, the grid voltage is forced to increase. This works normally at low frequencies, but at higher frequencies it starts to suffer from the effect called "transit time".

The voltage between the grid and the filament is never very large, so that the electrons move comparatively slowly between these electodes — slowly meeting at a few million metres per second! What we're comparing this with, however, is how quickly the voltage at the grid will change if a frequency of a 1GHz is being generated. One complete cycle of a 1GHz wave takes just one nanosecond, and the grid voltage would change from maximum to zero in a quarter of this time, 250 picoseconds. At the lower electron speeds, it would be possible for an electron to leave the filament when the grid voltage was positive, but for the grid voltage to have become zero or negative by the time the electron reached it!

An electron struggling along at a speed which is one hundredth of the speed of light, for example, will cover 3mm in one nanosecond, which is a lot less than the distance between the filament and the grid of a large transmitting valve. The snag is that if you close up the gap, you are likely to have problems of sparking across the gap, particularly as the metal expands and even more so if there is any vibration.

Enter The Magnetron

Much was done to develop the transmitting triode, but transit time remains a problem that can't be got around in valves any more than we can get around it in transistors. This was the problem that faced two men working at Manchester in the early days of World War II. One of the two was John Randall, the other Dr. Henry Boot. Together, they made the valve that won the war.

For a long time before those days, an effect called the "magnetron effect" had been known — it is used today in an 'A' Level Physics experiment to measure the ratio of charge to mass for the electron. The cross-section down a simple magnetron is shown in **Figure 3**; it consists of a diode valve using an electron-emitting cathode and a cylindrical anode in a glass tube, evacuated and sealed, all within a coil which provides a steady magnetic field.

Without any magnetic field, current flows between cathode and anode when the anode is at a positive voltage and the cathode is hot. When the magnetic field is switched on, the electron path becomes bent, and if the field is strong enough, the electrons will move in circles, just missing the anode, so that the anode current drops to zero.

Now the interesting thing about this device is that the electrons can be moving very fast, so the time needed to perform each revolution inside the anode is very short. The other point is that if a tuned circuit is connected between anode and cathode, the valve will generate oscillations as the electron beam alternately touches and misses the anode (**Figure 4**). Randall and Boot's great step forward was to combine the valve with the oscillating circuit to form the cavity magnetron.

Perhaps they had been watching a flautist, because what occurred to both of them was that as the electrons travelled past a bottle-shaped cavity in the wall of the anode, the cavity might act as a tuned circuit for microwaves, just as the air inside a flute acts as a tuned circuit for the breath of the flautist. They suspected already that the cavity would act as a resonant circuit; the question was — would it be forced into oscillation by the electrons?

It Works!

Randall and Boot constructed a prototype to test their ideas. The prototype still exists — it would nowadays be classed as a CW magnetron, because it generated microwave radiation continuously, rather than in pulses. To their delight, the frequency of oscillation was very high, well above 1GHz, and the power, even with continuous oscillation, was also very high. A breakthrough in the generation of microwaves had been made just at a time when such a development was sorely needed.

Pulsing the cathode voltage of the magnetron produced even more dramatic effects — the generation of very large peak powers (up to 100kW even in these days) which greatly extended the range of the early radar transmitters.

This, combined with the use of high frequencies (which allowed the radar to distinguish between smaller targets, and to see more details of large ones) formed the basis of our radar early in the War, and allowed us to concentrate our pitifully small airforce, reduced to a shell by well-meaning pacifist politicians, on facing the enemy, rather than trying to patrol the whole of our shores.

John Randall, like so many distinguished academics, quietly resumed an academic career after the War, and a grateful Government presented him with a prize of £12,000 in 1949. To understand what that means, you have to realise that you could buy a semi-detached house in Essex for around £900 at that time. He had been elected as a Fellow of the Royal Society in 1946, and he held several professional appointments in physics before changing his interests to zoology. He was knighted in 1962, and is at present Professor of Zoology at Edinburgh University. HE

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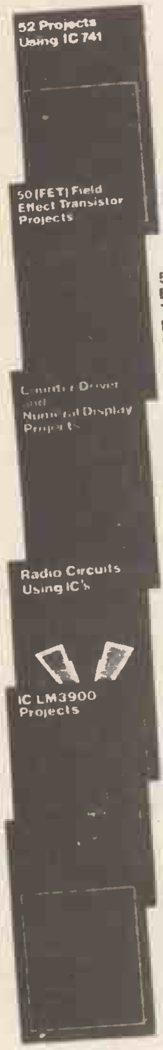

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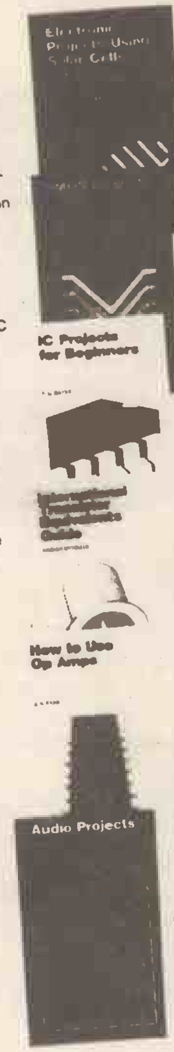

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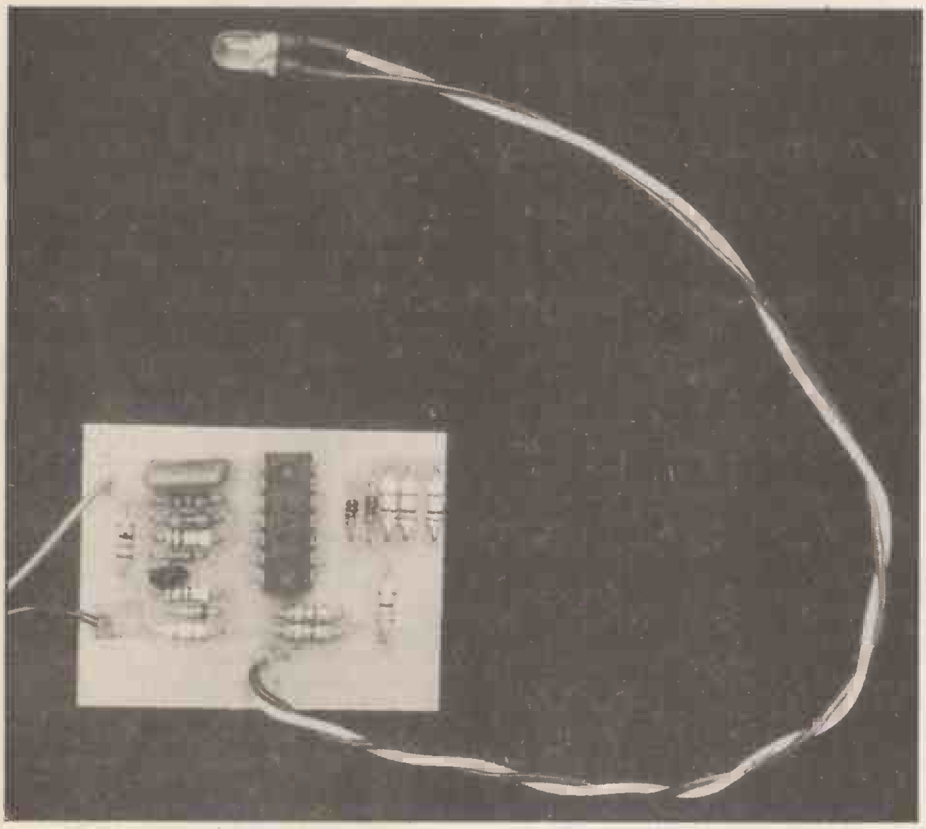
You're never alone in the dark with a Bat Light



Andy Armstrong

THIS IS a simple but unusual gadget which can enable you to tell if your car battery is getting low, if the fan belt is slipping, or if you have worn brushes in the alternator or similar faults. It employs a LED indicator which can glow red, through varying shades of yellow, to green. The LED is green when the battery is at about 13V5, and red when it is at 11V5. Thus a healthy but off-charge battery at about 12V5 will light the indicator to a mid-yellow colour.

Fine, you may say, I know about the battery voltage, but how does that tell me if the alternator brushes are worn out or the fan belt is slipping? Deduction, that's how.

If you find that the LED will not turn green, no matter how fast the engine is running when the headlights are switched on, then insufficient electricity is being generated to run the headlights and charge the battery at the same time. If the colour remains constant, then the fanbelt is probably slipping but if it flickers, the brushes are likely to be wearing.

Ignore this warning at your peril! A friend of mine did for about two months of daytime driving, then one night on a country lane, the engine and lights just faded out!

Indicator Circuit

The circuit uses a quad op-amp, type LM324. An LM348 would work equally well, and is pin compatible. The circuit splits into two main functions; a triangle wave generator using three parts of the quad IC, and a comparator using the fourth part.

The triangle generator looks complicated but isn't. IC1a forms an integrator which can ramp up or down depending on whether the voltage on pin 8 of IC1c is low or high, respectively. IC1c and IC1d define the upper and lower limits of the triangle waveform, by means of a bistable action.

If pin 8 is high, then the non-inverting input, pin 12, of IC1d will be held high via D3, forcing the output at pin 14 high. Since pin 8 is at a voltage near the positive supply rail, the integrator output (IC1a pin 1) will be ramping down. This voltage reaches pin 10 of IC1c, but not pin 14 of IC1d since D4 is reverse biased. When it falls below the reference voltage (derived from the divider chain R4 and R5) on pin 9, the output on pin 8 goes low. This allows the voltage on pin 12 of IC1d to fall to the ramp output voltage (5V8), so the output on pin 14 also goes low. This, in turn, has the effect of ensuring that the voltage on pin 8 remains low until the ramp output voltage exceeds the 6V8 reference voltage present on pin 13 of IC1d.

All this produces a triangle waveform with its limits at 5V8 and 6V8. This is fed to the inverting input of the IC16 comparator. The other input of the comparator is fed with a divided down version of the battery voltage, so that the output of the comparator switches rapidly, with a mark to space ratio determined by the battery voltage; R10 is included to ensure clean switching.

While the comparator output is high, the green part of the LED is on; when it is low the red part is on. The persistance of vision of the eye causes the colours to appear blended into various shades of yellow if the battery voltage is in a middle region. Resistors R11 and R12 are different values to equalise the red and green brightness levels. If the battery is either very good or very flat, of course, pure red or pure green will show.

The power supply is also of interest: car electrical systems sometimes have substantial voltage spikes on them. R13, D2, and C2 form a network which prevents these spikes from damaging the IC. D2 supplies an added bonus in that a reversed power supply will only heat up R13, rather than destroying the circuit; in this condition the LED will remain obstinately red, regardless of battery voltage.

One further comment on the functioning of the circuit: the more astute among you may have noticed that the function of parts c and d of the IC is that of a comparator with hysteresis, which can be carried out with a simple op-amp. True—but this circuit was designed for an economical quad op-amp and it has been used to provide a comparator whose switching levels do not depend on precisely how close to the supply rails the op-amp output can swing. For anyone handy enough to do their own layout, an alternative circuit using three op-amps is provided, without further comment (**Figure 2**).

Construction

In the main, construction is straightforward; having made the PCB, and made sure that there are no unetched areas causing short circuits, solder down the components, following the overlay and take care over the polarity of all the diodes and C2.

Several points need to be noted however. When the board is built and checked against the overlay, the bi-colour LED should be connected up. Do not at this stage worry which way round it goes. It is then ready for testing. If you have a variable voltage power supply and an accurate multimeter this is simplified—if not don't worry, it's just more time consuming. For those with power supply and multi-meter proceed as follows:
Connect the battery indicator to the power supply and, with the aid of the

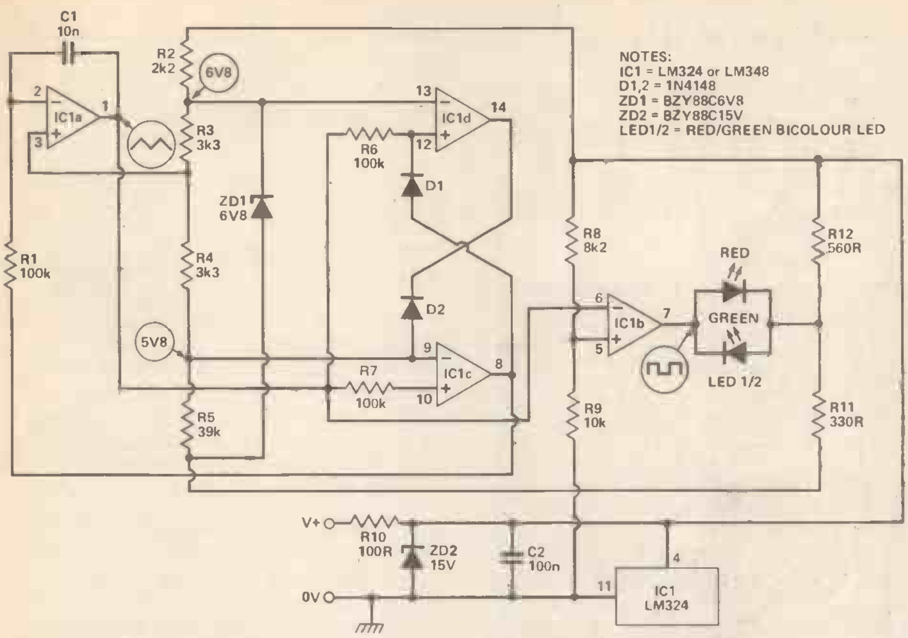


Figure 1a. The circuit. The colour of the LED varies with voltage.

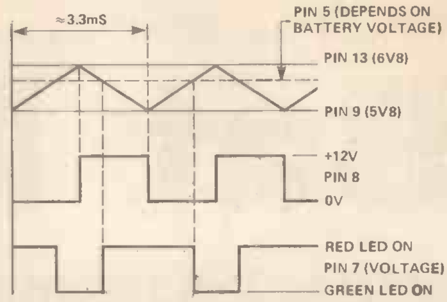


Figure 1b. Timing waveform. IC1a maintains the voltage on pin 2 at the level of pin 1. The current charging or discharging C1 cancels the current in R1. The total cycle time is 3.3mS.

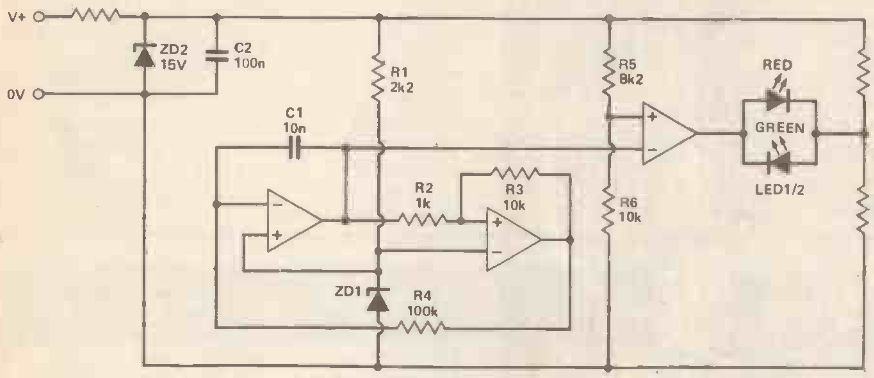


Figure 2. An alternative circuit using three op-amps.

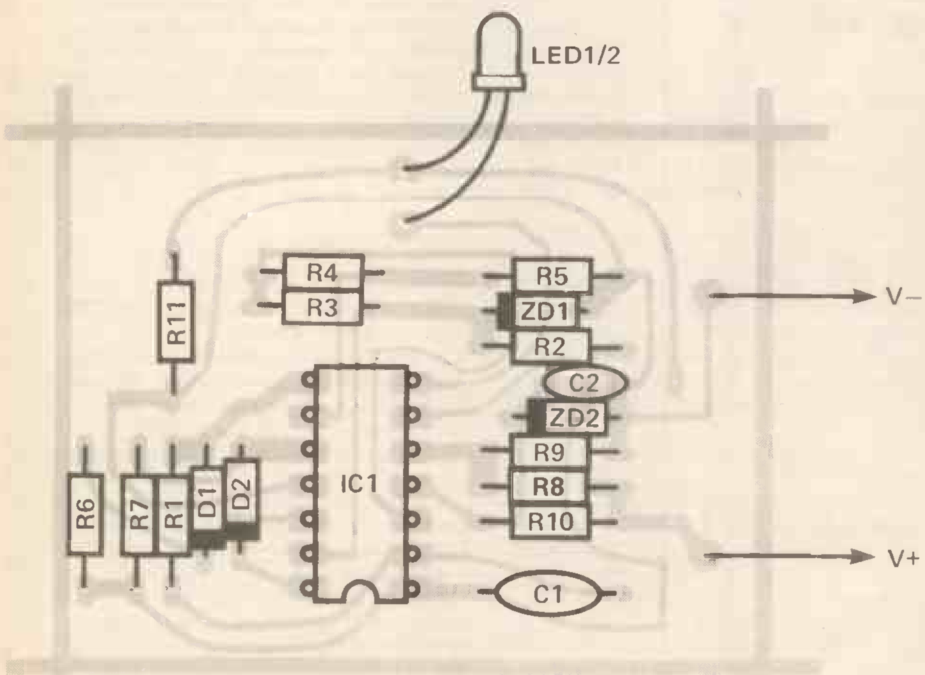


Figure 3. PCB component overlay.

meter, set the output to 12V5. The LED should glow with a shade of yellow; if only one colour shows, the power supply connections may be reversed. Assuming a yellow glow is obtained, increase the voltage to between 13V5 and 14V. Somewhere in this region a single-coloured glow should be obtained; if the voltage is outside this range, make a note of the voltage and continue; if the colour is red, then the LED connections should be reversed. Now reduce the voltage to 11V5, around which point a red glow should be seen. If the voltage is outside the range of 11V to 12V, or if the pure green glow was not obtained between 13V5 and 14V, then this can be altered: the cause is likely to be the inaccuracy of the Zener ZD1, or of R8 and R9. The cure is to add a resistor in parallel with R8 if the voltages at which pure colours were obtained were too high, or in parallel with R9 if these voltages were too low. In either case, a parallel resistance of 100k will cause a change of about 0V3 in the above voltages. Experiments based on this should soon indicate the resistor value needed. This resistor should be added in, above R8 or R9, as appropriate, simply soldered to its leads at the point where they are bent, as shown in the diagram, **Figure 4**.

For those lacking a bench power supply, a reasonable alternative method is to use the car itself as a means of calibration. The battery indicator should be connected to the supply, in a temporary manner, and the engine started. By choice of the appropriate add-on resistor (if needed) the indicator should be adjusted so that the LED just turns completely green when the engine is running moderately fast. Take care not to rev the engine *too* fast, as damage may result.

Installation

There are two methods for mounting this unit into the car. The first is to put the entire unit into a plastic box with a small hole drilled in it, with the LED mounted in the hole using the standard LED mounting bush which is normally supplied with the LED. The plastic box can then be mounted in any clearly visible position, probably under the dashboard, using double-sided adhesive pads. In order to make sure that these pads do not peel off after a few months,

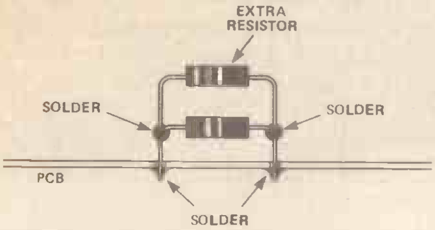


Figure 4. Mounting an extra resistor in parallel with R8 or R9. This may be necessary if the voltage is excessive or inadequate at this point.

Parts List

RESISTORS (All ¼ watt 5% carbon)		C2	100n disc ceramic
R1, 6, 7	100k	**SEMICONDUCTORS**	
R2	2k2	IC1	LM324 or LM348 quad op-amp
R3, 4	3k3	ZD1	BZY88C6V8
R5	39k	ZD2	BZY88C15V
R8	8k2	D1, 2	1N4148 or equivalent
R9	10k	LED1/2	red/green bi-colour LED
R10	100R	**MISCELLANEOUS**	
R11	330	PCB, wire, solder etc; optional case.	
R12	560R		
CAPACITORS			
C1	10n polyester	**BUYLINES**	page 34

it's necessary to thoroughly clean the surface to which they are to be stuck so that all grease and dust is thoroughly removed.

An alternative — and perhaps neater method—is to enclose the PCB in a plastic box, which need not be specially smart, and connect up the LED with a reasonable length of flexible wire. In this case it's necessary to take care to observe the LED polarity and to sleeve the connections so that they cannot short. A small hole may then be drilled in an appropriate place in the dashboard, to balance with any other indicator lights, and the LED may be mounted in the mounting bush. The PCB in its case may then be mounted on any convenient surface, the bulkhead for example, behind the dashboard, out of sight.

For either of these methods of installation, the board is best mounted into the plastic box with a double thickness of self adhesive pads, and the wiring from the PCB to the supply should be carefully insulated and clipped away from sharp edges where it may abrade. This is very important, because a short circuit of that nature in a car could be dangerous.

For the permanent installation, it is advisable to connect the power side of the unit to a source of power only energised *when the ignition switch is on*. If the unit is left connected and in operation while the car is stationary, the car battery may be significantly discharged over a period of two or three weeks. The ground side should simply be earthed under any convenient fixing screw in the area.

Variations

As it stands, this circuit is designed for a 12V electrical system. However, if ZD1 were changed to a 3V3, a limited degree of operation with a 6V electrical system would be possible, though the LED would be rather dim and, quite possibly, some experimentation would be needed with values of R11 and R12. For use on a 24V electrical system, ZD1 could be left at 6V8 and the value of R8 could be raised to between 15k and 20k, in order to provide suitable indication.

Should it be difficult to obtain the bi-coloured LED, two ordinary LEDs of different colours can be connected in parallel in opposite directions.

HE

BUYLINES

ZX Sound Board

This project uses the AY-3-8912 Programmable Sound Generator IC, the slightly more expensive of the two General Instrument PSGs. Why the 8192, which provides a single I/O port and is a 28-pin package, should be more expensive than the 8910 (which has two I/O ports and is a much larger 40-pin chip) is something of a mystery. However, the 28-pin IC is easier to use and allows the PCB to be smaller, too.

There are a few points to note with regard to the components: the potentiometer RV1 should be a miniature Cermet preset on the 5mm (0.1") format. Similarly, the switch SW1 is a dome top, momentary contact 5mm PCB mounting type, and should be used to complete a neat job. All the electrolytics are miniature radial types.

The 23+23-way edge connectors can be difficult to find, however **Rapid Electronics** of Colchester will be stocking all the parts for the ZX Sound Board, including the edge connectors. A case is really not necessary for this project and the total cost, excluding only the PCB (see page 72) should be around £15.

CB Rap Latch

Finding a single, convenient source for the components of this project was not an easy task — but after much dilligent searching, it was found that **Ambit International** stock either the required bits and pieces or suitable substitutes!

The 12V OUB type relay is listed by their stock code number 46-70030, and the four-way locking audio connectors are available as stock numbers 10-10004 (for the mic connector) and 10-11004 (for the socket).

The very common BC109 and BC 179 transistors are also supplied in plastic rather than metal cases, in which case they are known as BC239 and BC309 respectively, so don't get worried if you are offered these devices as alternatives! There may be some difficulty, also, in obtaining a 33u tantalum capacitor (C6); if this is the case, simply use the next largest value (which should be 47u) and replace the 1MR timing resistor (R9) with the value 680k. This will produce approximately the same timing period (35 seconds, in fact) which can be confirmed by substituting the new values into the formula given in the text. All the polyester capacitors are C280 types.

The cost of this project, excluding the case and PCB, should be around £6.00. Ambit will supply a suitable case for about £2.36 if you quote their stock number 21-06103, and the printed circuit board is available through our own PCB Service (see page 72).

Traffic Light Toy

A simple project, this, with a simple list of parts, all of which are available from **Greenweld Electronics**. Fittingly, the cost is quite low, too; around £2.50 excluding the case and PCB. The most suitable case from Greenweld is their type V213, which measures 100x75x40mm and costs 84p — dearer than a tobacco tin, but neater with it.

We have put the Traffic Light Toy on a PCB because this method of construction results in a more reliable job, and provides less margin for error! The cost could be reduced to rock bottom by constructing on stripboard — however we would not then be able to offer advice or assistance should there be any problems.

Pop Amps

All of the components and parts used for these simple circuits are readily available from suppliers advertising in HE. Dedicated experimentors will already have most of the bits and pieces in their 'junk box', but newcomers trying out these circuits for the first time should try to build up a collection of components and parts; the best buys are available from bargain-pack dealers such as **BI-PAK**, who provide low-cost selections of resistors, capacitors and so on to the electronics world at large. Their address is **BI-PAK**, PO Box 6, Ware, Herts., or phone 0920 3182.

Car Battery Indicator

None of the components for this ingenious circuit are particularly hard to find. You have a choice of ICs, but the LM324 is the cheaper of the two. Red/Green bi-colour LEDs go by several different code numbers but are generally easily obtainable; however, we know that both **TK Electronics** and **Bi-Pack** stock all the necessary, so they are the most convenient suppliers.

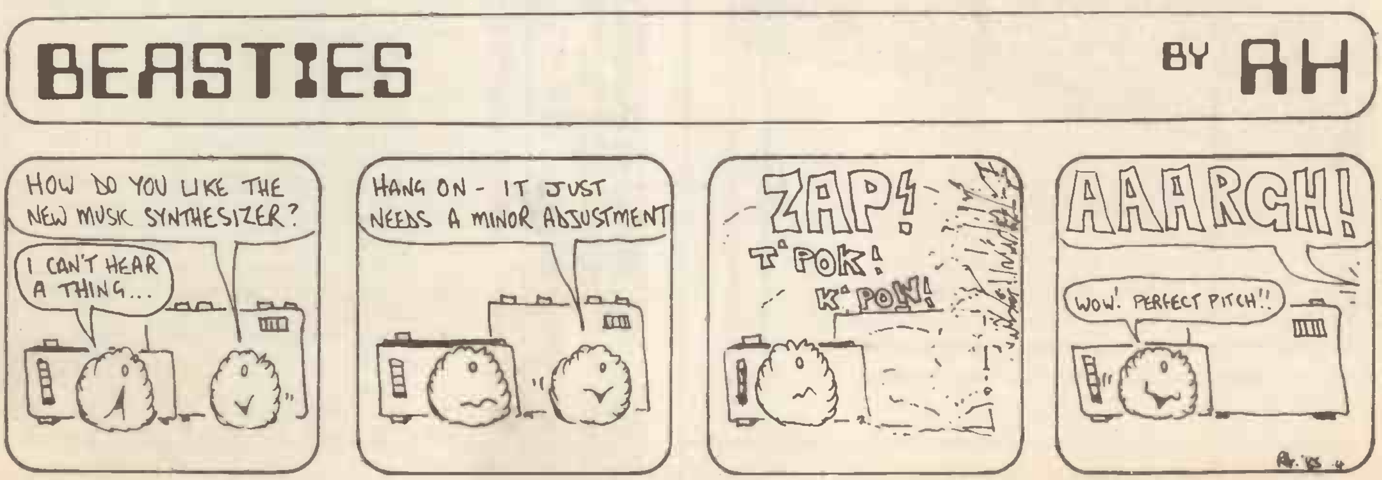
The PCB measures only 52 x 40mm, so only a small case is needed if you choose a concealed installation. Be sure to keep plastic cases away from heat sources, though!

Component cost, excluding case and PCB, should be around £2.00.

Update

The most difficult component to source for our **BBC Micro/HEBOT Interface** project proved to be the connector mating with the BBC's Auxiliary Power Output socket. BBC owners might like to know that **Kelan (Hobbyboard) Ltd** has a large stock of the correct plugs and will happily supply them separate from the BBC/HEBOT interface kit.

The toroid for the **Aerial Without Wings** project is being supplied by **Neosid Small Orders 1982** and is their type number 28-041-28. For reliable long wave reception, the number of turns should be increased to between 20-25. If, in any event, reception appears weak when using the Aerial, winding the additional number of turns should provide a sure cure.

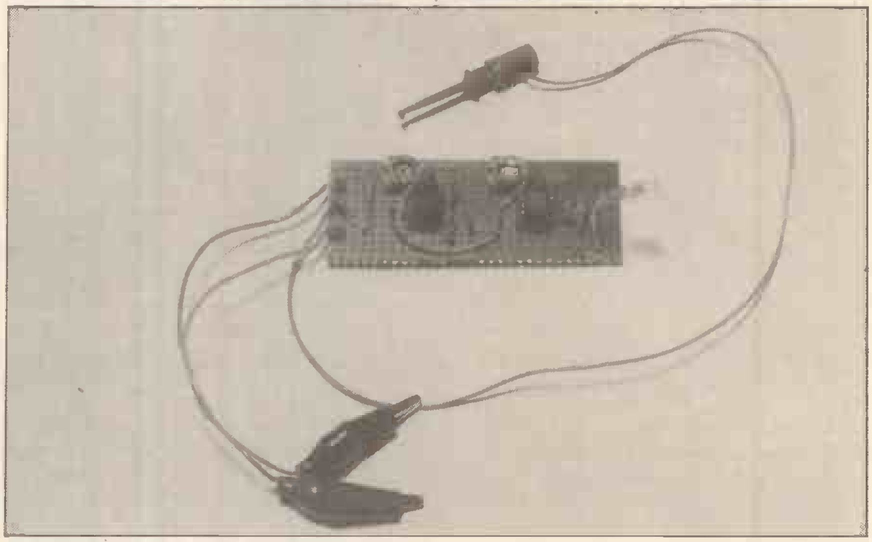


POP AMPS

Owen Bishop

Simple measuring circuits based on operational amplifiers

No. 8: TTL logic probe



THIS CIRCUIT is for testing logic levels in TTL (transistor-transistor logic) circuits. When we discuss these we so often think in binary terms of '1's and '0's, or 'highs' and 'lows', or +5V and 0V levels, that we sometimes lose sight of the fact that TTL input and output levels need not be exclusively 0V or +5V. Voltages in between these levels are perfectly acceptable, for these circuits are designed to tolerate manufacturing variability. Nevertheless, there must be standards of some sort, with guaranteed output levels and acceptable input levels.

The INPUT voltage levels specified by the manufacturers for all members of the 7400 TTL family, including the 74LS00 series are:

Logical '1' — minimum is +2V
Logical '0' — maximum is +0V8

Thus any voltage between 0V and +0V8 is recognised as 'logical 0' or 'low', while any voltage between +2V and +5V is recognised as 'logical 1' or 'high'.

The OUTPUT levels are specified so as to give a margin of error (0V4 to 0V5) which puts them securely within the input ranges:

Logical '1' — minimum is +2V4 (+2V5 for LS)
Logical '0' — maximum is +0V3 (+0V4 for LS)

When we are testing a circuit, it is the input levels which matter most, for the question is: "What effect is this level having on the logic gates to which it is being fed? Which will they take it to be, a '0' or a '1'?"

The probe tells you instantly how the test output will look to a TTL input. It has a multicoloured LED which glows green for 'low' level, and red for 'high' levels. At intermediate levels, which could mean anything (or nothing) to a TTL input, the LED is out. Should the test output be changing rapidly between 'high' and 'low', the LED glows yellow.

How It Works

The probe is based on two op-amps, both acting as comparators. This project uses the 7611 CMOS op-amp because it can operate on a + 2V5 supply (actually it works down to + 0V5) and its output swings fully to either rail. The test voltage is fed to the inverting input of the first op-amp (IC1) and, at the same time to the non-inverting input of the second op-amp (IC2). This voltage is compared with a reference voltage which is supplied to the other input of each op-amp from a potential divider (RV1, RV2). The voltage at the wiper of RV1 is set to +0V8, consequently whenever the input voltage from the test point is lower than 0V8, the output from IC1 rises sharply to +5V and current flows through the green element of the LED. The op-amp has no feedback resistor so its full gain is operative and it switches sharply at the threshold point. This means that the green element of the LED is either fully off or fully on, and a clear indication of the state of the test point is given.

IC2 works in the opposite fashion; RV2 is adjusted so that the voltage at its wiper is +2V. As a result, the output of IC2 swings high and turns on the red element of the LED whenever the test voltage exceeds 2V

A voltage between 0V8 and 2V is too high to turn on the green element, but too low to turn on the red element, so the LED is not lit. However if the voltage is oscillating between 'high' and 'low' levels, the red and green elements are switched on alternately; the eye merges the

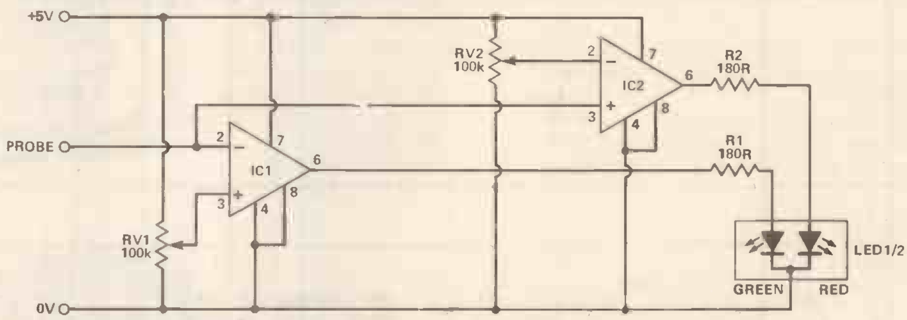


Figure 1. The circuit: watch the probe connections.

Parts List

RESISTORS
(¼ watt 5% carbon)
R1,2 .... 180R

POTENTIOMETERS
RV1,2 .... 100k min preset

SEMICONDUCTORS
IC1,2 .... 7611 CMOS op-amp
LED1/2 .... tri-colour LED common cathode type

MISCELLANEOUS
Stripboard, 78 x 30mm (11 strips x 30 holes); 2 x 8-pin IC sockets; 3 x 1mm terminal pins; 1 x red, 1 x black miniature croc clips; 1 x miniature probe clip; wire, solder etc.

BUYLINES .... page 34

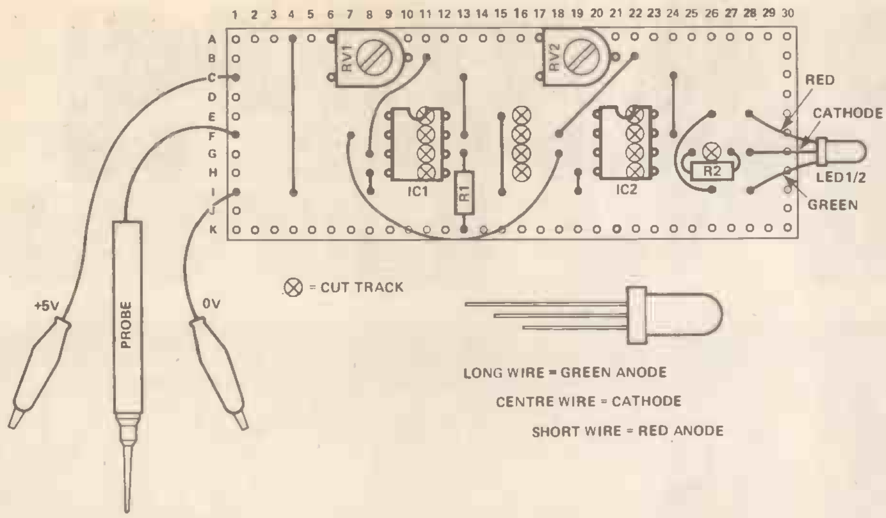


Figure 2. The veroboard layout. Keep the wire links as neat as possible.

colours and the light from the LED appears to be yellow (the exact shade depends on the mark-space ratio).

Construction

As the photograph shows, this project can easily be fitted onto a scrap of stripboard. It takes its power supply direct from the power rails of the circuit which is being tested and needs only 9mA, so it is unlikely to cause an overload. The power leads are fitted with crocodile clips, but it is recommended that you use a miniature probe clip on the test input lead. These spring-loaded hooks, which are sold under various names (such as E-Z-Hook), are very easy to attach to almost any part of a test circuit. You can clip these to the terminal pin of a logic IC, the wire lead of a resistor or (through one of the holes) to the copper track of a circuit-board.

Wiring up the probe circuit takes very little time. Points to watch for are:

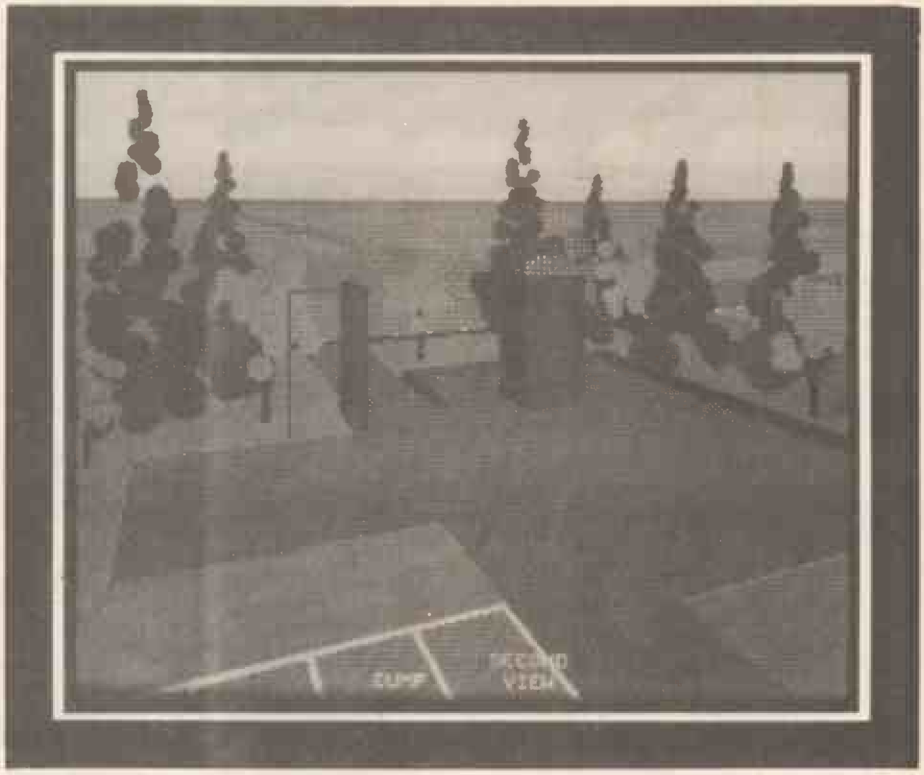
1). The 7611 is a CMOS IC, so you should take the usual precautions to avoid electrostatic charges while assembling the circuit. It is safer not to put the ICs in their sockets until all the wiring has been done.
2). The test input goes to *pin 2* of IC1, but to *pin 3* of IC2.
3). The terminal wires of the LED must be correctly connected. The type specified contains two LEDs in a single moulding, and they have their cathode wire in common (common cathode). For the LED used in the prototype, the connections were indicated as shown in the drawing.

When you have completed assembly, connect the power leads to 0V and +5V (regulated supply). Adjust RV1, until the voltage at pin 3 of IC1 is exactly +0V8, then adjust RV2 to bring the voltage at pin 2 of IC2 to exactly +2V. Touch the probe lead to +5V and the LED shines bright red. Touch the lead to 0V and it shines bright green. When the lead is not connected to anything you will probably see the LED glowing in various yellowing-orangy shades, due to the test lead picking up alternating electromagnetic interference from the mains. This happens because the op-amps have extremely high input impedance. **HE**

COMPONENTS FOR COMPUTING

This month we look into the television screen — or rather, behind it.

Paul Kelly



TODAY, with as little as £50, it is possible to go out and buy a home computer that plugs straight into a TV set to provide a text and graphics display. High level language programming and interactive graphics require a great deal of simultaneous information to be presented to the computer user and, at present, the cathode ray tube (CRT) provides the only real effective method. Virtually no computer currently on the market is without an interface to either TV or monitor, the exceptions being rather special purpose machines (machine code trainers, industrial controllers etc.) and therefore irrelevant to the mass market. It is hardly surprising, with personal computer sales running in excess of £1M per annum (in the UK) and with fierce competition between at least a dozen manufacturers, that the price barrier of £50 has been broken. Once again LSI chips (large scale integration) are responsible for the fall in the manufacturing costs of computers; in particular most of the circuitry associated with the video display can now be provided by an inexpensive device called a CRT Controller.

This month we introduce our subject with some facts and figures relating to the CRT displays (TV and monitors) and the basics of video circuitry, leading to a detailed investigation of CRT controllers next month. Also, there will be a small cheap project intended to illustrate the principles of video generating circuitry: however it will not incorporate a CRT controller but some simple low-cost discrete circuitry with plenty of scope for experimentation.

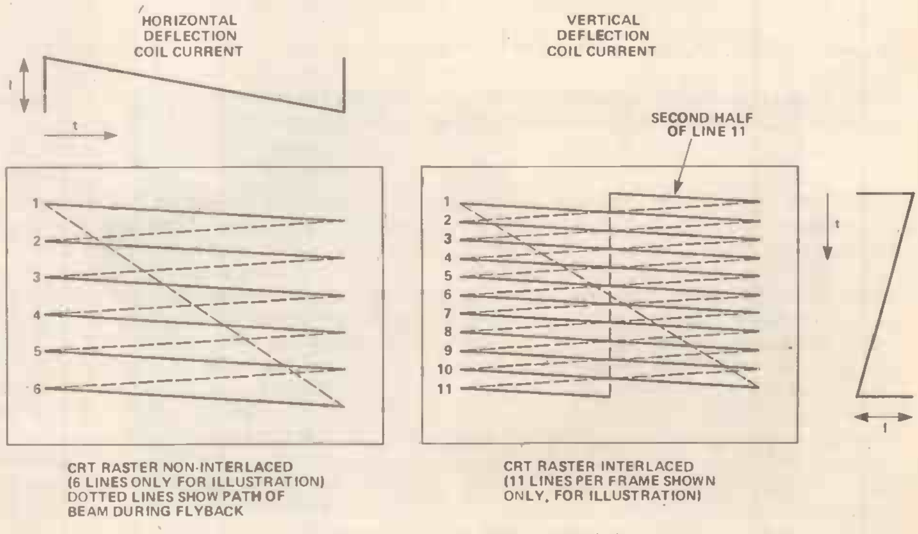


Figure 1a, b. A CRT raster is generated by scanning an electron beam from the top left hand corner of the screen, one line at a time, down to the bottom right. Figure 1a shows a non-interlaced raster of 312 lines (only six are shown for simplicity). An interlaced raster, shown in 1b, generates 625 lines (of which 11 are shown here) by scanning, first, the odd-numbered lines. The dotted lines indicate the 'retrace' or 'blanking' periods (flyback).

The Cathode Ray Tube

CTRs are employed in both television sets and monitors in much the same way; an electron beam is scanned across the fluorescent screen in a

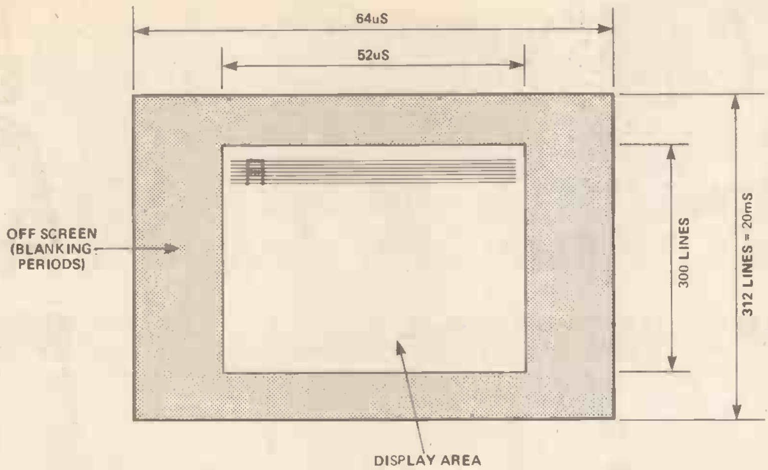


Figure 2. The time required for the flyback (blanking) periods overlaps the horizontal and vertical scanning periods. Thus the 'active line period' is 52us instead of 64us and the vertical picture is 300 lines deep, not 312. However in computer displays the active line period is limited to approximately 40us wide and about 200 lines deep.

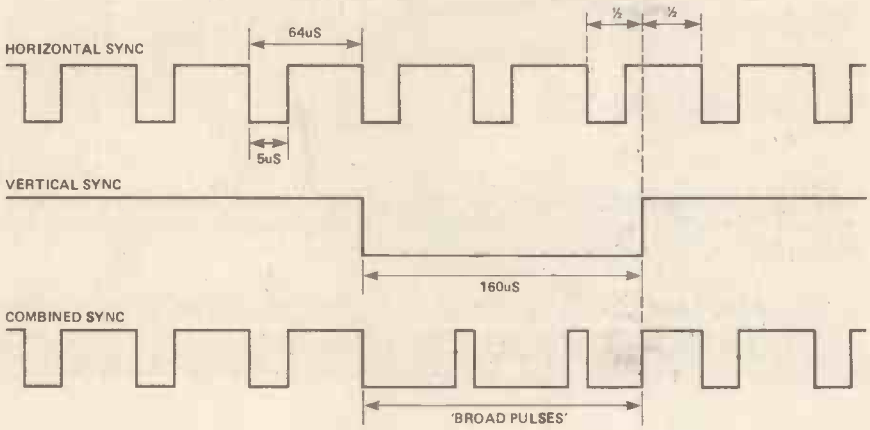


Figure 3a, b, c. The horizontal and vertical synchronization pulses are combined to produce a 'combined sync' signal; during the vertical sync period, the horizontal pulses are 'stretched' to produce the so-called 'broad pulses' to ensure that the horizontal oscillator stays locked in during these times.

mesh of horizontal lines called a 'raster', illustrated in **Figure 1**. A periodic sawtooth current waveform is passed through the 'horizontal' magnetic deflection coil of the tube, causing the electron beam to sweep across the screen, tracing a horizontal line across its width and then rapidly flying back to the far left before repeating the process. Simultaneously a much slower sawtooth waveform is applied to the 'vertical' deflection coils of the CRT, and this has the effect of spreading the horizontal traces into a cascade of discrete lines over the entire area of the screen. The fluorescent coating of the screen has the property of emitting light (usually white, but some monitors show green or amber) when bombarded with an electron beam and this emission persists for some tens of hundreds of milliseconds after the electron beam has passed. In Figure 2 the path of an electron beam has been traced out (6 lines only are shown) as in a CRT raster. The dotted line indicates the fast 'flyback' or retrace periods, during which the electron beam is always suppressed. During the forward traces (solid lines) the electron beam may be turned on, for all or part of its travel on each line, by means of a signal applied to the control grid of the CRT; by this means a picture can be built up. In **Figure 2** it is shown how the character 'A' is displayed by the raster. The character will persist without flickering provided that the display is refreshed (ie, the character redrawn) in regular frames and at intervals shorter than the persistence time of the phosphor (fluorescent material).

In a TV set or monitor there are many more lines to a raster than has been shown in the two figures — in fact in the UK there are 625 lines/frame (a 'frame' is a complete picture) for an interlaced TV picture (we will explain interlacing in a moment) and usually 312 lines for a non-interlaced monitor. Each line is scanned in 64uS and half a frame (called a 'field' in TV parlance) is repeated every 20mS. These figures ensure that a flicker free raster can be constucted with no visible 'gaps' between the lines.

Raster Master

Internal to a TV or monitor are all the circuits required to generate a raster. To display a picture it is also necessary to provide two external signals: a control signal that modulates the brightness of the scanning electron beam and some 'synchronisation' signals that force the monitor to generate its raster in registration with the incoming control signal. This control signal is obviously analogue (continuously varying) in the case of a TV picture so as to represent the various shades of grey, however for a computer display only black and white are normally required so that the control signal is in the form of a serial stream of 'highs' and 'lows', representing white and black respectively. For a monitor, separate inputs are generally provided for the control signal and sync signal but in a TV set they must be combined (forming a 'composite video' signal) and modulated onto a UHF carrier. Inevitably the process of modulation and subsequent demodulation within the set causes a deterioration in the display quality when compared with a monitor, but it is a small price to pay.

Synchronisation signals for UK standard CRT displays have been drawn in **Figure 3: 3a** shows the horizontal or 'line' synchronisation signal, which is a negative going pulse of about 5uS duration repeated every 64uS. The negative transition of this pulse triggers the start of each horizontal sweep within the TV set. **Figure 3b** is the vertical or 'field' synchronisation signal, which also is a negative going pulse, but of 160uS duration (two and a half lines) and a period of 20mS (ie 50Hz scanning rate). The negative transition of this signal triggers the start of the TV set's vertical timebase circuit. As shown in **Figure 3c** the vertical and horizontal sync pulses are mixed together to form a combined sync signal. It is essential for picture stability that the horizontal sync pulses are still present during the vertical sync pulses, as the horizontal oscillator in the TV can easily drift out of synchronisation in two and a half lines. The horizontal sync is effectively superimposed onto the vertical sync by 'stretching' the horizontal sync pulses almost to the full length of a line, all but for the last 4uS or so, during the period of each vertical sync pulse; these are the so-called 'broad pulses'. Inside the TV, the sync separator circuit can identify each horizontal sync pulse by the negative transitions of the combined sync signal, even during vertical sync period. To extract the vertical sync itself, an RC integrator circuit having a time constant longer than the short horizontal sync pulses is used. This circuit does not give a trigger output for the ordinary horizontal sync pulses because, even during the broad pulses, it 'sees' only one long pulse of about two and a half lines width.

In a TV set it is normal to 'interlace' the rasters of alternative frames as shown in **Figure 1**. This means that the lines making up one-half of a complete picture (one 'field') fall exactly midway between the lines making up the other half of the picture (the previous 'field'), effectively doubling the number of lines of the raster. The purpose of this is to double the vertical picture resolution, showing 625 lines instead of 312, but without increasing the bandwidth of the picture signal. If all 625 lines were to be displayed sequentially in one frame while maintaining the same bandwidth (and hence line frequency), then the vertical scanning rate would have to be halved from 50Hz to 25Hz and the picture would flicker badly. Because of the tendency of the human eye to average the brightness of points (in this case, lines) that are close together, an interlaced scan of a frame appears to flicker much less than the same frame scanned fully sequentially. However interfacing is not often used with computer displays or, if it is, it should in any case be used with caution. The system works well with television pictures where object boundaries tend to be smooth transitions of grey — which is not the case with computer displays. The perception of flickering brightness varies from person to person and from picture tube to picture tube. Many people find CEEFAX and the BBC computer display (which can use interlacing) intolerably irritating. Monitors with long persistance phosphors are available specifically for interlaced displays, however, they had a a disadvantage that fast moving objects show a significant afterglow and so are not suitable for video games.

The synchronisation requirements of an interlaced raster as shown in **Figure 4 (a)** and **(b)**. In principle, interlacing is achieved by scanning 312½ lines in each field, as illustrated in **Figure 1b** (which shows only 11 lines/frame — 5½ lines/field — for simplicity). As you can see from the sync waveforms in **Figure 4**, there is another oddity included, called 'equalisation pulses'. It is difficult to describe the need for these pulses without explaining the sync separator and trigger circuits inside the TV; suffice to say that the horizontal sync pulses have some influence on the exact trigger point of the vertical oscillator (due to imperfect separation of the two types of sync pulse) and that the equalisation pulses ensure that horizontal sync events leading up to the vertical sync pulses are identical for even and odd fields. These equalisation pulses have no effect on the horizontal oscillator.

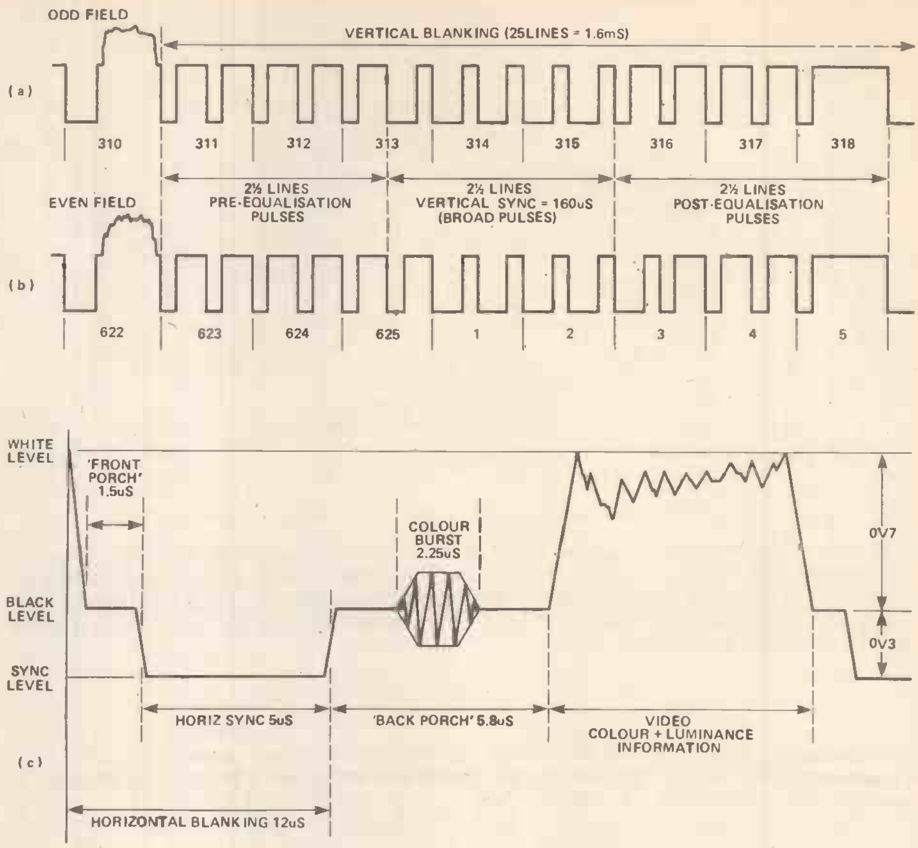


Figure 4. To maintain the stability of an interlaced scan, 'equilisation pulses' are inserted during the vertical blanking period. Diagram c shows, in simplified form, the waveform of a single line scan.

Colour It . . .

A colour cathode ray tube contains three electron guns which train on a matrix of red, green and blue phospher dots arranged in alternating sequence (red, green, blue, red, green, blue, etc.) across each horizontal line of the screen. A 'shadow mask' is placed immediately behind the screen, so designed that each electron beam may strike dots of one of the three colours only. A raster can be produced on a colour tube in the same way as for a monochrome (black and white) tube, ie using sawtooth current waveforms supplied to magnetic deflection coils and effecting all three beams equally. During the travel of the electron beams along the lines of the raster, signals applied to the individual control grids of the three guns will control both the colour and brightness of the picture at each point on the screen. The overall brightness of a spot is the sum of the brightness components of the three colours while the colour is determined by the relative proportion of each colour in the 'mix'.

Compared with a television receiver, colour monitors are relatively simple to drive; there are three inputs called R, G and B, which directly control the spot brightness of the picture in each colour and, of course, a sync input. In hardware terms it is a small step from providing one control signal for a monochrome monitor to provide three signals for a colour one, as we shall explain later.

When colour television was introduced it was thought desirable that black and white sets should also be able to receive the signal. This means that colour information must be added to the monochrome composite signal in such a way that a monochrome receiver will be unaffected by its presence. The method of encoding colour or 'chrominance' signals on TV broadcast transmissions (in the UK and most of Europe) is called PAL, standing for Phase Alternating Line, and the same method of encoding must be employed by a computer providing an interface to a colour television set.

A full description of the PAL system is beyond the scope of this article, because quite complex mathematics are required, however for interest we offer a brief qualitative description — those of you who wish to experiment with video circuits will be relieved to learn that commercial PAL encoder/modulators are available that accept a standard RGB input and give an output for direct connection to a TV!

Colour information in the PAL system is modulated onto a subcarrier at 4.44MHz. This frequency has been chosen because it is mid-way between two adjacent high order harmonics (integer multiples) of the TV horizontal frequency (15625Hz). Now the added signal falls within the bandwidth of the ordinary monochrome signal (6MHz) but, because of the chosen frequency of the subcarrier, it is possible to separate the subcarrier from the monochrome brightness or 'luminance' signal within the TV set with minimal interference (in fact, the Fourier components of the luminance signal interleave in the frequency plane with the Fourier components of the subcarrier — but this is a difficult concept without the necessary mathematical background

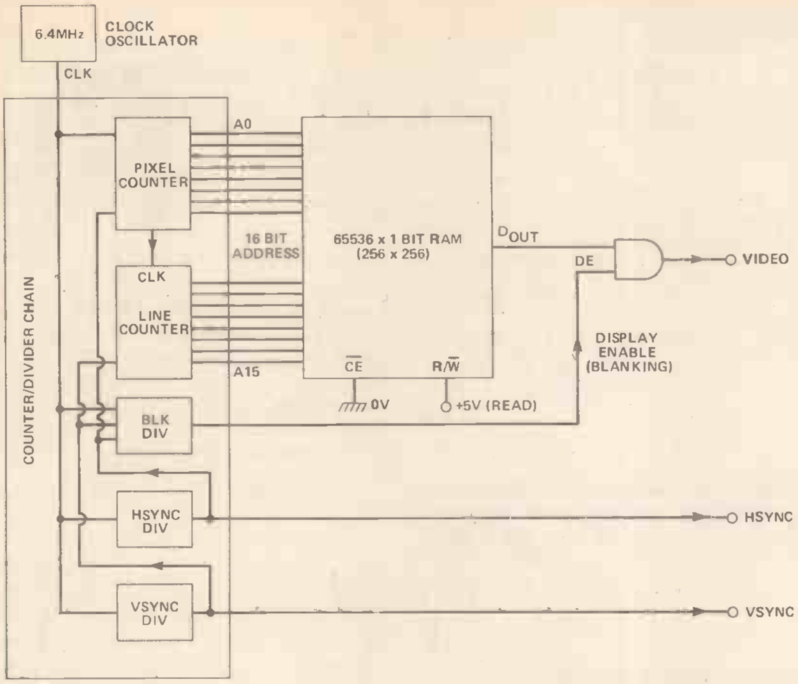


Figure 5. Block diagrams of a simple computer video display generator, which can read out 256 bits of information (each bit corresponding to a single picture element or 'pixel' per line,) for 256 lines.

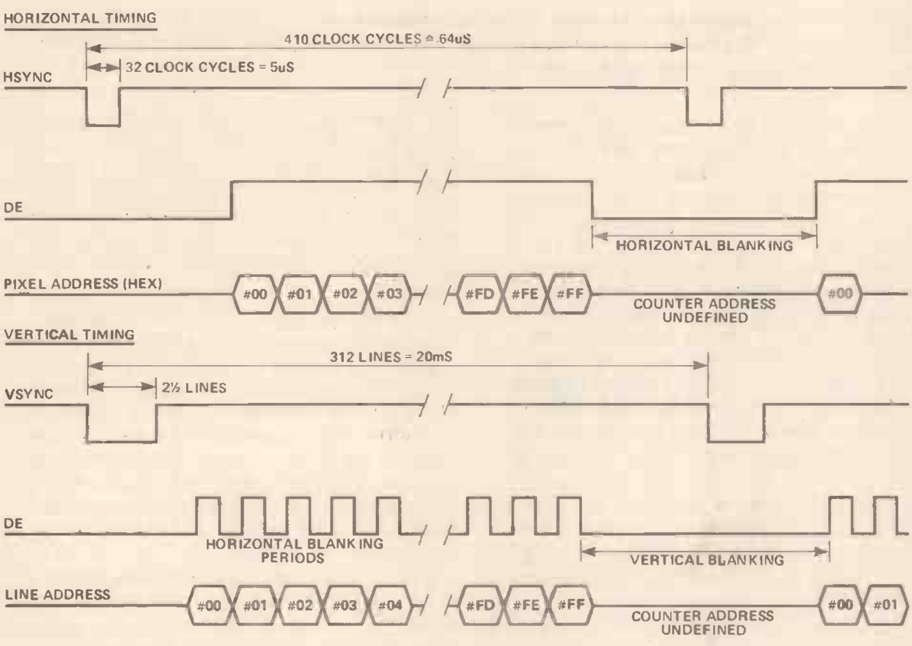


Figure 6. The waveforms which would be produced by the system shown in Figure 5.

and this the reason for a 4.43MHz subcarrier being chosen.

The colour information is 'phase-modulated' onto the subcarrier so as to allow two signals to be carried; these are 'colour difference' signals (R-Y) and (B-Y), where the Y is the luminance signal. The three signals of Y, R-Y, and B-Y are sufficient to reconstruct the R,G and B signals inside the receiver. The television set decodes the 'colour difference' information by comparing the phase of the modulated subcarrier with an internal 4.43MHz oscillator to separate the R-Y signal, and with a phase quadrature (90°) of the oscillator to extract the B-Y information. In order to establish a common phase reference between the transmitter and the TV receiver, a 'colour burst' signal of ten cycles of 4.43MHz is transmitted following the horizontal sync pulse, and is used by the TV receiver to lock its internal oscillator. The situation is further complicated by the fact that, every alternate line, the phase of the colour burst is inverted, together with the subcarrier phase. In so doing any errors in phase occurring during transmission through a "foggy" atmosphere, which will cause errors in the displayed colours to appear, will be in opposite senses on alternate lines; the human eye will average these colour errors and will see the correct colour. It is the lack of this refinement in the American NTSC system that has earned it the description 'Never Twice the Same Colour', for in areas of fringe reception in the US (ie, just about everywhere) colour TV pictures can be seen with the colours waxing and waning with the wind.

Compared with the price of a portable colour TV these days, a colour monitor (at £300-£400) seems poor value for money. This is misleading because the colour bandwidth of a TV (about 1-2MHz) results in a very much poorer picture, where computers are concerned, than with a colour monitor; if you look closely at the screen of a high resolution colour monitor you will see that the density of phosphor dots is generally a lot higher than on even the best colour TV set!

Generating Video

The block diagram of **Figure 5** is the basis of most computer video circuits. Any picture displayed on a CRT can be considered built up of a number of pixels (picture elements) in a rectangular array; say for example, 256 pixels per line and 256 lines (of a possible 312 non-interlaced). In the case of a computer display, each pixel is either off (black) or on (white) and thus may be represented in the computer by a single logic level (or one bit of data). To represent a picture of 256 pixels by 256 lines a memory of 65536 x 1 bit capacity is required. In **Figure 5** a random access memory (RAM) is used to 'store' a frame of display data. Now in order to produce a signal that can be presented to a monitor video input and so generate a display, it is necessary to read, in sequence, the entire contents of the RAM for each frame at a rate of 256 pixels/40uS, for each line.

All the necessary timing signals for our video generator are produced by a chain of counters and dividers (and supporting logic) clocked by a common 6.4MHz oscillator (preferably crystal controlled) **Figure 6** shows the signals that are generated, and these repeat over the period of one non-interlaced frame. The video RAM is cyclically accessed by an 8-bit pixel address counter and an 8-bit line address counter, which sequence through all 65536 addresses every frame. Obviously the counters (shown as blocks) are quite complex, in that they are required to start counting after a

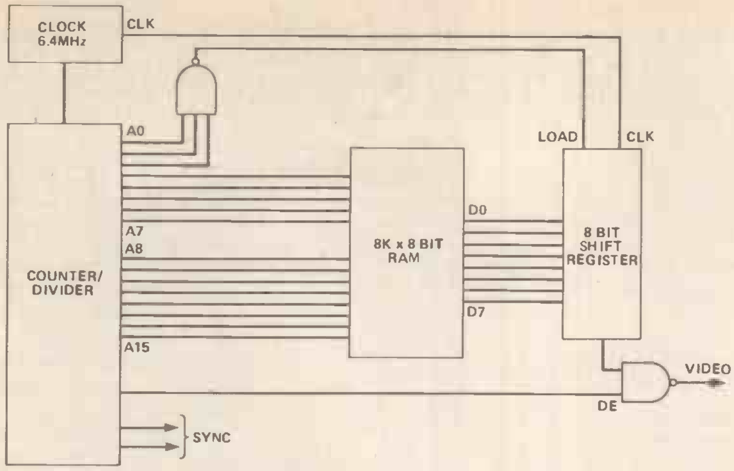


Figure 7. The system adapted for use with byte-wide (8 bits wide) RAM; the three low-order address bits A0-A2 are used to LOAD the shift register every eighth clock cycle with a byte addressed by the remaining 13 addresses bits. Because the address bits A3-A7 can address 32 bytes, the display remains 32 x 8 = 256 bits wide.

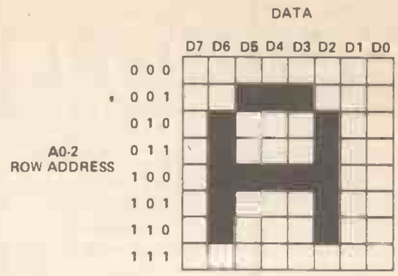


Figure 9. The pixel information in ROM representing the character 'A' (a pixel or picture element is the smallest element that can be displayed and is essentially limited by the highest frequency that the display generator or television can handle).

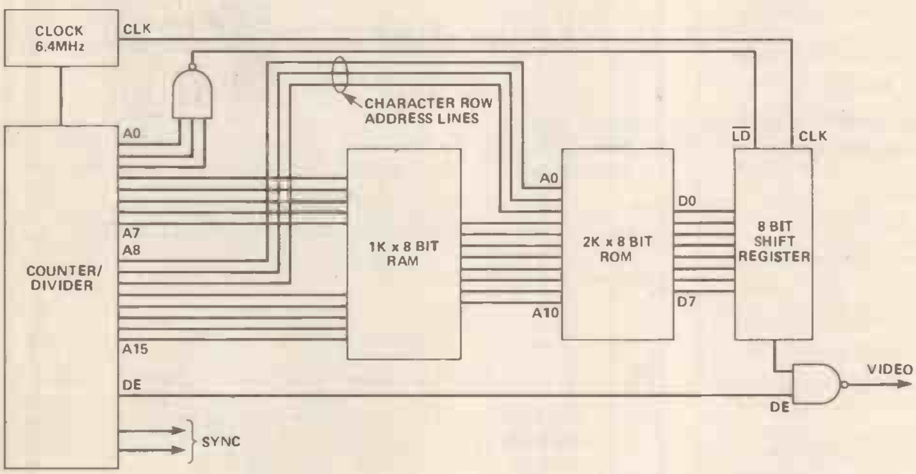


Figure 8. Using a character-generator ROM reduces the dynamic memory size, but makes the circuit more complicated. Briefly, the RAM is first loaded with 1024 (32 x 32) characters which will form a 32-character by 32-line display. The RAM sequentially decodes address lines A3-A7 and A11-A15 to select the character to be displayed; address lines A8-A10 select in turn each of the eight rows of pixel information for the characters (selected in turn by A3-A7) to be displayed on a particular line (selected in turn by A11-A15). Lines A0-A2 are again used to LOAD the shift register with pixel data once every eight clock cycles. The display is still 256 x 256 pixels!

period of blanking (flyback) and to stop at the end of the display period of each line (in the case of the pixel counter) or of each frame, (for the line counter), and are triggered by the blanking and sync signals which themselves have been divided down from the clock frequency. Nevertheless, each block in the counter chain can be made from two or three TTL chips, (as will be seen in our project). Notice that the output stream of data is gated with the DE (Display Enable) signal to ensure a black level during blanking; This gives a black border around the picture display and is also used, in some TV sets, as a black level reference.

Most memory devices are organised as 8 bits by so many words, to ease their use with 8-bit microprocessors. Figure 7 shows how our black system can be modified to accommodate these devices. This change is also beneficial when we come to describe how data is written into the video RAM by the microcomputer. Basically, the RAM is addressed, as before, by the high order 13 bits of the 16-bit pixel/line counter, while the low order three bits of the counter are used to load the output of the byte-wide RAM into an 8-bit shift register on every eighth cycle of the clock. During the other seven cycles the data in the shift register is clocked to the video output sequence. This is an alternative to the more obvious solution of multiplexing the RAM outputs onto the video output with an 8-1 line multiplexer addressed by AC-A2; the advantage of the shift register is that, once the data is latched in it does not matter if the outputs of the RAM change. This becomes important when the RAM is shared with a microprocessor (again more of this next month).

In computing displays that require only a fixed set of characters (alphanumerics) to be displayed it is possible to make a large saving on the size of the RAM required. Figure 8 contains a 2K 8-bit 'character generator' ROM which contains data describing (pixel by pixel) up to 256 characters, each of 8 pixels by 8 lines (see Figure 9 for the character 'A'). In addition there is a IK 8-bit RAM which can store 1204 character codes for a display of 32 characters of 32 lines. The data outputs of the RAM address the character ROM, thereby selecting the appropriate character.

For each raster line, addresses A3-A7 select in sequence the character codes of the 32 character line specified by A11-A15 (32 lines). This repeats over eight lines for each character row as the address lines A8-A10 select each of the eight rows of the characters stored in the ROM. This is difficult for some people to visualise. If you imagine the addresses A0-A15 going through a straight binary sequence you should be able to work out what, in terms of character codes in the RAM and character data in the ROM, will appear on the video output stream.

HE

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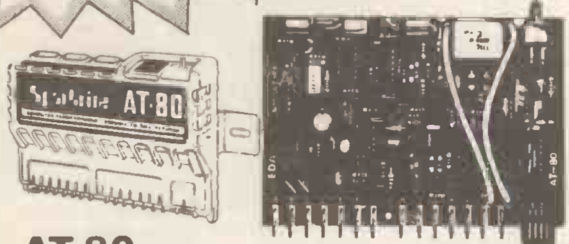

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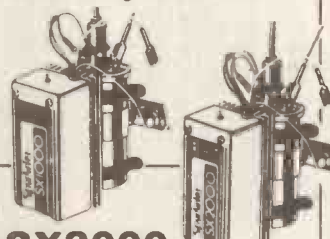

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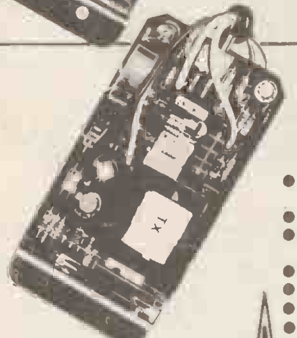

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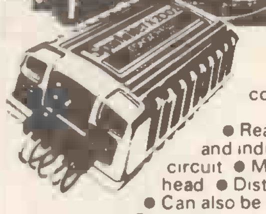

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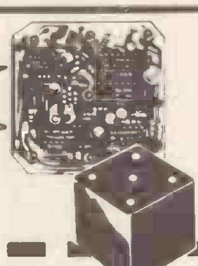

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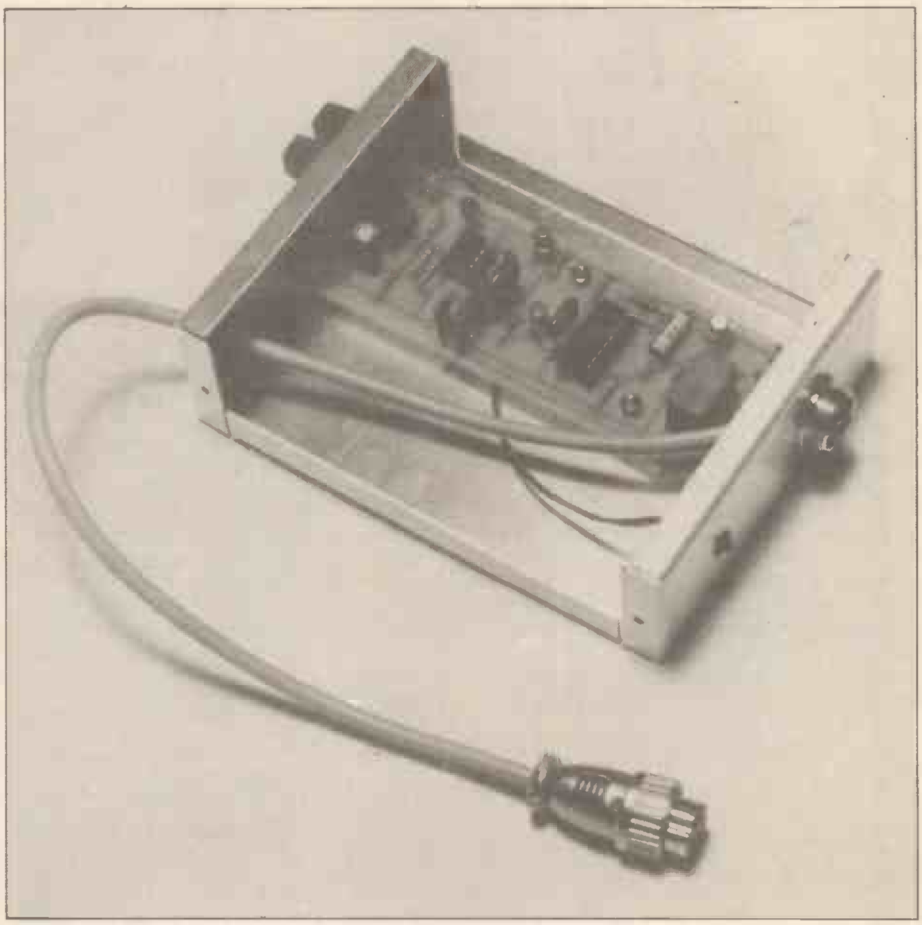
The second function is an automatic return to the receive mode after about 36 seconds. This is included as a fail-safe system to ensure that the equipment cannot be accidentally left transmitting, blocking a channel for a long period of time. If you should accidentally leave the unit in the transmit mode it will simply revert to receive after 36 seconds and prevent the channel from being blocked for any longer than that. It also discourages long uninterrupted transmissions which tend to be unpopular with other CB users! A LED indicator switches on about ten seconds or so *before* the unit automatically reverts to the receive mode so that the user has reasonable warning before the transmission is cut off. Of course, once the unit has automatically returned to receive it is simply necessary to push the PTT switch again in order to return to transmit.

PTT Switching

The microphone PTT switching and latching action circuits are shown in **Figure 1**. The PTT switch is usually a double pole changeover type, with the centre tag of one pole connected to earth. The switch is biased to the receive position by a simple spring mechanism, and this produces a short circuit from the NC (normally closed) tag to earth. This is used to provide the path to earth for the loudspeaker and, more importantly, to disconnect the loudspeaker when the switch is placed in the transmit position. This is because there is often a significant level of breakthrough from the microphone to the loudspeaker, and if the loudspeaker was to be left connected it would result in acoustic feedback and could even cause oscillation. The short circuit that is produced from the NO (normally open) tag to earth when the switch is set to transmit is used to operate the transmit/receive switching within the rig. This can be performed using a relay, but in most modern rigs purely electronic transmit/receive switching is used.

The other pole of the PTT switch is used to disconnect the microphone when set to the receive mode. While this may seem pointless it must be remembered that the transmit/receive



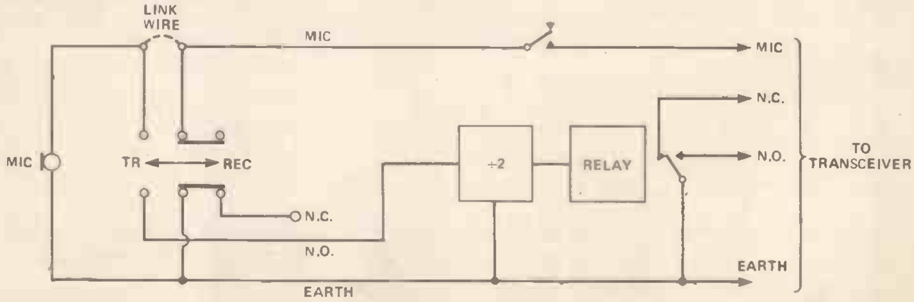


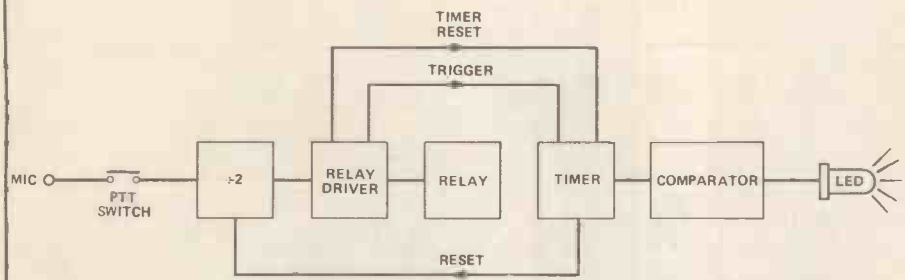
Figure 1. Switching and latching circuits: note the link wire.

How It Works

THE PTT switch is not used to directly control the transmit/receive switching, but is instead used to control a relay and the relay contacts then control the rig. A divide-by-two flip-flop circuit is used between the PTT switch and the relay driver; the output of this changes state each time the PTT switch is operated. If the output of the flip-flop is initially low (the relay is switched off), operating the PTT switch sends the output of the flip-flop high and switches on the relay. This takes the rig from the receive mode to transmit. Operating the PTT switch again sends the output of the flip-flop low, so that the relay switches off and the rig is set back to the receive mode. Another operation of the PTT switch sets the rig to the transmit mode again, and so on, so that only a brief operation of the PTT switch is needed to switch modes.

A simple timer circuit is triggered each time the relay is switched on and the rig is placed in the transmit mode. If the relay switches off before the end of the output pulse from the timer, a reset pulse is sent from the relay driver to the timer circuit. This pulse ensures that when the timer is triggered again it commences a fresh timing run and gives a full length output pulse. However, if the pulse from the timer finishes first, the flip-flop is reset and the rig is returned to the receive mode.

A voltage comparator monitors the voltage on the timing capacitor in the timer circuit, and when this reaches a certain threshold level (which occurs about ten or fifteen seconds before the pulse from the timer ceases) the comparator switches on a LED indicator.



switching within the rig will operate very rapidly but not instantly. The result could be a short burst of oscillation, due to acoustic feedback, when releasing the PTT switch since the loudspeaker would be instantly reconnected while the rig would take a moment longer to go to the receive mode. In practice this would be unlikely to happen unless the microphone and the loudspeaker were in very close proximity to one another, but the PTT switch ensures that it *cannot* occur, as it will only connect the microphone or the loudspeaker to the rig, and not both at once.

The latching action of the unit is obtained using a simple divide by two flip-flop circuit which drives a relay. The PTT switch provides a short circuit to earth each time it is operated, and this is used to clock the divide by two circuit and change the state of the relay. The latter has a pair of changeover contacts which are used in place of the PTT switch.

Note that the PTT switch must have a link wire added, as shown in **Figure 1**. If this is not done, the microphone would be disconnected by the PTT switch when it was released, and the microphone signal would not be coupled through to the rig.

The Circuit

The full circuit diagram of the Rap Latch unit is shown in **Figure 2**.

The divide by two circuit is a CMOS 4020BE device (IC1): it is actually a 14-stage binary counter but only the first stage is used here. Although it may seem wasteful to leave more than 90% of the device unused, where a single, simple flip-flop is needed there is not much choice. The 4020BE is not an expensive device anyway, and in this application it is ideal because it has a Schmitt trigger input and, together with R1 to R3 plus C1, this eliminates problems of multiple operation due to contact bounce in the PTT switch. The 4020BE is clocked on the negative edge of the input signal and the PTT switch is therefore used to generate a negative going signal when it is operated so that IC1 is clocked immediately, rather than as the PTT switch is released. R4 and C2 provide a reset pulse for IC1 at switch-on, so that the circuit starts with the relay switched off and the CB rig in the receive mode. Common emitter transistor Q1 is used as the relay driver.

The timer circuit is a standard 555 monostable (IC2), and C4 couples a brief trigger pulse to this as the relay switches on. Pin 4 is the reset terminal of IC2 and this is taken high by R8 so that the timer operates normally. However if the relay switches off before the end of the timing period, C3 couples a positive pulse to the base of Q3, and this device momentarily pulls pin 4 of IC2 low so that the monostable is reset and will start a new timing run when it is triggered again.

If the output pulse of IC2 is allowed to reach a natural conclusion, a negative pulse is coupled to the base of Q2 by C5, and this results in Q2 briefly switching on. This gives a reset pulse to IC1 so that the relay is switched off and the rig is

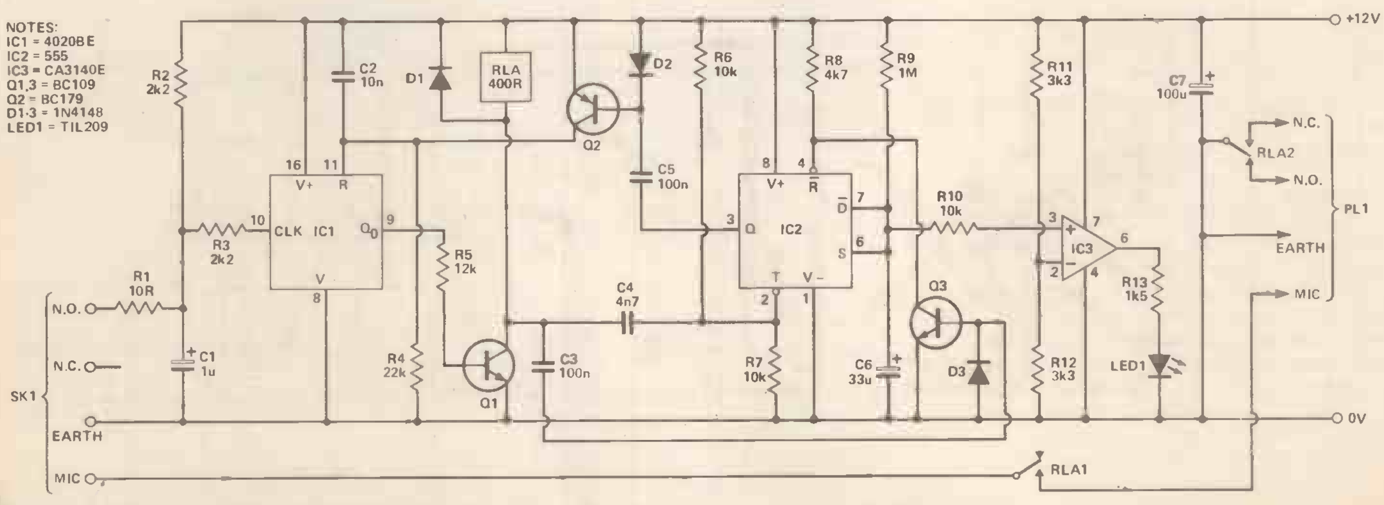


Figure 2. The entire Rap Latch circuit.

automatically returned to the receive mode.

IC1 is the voltage comparator, and this has a reference voltage of about half the supply potential set at its inverting input by R11 and R12. R10 couples the non-inverting input to C6, the timing capacitor for IC2, and the potential on this capacitor will normally be less than half the supply voltage. This gives a low output from IC3 and LED 1 is not switched on.

If the charge on C6 is allowed to go beyond 50% of the supply potential, though, the non-inverting input of IC3 is taken to a higher voltage than the inverting input, IC3's output goes high, and LED4 switches on. The output pulse from IC2 does not end until the charge potential on C6 has reached two thirds of the supply voltage, and LED1 is therefore switched on several seconds before the pulse from IC2 ends.

Note that IC3 is a MOSFET input device which draws no significant current from the timer circuit and does not have any detrimental effect on it. Due to the high value timing resistor (that must be used to give the fairly long pulse length from IC2), it is essential to use a good quality component for C6; for this reason a tantalum capacitor is specified. The switch-off time provided by IC2 can be changed if desired, and the time in seconds is nominally 1.1 x R9 x C6, where R is in ohms and C is in microfarads.

Parts List

RESISTORS
(All ¼ watt 5% carbon)

R1	10R
R2,3	2k2
R4	22k
R5	12k
R6,7,10	10k
R8	4k7
R9	1M
R11,12	3k3
R13	1k5

CAPACITORS

C1	1u 63V axial electrolytic
C2	10n polyester
C3,5	100n polyester
C4	4n7 mylar
C6	33u 10V tantalum
C7	100u 16V radial electrolytic

SEMICONDUCTORS

IC1	4020BE 14-stage ripple counter
IC2	555 timer
IC3	CA3140E MOS op-amp
Q1,3	BC109 NPN
Q2	BC179 PNP
D1,2,3	1N4148 silicon diode
LED4	TIL209 3mm red LED

MISCELLANEOUS

RLA .... 400R 12V relay DPDT contacts, min. PC-mounting
SK1/PL1 .... 4-way locking audio connectors
Four-way screened cable; case; PCB; wire, solder etc.

BUYLINES .... **page 34**

Construction

Details of the printed circuit board are provided in **Figure 3**. IC1 is a CMOS device and IC3 has a PMOS input stage, so these both require the usual MOS handling precautions. Fit them in IC sockets (sixteen pin for IC1 and eight pin for IC3), handling them as little as possible, and do not fit them until the unit is complete in all other respects.

Provided the specified relay is used, this will fit directly onto the printed circuit board. It is possible to use any relay having a 12 volt operating coil with a resistance of about 300 ohms or more, provided it has at least two sets of changeover contacts, but if a relay other than the specified type is used it may be necessary to extensively redesign the printed circuit layout, or mount the relay off-board.

An aluminium box measuring 102mm wide by 133mm deep by 38mm high makes an inexpensive but practical housing for this project. If an alternative case is used it is advisable to choose a metal type so that any exposed microphone lead is screened by the case. A somewhat narrower case could be used, but the depth and height dimensions given above represent just about the minimum usable figures.

A LED indicator, LED1, is mounted on the front panel in the normal plastic panel clip, and SK1 is mounted to the right of this (as shown in the photographs). SK1 will probably need to be a four-way locking audio connector, but a few rigs use a DIN microphone connector and, if necessary, SK1 must be altered accordingly. PL1 is a matching plug for SK1, and this connects to the printed circuit board via a four-core screened cable. The earth connection is carried by the outer braiding of the cable plus one of the inner conductors. This leaves three inner conductors to take the remaining connections.

Wiring SK1 and PL1 to the unit correctly represents the only awkward aspect of construction, and the circuit diagram of the transceiver should include details of the connections between the microphone insert, PTT switch, and microphone plug. Reference to this, plus **Figures 1** and **3** of this article should make the correct method of connection clear. If a circuit diagram of the transceiver is

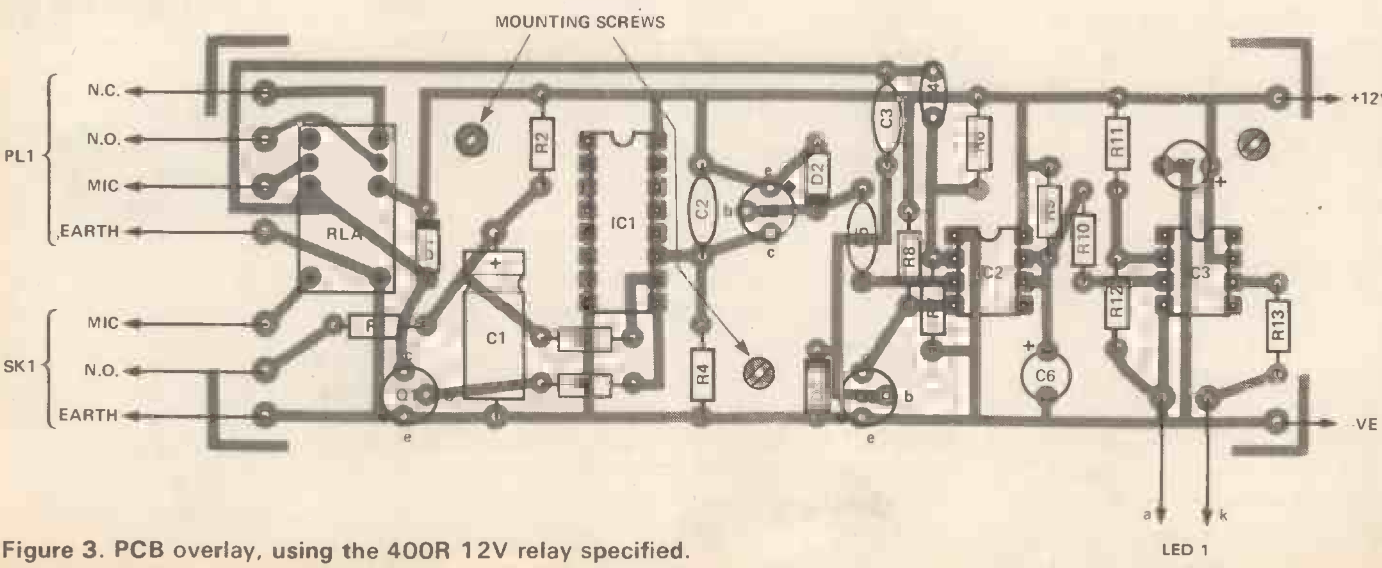
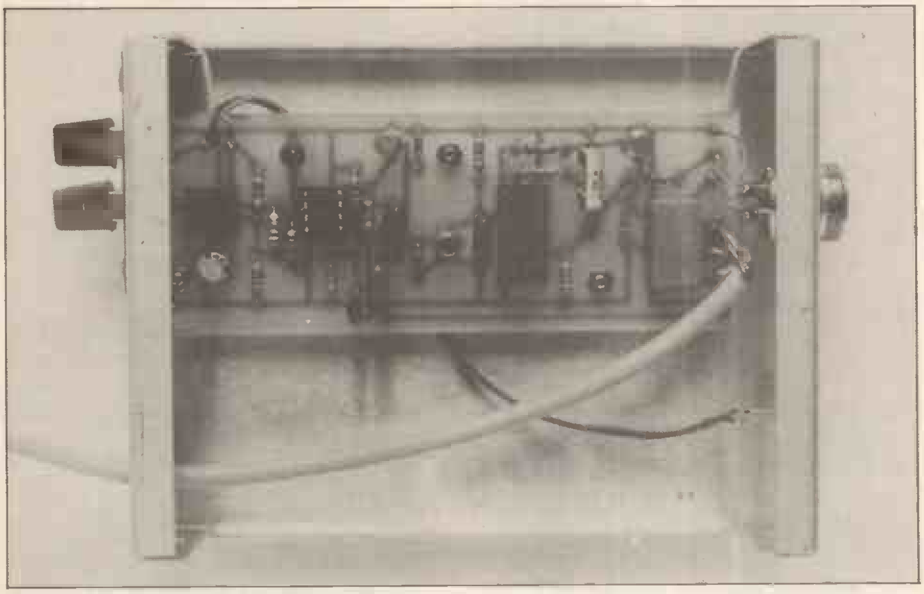


Figure 3. PCB overlay, using the 400R 12V relay specified.

not available it should be possible to deduce the correct method of connection by opening the microphone and output plug and examining the wiring. It would be sensible not to attempt this project unless or until you are confident that SK1 and PL1 can be connected correctly for your rig!

An exit hole for the output lead is drilled in the rear panel of the unit and this should be fitted with a grommet. A two way terminal strip is also fitted on the rear panel, providing a convenient way of connecting the unit to a 12 volt power source (which can be either a car battery or a CB mains-powered supply).



Inside the Rap Latch.

As explained earlier, a link wire must be added to the PTT switch to prevent the microphone from being disconnected when the switch is released. With most PTT microphones, it is possible to gain access to the switch by removing three screws at the rear and then carefully removing the unit; microphones of this type are readily available, if your rig was supplied with a less accomodating type! There should only be two leads connecting to one pole of the switch — one coming from the microphone insert and the other being part of the microphone lead. The link wire is soldered across the two tags to which these leads connect, but make sure that you do not accidentally desolder one of the leads.

Testing

Connect the unit to the 12 volt DC power source, being careful to get the supply polarity right. With the microphone connected to SK1 the relay should switch on or off (as appropriate) each time the PTT switch is operated. If the relay if left switched on, after about 20 to 25 seconds LED1 should switch on, and after a further ten to fifteen seconds both LED1 and the relay should switch off. Once the unit is functioning correctly it can be connected to the rig (ie, connect PL1 to the microphone socket of the rig) for an on-air test.

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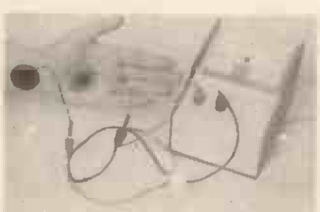

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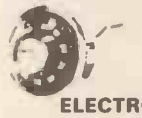

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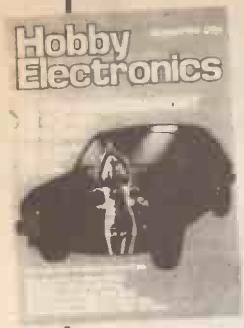

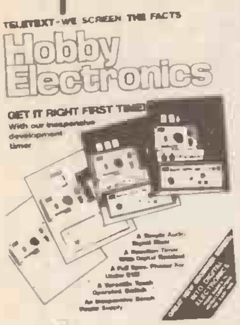

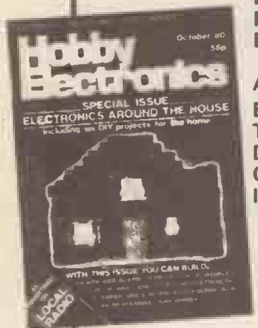

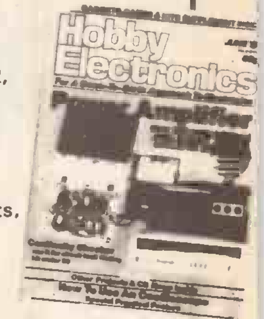

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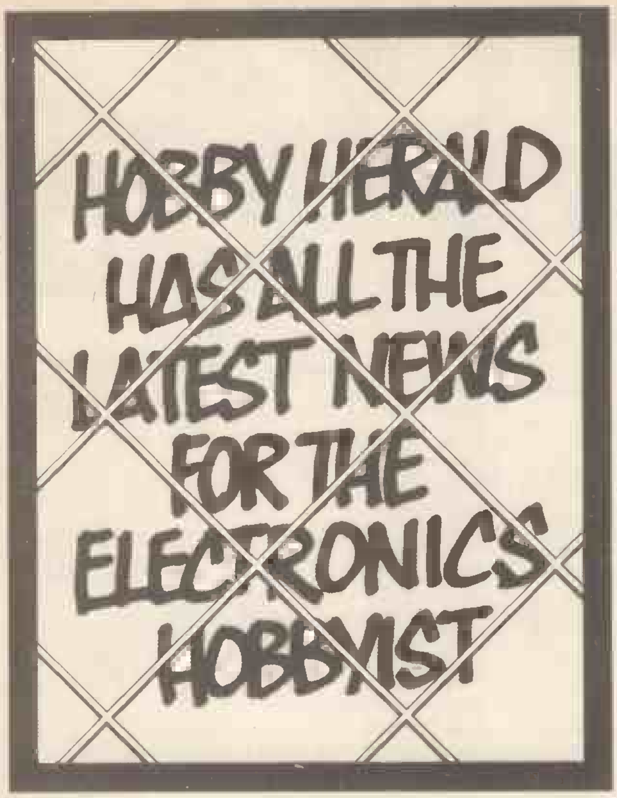

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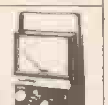

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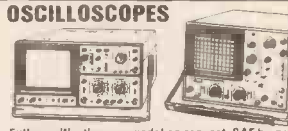

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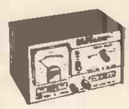

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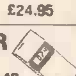

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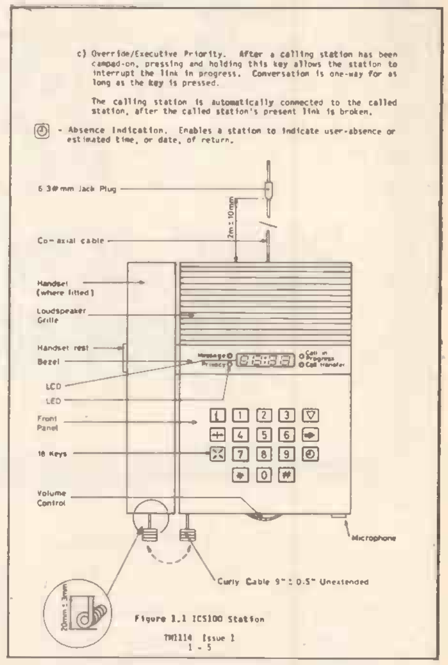
CAREERS IN ELECTRONICS '83

Brian Donaldson

If you are looking to the future with an eye towards a career in electronics, you could do worse than checking out the lot of the technical writer. Theirs is the sort of career which would interest people who care about their work, who would enjoy writing and who like plenty of variation.


c) Override/Executive Priority. After a calling station has been camped-on, pressing and holding this key allows the station to interrupt the link in progress. Conversation is one-way for as long as the key is pressed.

The calling station is automatically connected to the called station, after the called station's present link is broken.

- Absence Indication. Enables a station to indicate user-absence or estimated time, or date, of return.

Figure 1.1 ICS100 Station

TM1114 Issue 1
1 - 5

A page from the technical manual for Multitone Electronics' ICS 100 Internal Communications System. The technical author not only writes the text but also prepares the drawings.

ESSENTIALLY, there are two directions a technical writer can take his communicative talent — into technical journalism or technical authorship. Each direction demands a different approach, and each requires a different writing style (see later examples) but, even so, many similarities exist between the two careers, allowing the possibility of moving from one to the other. I suppose I am a good example of such an exchange. My initial background in writing was technical journalism but, after a number of years, I decided a change was a good idea and so moved to technical authorship. Now, incidentally, I do neither for a living, but it's like riding a bike — once the skills have been learned they will never be forgotten. And writing *is* a skill. Don't let anyone tell you it's an art which cannot be learned because that is just not so!

The Same But Different

Both technical author and technical journalist are concerned primarily with the reader. The author's reader will probably (though not always) be an engineer or technician: often the service engineer who repairs faulty equipment belonging to a customer. Speed of repair is the most important factor to him — the sooner the equipment is working again, the sooner the customer is happy! Readers of a journalist's work, however, will probably be members of the public, and this pin-points the main difference between the author and the journalist: the author has a captive audience — his reader will read because he *needs* to know specific information. The journalist's reader will *only* read if he is interested. So, the writing style must differ to cater for the different readers.

The author must be concise: his work must be purely factual and written in as logical and clear a manner as possible.

Getting In Touch

The two writers' professional organisations, the NUJ and ISTC, will be able to provide information about relevent training courses. Their respective addresses are:

NUJ, Acorn House, 314-320 Gray's Inn Road, London, WC1X 8DP.

ISTC, 17 Bluebridge Avenue, Brookmans Park, Hatfield, Herts. AL9 7RY.

In comparison, a journalist's work may be quite 'loose' and not so strict regarding, say, grammatical construction or formality. This is because the journalist's reader has time to re-read an article if it wasn't fully understood on first reading. Personal feelings may be displayed by the journalist but this would be frowned upon if shown by the author, because the author's reader needs to understand straight away the important points and not be bothered by trivia not directly concerning him.

Illustration is often best by example so I'm going to write two brief paragraphs now, which show the difference between the writing styles of the journalist and the author. Both paragraphs describe the same thing — a TV — and cover the same aspects, but in them the different writing styles (exaggerated for the purpose) are apparent.

How a journalist might write about the TV:
The latest offering from the Itchitoesanfeet Company of Japan is the K3026, new 26 inch colour TV with advanced microprocessor-controlled circuitry to improve picture quality. Capable of receiving up to 12 different, preselected English TV channels, the set can also be adapted for use worldwide. This TV is the first of a completely new range of 5 screen sizes to be introduced by Itchitoesanfeet. The range will extend down to a 12 inch portable TV and all TVs will feature similar picture quality improvments as in the K3026.

How the author might write about the TV:
A new receiver chassis has been released: the K30. The chassis is used with a range of colour tubes of: 26 inch; 22 inch; 18 inch; 14 inch; 12 inch sizes to give identical electrical features to all television receivers in the K30 range.

Features include:
- plug-in PCB option to select picture format (PAL, SECAM, NTSC)
- preselect tuning of 12 reception frequencies in the range 40 to 860MHz.

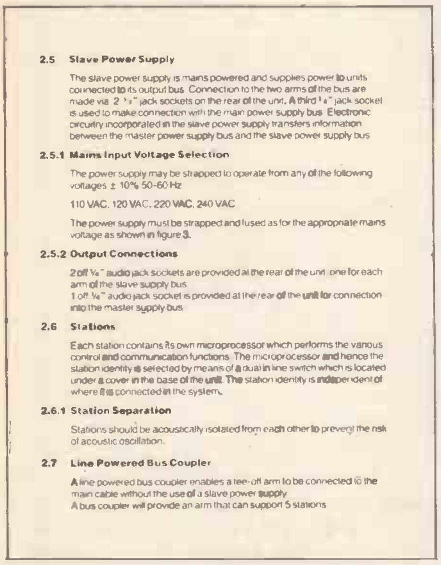
First television to be marketed from this range is the K3026.

You'll see, I hope, that both examples say more or less the same thing but in very different ways!

Qualifications

Any kind of technical writing, combining as it must an understanding of electronics at some level with the ability to write sensibly and with clarity, is a kind of a hybrid craft for which there is very little specific formal training of

The conclusion of the technical author's labours: a service engineer slaving over a hot soldering iron, the technical manual by his elbow.



2.5 Slave Power Supply

The slave power supply is mains powered and supplies power to units connected to its output bus. Connection to the two arms of the bus are made via 2 ¼" jack sockets on the rear of the unit. A third ¼" jack socket is used to make connection with the main power supply bus. Electronic circuitry incorporated in the slave power supply transfers information between the master power supply bus and the slave power supply bus.

2.5.1 Mains Input Voltage Selection

The power supply may be strapped to operate from any of the following voltages ± 10% 50-60 Hz

110 VAC, 120 VAC, 220 VAC, 240 VAC

The power supply must be strapped and fused as for the appropriate mains voltage as shown in figure 3.

2.5.2 Output Connections

2 off ¼" audio jack sockets are provided at the rear of the unit, one for each arm of the slave supply bus.
1 off ¼" audio jack socket is provided at the rear of the unit for connection into the master supply bus.

2.6 Stations

Each station contains its own microprocessor which performs the various control and communication functions. The microprocessor and hence the station identity is selected by means of a dual in line switch which is located under a cover in the base of the unit. The station identity is independent of where it is connected in the system.

2.6.1 Station Separation

Stations should be acoustically isolated from each other to prevent the risk of acoustic oscillation.

2.7 Line Powered Bus Coupler

A line powered bus coupler enables a tee-off arm to be connected to the main cable without the use of a slave power supply.
A bus coupler will provide an arm that can support 5 stations.

Tasks for the technical author also include writing and preparing other documents such as the installation manual (above), user instruction books and even sales literature.

benefit to the prospective candidate.

Yet, technical authors, who are required to be more precise, generally need a greater depth of understanding and usually come to their trade from a diploma or degree level course in electronics. For such as these, courses are sometimes provided by universities or polytechnics at post-degree level, which offer short but intensive training in the discipline of writing. Such courses force-feed the graduate with enough information to allow a jump straight into either journalism or authorship; this jump can take place at a reasonably high level!

On the other hand, recruitment advertising seeking technical journalists will rarely specify a formal electronics background — though obviously some knowledge of the subject is necessary! Of more importance in technical journalism is enthusiasm, the ability to work with other people, good humour under pressure (the corridors ring with laughter — Ed.) and the capacity to learn at all times.

At this end of the scale, 'A'-level or even 'O'-level students may be fortunate enough to be employed as a junior assistant; such vacancies often

The technical journalist at work: Steve Ramsahadeo, former project development editor of ETI, makes sure the project works before writing the text.

occur and many good writers have entered journalism or authorship this way. There' nothing quite like experience and, it may reasonably be argued, three years of learning how to do the job, while actually sitting at the desk and doing it, will make a more able writer than any degree will. In the end, it all depends on the individual and making the best of an opportunity.

All good employers realise the importance of, and benefits gained by providing, an in-service training scheme of some description for their employees. Some universities, polytechnics and a number of specialist companies can help with such a scheme. All writers — graduates, non-graduates, old, young, experienced, inexperienced alike will, because of this in-service training, be able to give greater service to the employer afterwards.

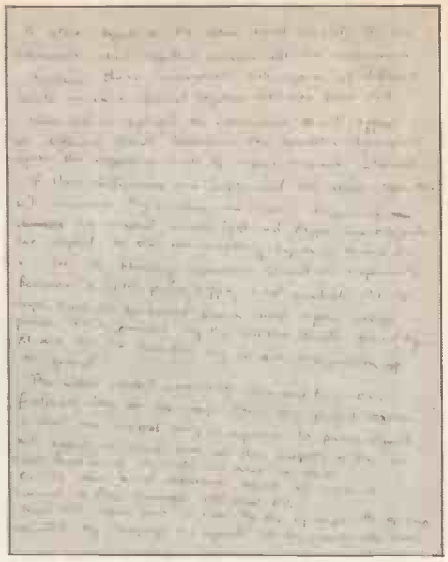
Union Dos

Whatever your career, it is always a good idea to join a professional authoritative body. The main journalists' organisation is the National Union of Journalists (NUJ) which, although officially a union, also provides information, news and views of current affairs involving journalists of all kinds. No member is under pressure to take an active rôle in the life of the union but, also, no member is prevented from doing so.

The technical authors' main professional body is the Institute of Scientific and Technical Communicators (ISTC), which provides a similar service as the NUJ in that news, information, details of courses and lectures of interest are regularly circulated to members.

The Job Itself

The title 'technical writer' is slightly misleading, actually, since neither journalist nor author spends the whole day writing: putting pen to paper can only be attempted after an amount of research into the topic has been



Technical journalism also requires working with other writer's text. Often this means transcribing hand-written copy, editing it into the prescribed style for the magazine as it is re-typed.

undertaken. The writer must thoroughly understand the subject in order that his words convey the correct and full meaning to the reader because, if the writer doesn't know what he's writing about, how can the reader understand? At best the reader will not grasp the meaning, at worst he will be confused! So the first thing the writer has to do in his work is to study closely and carefully the topic he is going to write about.

The second thing is to think about is: who is the reader? How much does he already know about the subject? It is necessary to decide and define the reader at this early stage, before the writer begins an article or book.

When finally the article, manual, report, pamphlet, or whatever has been written, it must undergo a number of stages of close scrutiny in an attempt to remove all errors: in grammar, spelling, typing, accuracy etc. Often, in these stages, other people are involved, working as a team to produce the final printed work. Inevitably, errors will creep in at any or all of these stages, possibly making their way to the printed page, but a small team of, three people say, with experience, good management and just a little bit of luck, will be able to eliminate the majority.

I hope, in this limited space, I have been able to give an idea of the work of a technical writer, whether a journalist or an author. Both careers can be interesting and rewarding, and can give a high level of job-satisfaction. If you are interested in pursuing either career, your first stop is your local Careers Office; they'll be pleased to help and advise regarding suitability and be able to suggest methods of entering the profession. The rest is up to you!

Our thanks to Multitone Electronics P.L.C., 6-28 Underwood Street, London N1, who kindly supplied the technical manuals illustrating this article.

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NEXT MONTH

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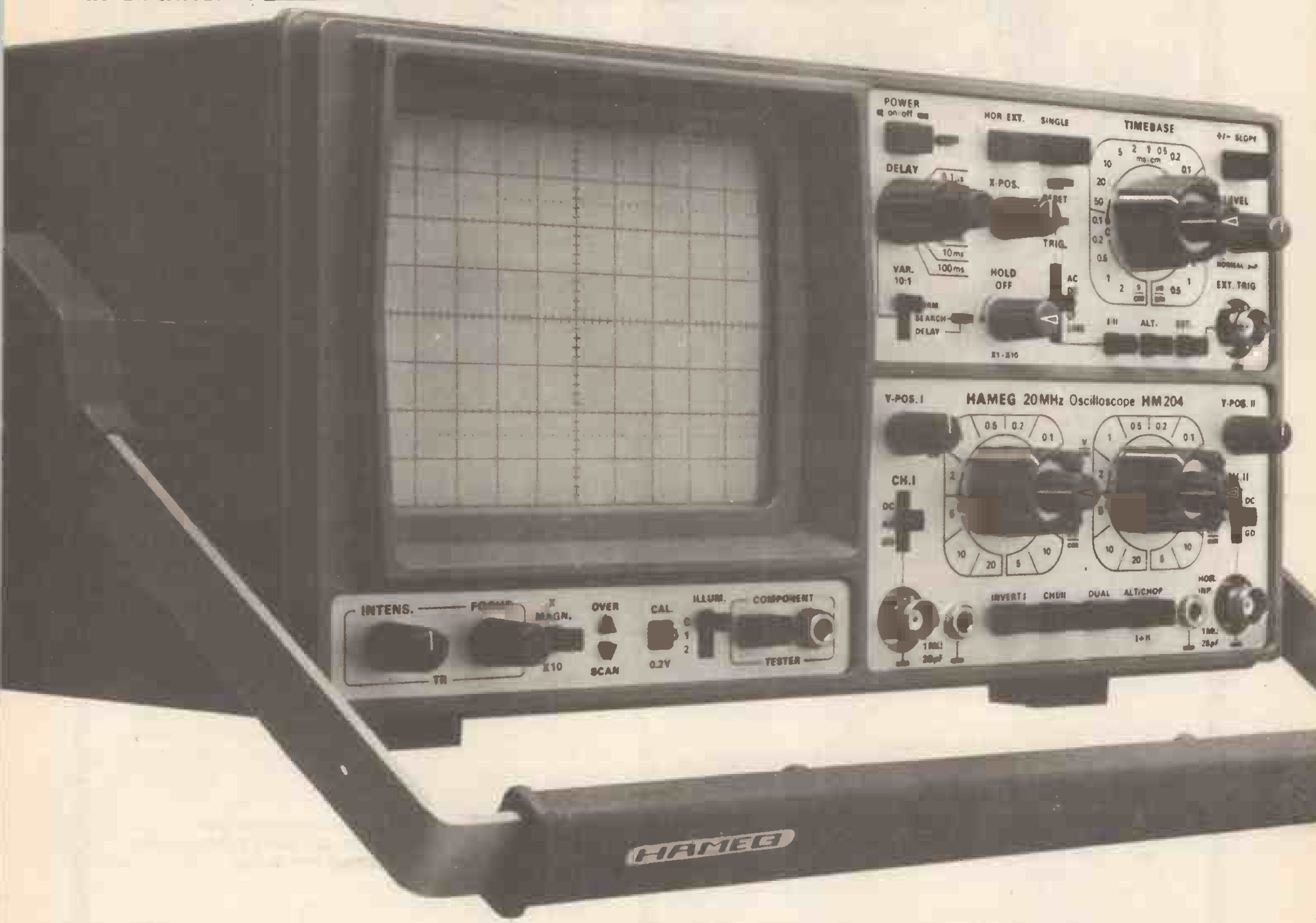


Portable Induction Loop

Following the degree of interest that our feature on Induction Loops aroused, Vivian Capel has designed a practical system. Now there's no excuse for the hard-of-hearing to be left out of things anymore.

Tech Tips Special

Eight pages of ingenious, novel, and money-saving designs from one of the country's largest design teams — yourselves.

Microcomputer Output Driver

Don't let your micro just sit there, contentedly passing information back and forth inside itself — get it busy working for *you*, with this 16-channel output driver.

TV Storage Scope

This little unit will enable you to utilise your TV screen to display oscilloscope waveforms. It's always seemed illogical that you have to use two CRTs for different jobs, hasn't it — now you can use just the one. Not only that, but the unit will store waveforms too, all for under £100.

Oscilloscope Survey

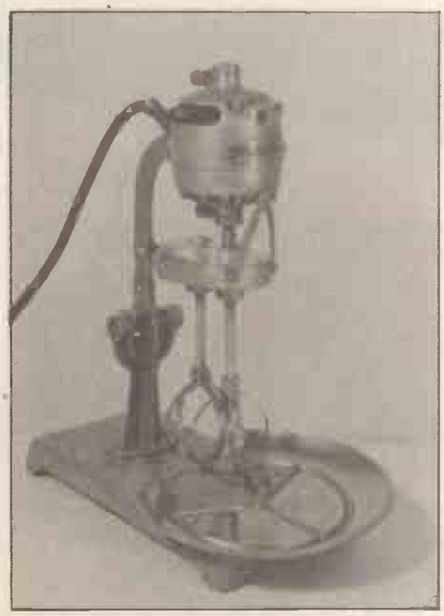
Just in case you're too lazy to build the TV Scope, we're taking a look at the options open if you want to buy one. And if you're too poor to afford a new scope, we'll be examining the state of the second-hand market too. If you're on the look-out for test equipment, don't miss the July issue of ETI.

LOOK OUT FOR THE JULY ISSUE ON SALE JUNE 3rd

Articles described here are in an advanced state of preparation. However, circumstances may dictate changes to the final contents.

THE ELECTRONIC REVOLUTION: POWER IN THE HOUSE

In the last of the series, we scan the least celebrated but most ubiquitous aspect of electricity. Without household gadgets, not many people would have the time to experiment with micros or relax with the video. Nor are we just talking about the ladies — you could have been chopping the wood or salting a side of pork. What a difference a plug makes . . .



Getting back to the basics: an early electric eggbeater, c. 1920; with no handle and precious little insulation, it was definitely not intended for portable use!

John Biggins

Over the past hundred and fifty years electricity has brought about two of the most spectacular changes in the entire course of human affairs. One was the communications revolution, which began with the electric telegraph, and gained momentum in the years between the Wars with the development of broadcasting by wireless and television. The other was the great cybernetics explosion which began with the first electronic computers in the years just after 1945 and which was accelerated in the 1950s and 1960s by the application first of the transistor and second of micro circuitry. Both these developments have had incalculable effects on the way we live and think. But what about the third and quietest of the electronic revolutions: electricity's overthrow of traditional order in the domestic world?

This might not seem much when compared with the other two. There were no Zworykins or Marconis, and it was only very rarely — with things like the hair-drier perhaps — that electricity produced a completely new service rather than greatly improving an already existing one. Yet the changes which electricity has brought about in the kitchen and the laundry since 1900 have been quite as momentous in their way as broadcasting or computers. Throughout the developed world — even in a fitful sort of way in the Communist part of it — it has liberated half the population from the endless back-breaking tyranny of household labour, reducing domestic service as a form of employment and spawned an economic sea-change (labelled the Consumer Society) in the process. If you want to find the origins of Women's Liberation look as much to the small, mass-produced AC electric motor as to the pill.

Not bad. But how did all this happen? The answer is, very gradually. Public electricity supply had started out in the USA and Britain at the beginning of the 1880s as a street- and house-lighting service and although a couple of the early electricity generating pioneers — notably Thomas Edison — had tried to build up demand for power by marketing a range of consumer electrical gadgets, public use of electricity had been very slow indeed to get beyond illumination;

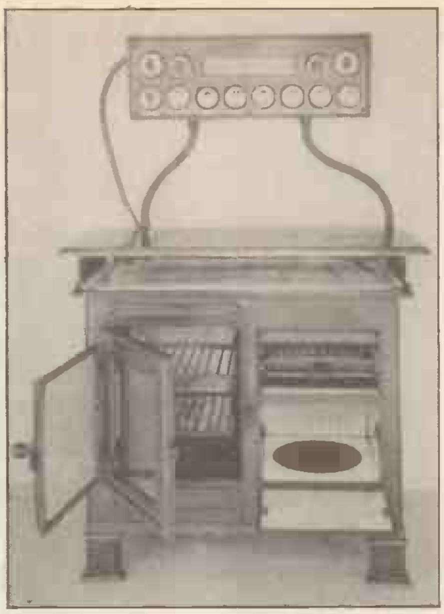
A Crompton electric iron from 1891 — an advance on the old style of fire-heated flat-iron.

GEC's 1895 version of the electric cooker; notice the brass lighting-style switches mounted on one side.

all the more so since the electric light was very nearly strangled at birth by the invention of the incandescent gas mantle in 1881. Electric flat-irons began to appear in the late 1880s, some of them quite lethal like the French models which operated by means of an arc burning between two carbon electrodes inside the casing. Fitful experiments were made with electric hotplates, but it was not until 1894 that the Crompton firm in the UK began marketing an electric cooking stove, a bulky sheet-iron affair with exposed heating elements made of iron wire wrapped around fireclay bars.

Electric vs. Gas

The design of cooking ranges had advanced a great deal from the open fire days at the beginning of the 19th century. As metal-casting and production engineering had improved a whole industry had grown up supplying standard cast iron coal-burning cookers, sometimes with refinements like water-heaters and glass oven doors. These had done a great deal to make cooking less laborious by allowing the heat to be controlled with some



By 1912, electric cookers had come to resemble modern ones — almost!

Preparing the way for the teabag that mainstay of Western civilisation, the electric kettle, was around by 1905.

accuracy. But kitchen work was still a tedious, time-consuming, dirty business for housewives and servants, with all the early morning ritual of coal heaving and clinkering and raking and firelighting to be gone through before cooking could begin. It was not until the first gas stoves appeared in the 1840s that the work got any lighter. However, gas was not without its drawbacks, as was pointed out by an 1895 publicity blurb emanating from the City of London Electricity Company, which was trying to interest the public in electric stoves:

No danger; No combustion; No chimney; No fires to light and watch; No matches to look for; No heat wasted; Perfect regulation; No more burnt meats or pastry; No explosions; Pure air; Sanitary kitchens — NO POISONOUS GASES AROUND FOOD WHILE COOKING!

Still, poisonous gases or not, electricity for cooking took a long time to catch on with the public outside the few wealthy households who could afford a cooker and the electricity bills which followed. This was partly a result of the fact that by 1914 only about one British home in ten was connected to the mains. But it also stemmed from the faults of the cookers themselves, and in particular their elements, which tended to corrode and burn out in a remarkably short time, as well as short circuiting freely when cooking water slopped over them.

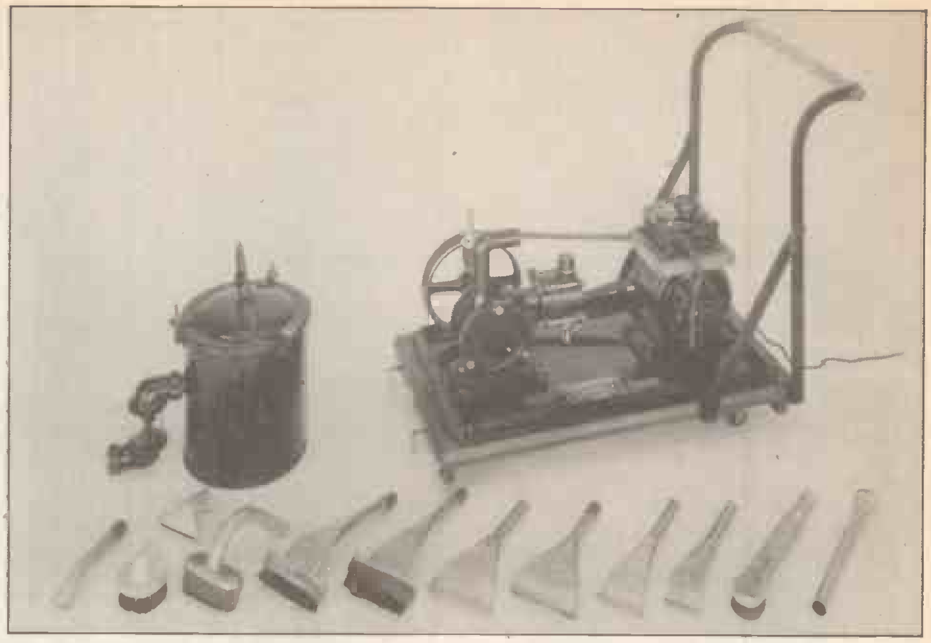
Things took a marked turn for the better in 1906 when A.L. Marsh patented nickel-chrome electrical heating elements. Not only had ni-chrome a much better resistance than iron or carbon, it was also much less vulnerable to corrosion. Less frequent element changing meant that elements could be better protected inside cooking stoves and at the same time design improved considerably, with blue-grey and later white enamel panels replacing the blacked ironwork of the earlier stoves. And after 1918 electricity tariffs got cheaper as the national system was rationalised and uniform charges came in. Electric cookers began to acquire thermostatic oven regulators in the mid-1930s, which reduced the bother of cooking. After this, little improvement took place until the arrival of the micro-wave cooker in the late 1960s. Electric cooking never managed to knock gas out of first place as the nation's favourite means of food preparation but it still made a large contribution to the lightening of the housewife's lot.

Putting on the Heat

Ni-chrome elements also did a great deal to aid electric space heating in the later 1900s. Previous attempts at electric room heaters had centred on wall-plates with iron wires embedded in a ceramic surface, or on large incandescent bulbs warmed to red heat, rather than on wire elements around a clay core. Reliable wound-wire

This GEC cooker from 1936 is cut away to show the heating elements, and insulation, of both the oven and the hob.

An "Apollo" electric fire from 1904; the elements are encased in glass globes — like electronic valves!



This British Vacuum Cleaner Company model, from an age when motor cars were scarce, looks as suitable for the Stables and the Garden as for the House, with an attachment for every eventuality.

elements were now possible and by about 1912 the electric fire had made its appearance in the shape loathsomely familiar to generations of dwellers in digs and bedsits, combining voracious consumption of meter shillings with a heat output barely perceptible more than a yard or so away. A good part of the problem was that until the mid-1960s, when decadent foreign notions of central heating began to make their way into the nation's domestic architecture, Britain was a country whose home heating was built around abundant supplies of cheap coal burnt in the most wasteful and inefficient way possible in an open grate.

The legendary dank chill of the British bedroom could not be dispelled by the puny glow of a two-bar electric fire, which rather served to make the arctic gloom even more noticeable. Chilblains remained the English Disease and the Permissive Society had to wait for the advent of the gas-boiler rather than the cheap electricity which had done such interesting things for the social life of the Scandinavians. But all the same, some experiments in economical and effective space heating by electricity were made over the years. After a mere half-century of public electricity supply, in 1930, some unknown genius of the staff of the Watford electricity supply company had realised that, although the generators had to be kept running, very little power was used between 10pm and 6am. So why not sell it at cheap rates, so that people would be encouraged to invest in those new Swedish-built storage heaters carved out of a block of steatite? The result of this unexpected stroke of imagination was the first UK experiment in cut-rate electricity for home heating, or "the soapstone tariff" as it was called.

By 1925, electric heater design had achieved a form which remained virtually unchallenged for the next 50 years.

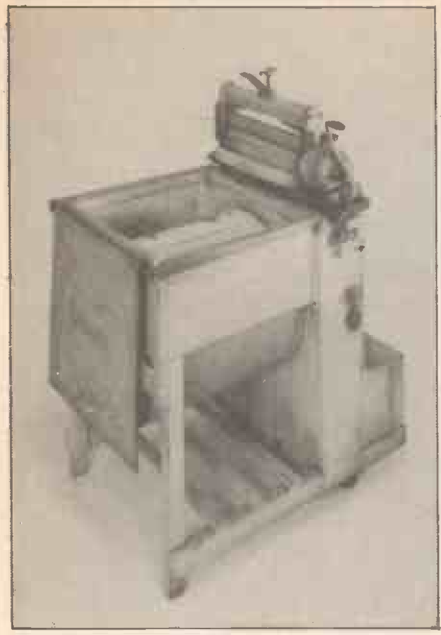
But even amongst the citizens of Watford, it seems that electric central heating never really caught on. Electric immersion heaters became moderately popular in the 1950s after the problem of making a watertight seal around the element had been solved. But as for house warming by electricity, the position is best summed up by a plaintive sticker seen a couple of years ago in the back of a decrepit Cortina parked on a London street: "I Had a Rolls Royce, But Then I Invested in Electric Central Heating".

Cleaning Up

The great electric labour-savers were the washing machine and the vacuum cleaner, and although neither of these devices was created by electricity, both owed their existence as a consumer durable to the perfection of small, mass-produced electric motors in the USA around 1910. Between them they not only took most of the pain and drudgery out of the business of household cleaning (a far more time-consuming business then than now, thanks to coal fires and dirty city air) but also made possible a major economic revolution by allowing the disbandment of that huge army of ill-paid female servants who kept the pre-1914 civilised world going, figuring in the households of even the most lowly of office-clerks.

The idea of mechanical clothes washing and carpet cleaning had already been around for quite some time before electricity was applied to them. For most women before the First World War, washing day had been a gruelling weekly ordeal of copper boiler and possing stick (for those who have never heard of it, a length of telegraph pole fitted with two handles to allow it to be pounded up and down on the clothes in the boiler). All in all it was not far advanced from two stones on the bank of a stream, and the idea of a mechanical agitator had been tried in one form or other for over a century: either a barrel with paddles rotated by a crank, or a wooden trough on rockers with a stone roller running to and fro inside.

At the end of the 19th century some of the larger public laundries had experimented with steam engines as prime-movers for mechanical washing. But female muscle power was cheap, and it was not until the mid-1900s that electric motors were tried as motive power for washing agitators, though the water was still heated separately by a coal fire. Likewise, with the cleaning of carpets and furnishings, various ideas had been tried since the mid-19th century to get around the necessity for taking everything out of doors and thrashing it energetically with a carpet beater. Sir Joseph Whitworth had patented a carpet-sweeper with spiral revolving brushes in the 1840s. And in



Despite its clumsy appearance, the washing machine was a tremendous advance on boiling and hand-washing.

1901, H.C. Booth had developed a system for sucking up dust and decanting it into a cloth bag. The earliest vacuum cleaners were operated on contract by the Vacuum Cleaning Company Ltd. and consisted of vans the size of a small milk float driven around London by uniformed staff who sometimes gave demonstrations at specially arranged parties held for members of society, like a kind of up-market Tupperware. Domestic vacuum cleaners also appeared during the 1900s, though these were anything but labour-saving devices, requiring as they did *two* servants to operate them: a maid to do the sweeping and a boy to operate the bellows with a lever, rather like an old-fashioned harmonium. The trouble was that, prior to 1914, there was really not a great deal of demand for either washing machines or vacuum cleaners. In Europe at any rate servants were cheap and plentiful, so why pay fifty pounds for a washing machine when that amount would hire you a human drudge for a whole year?

Servants' Lib.

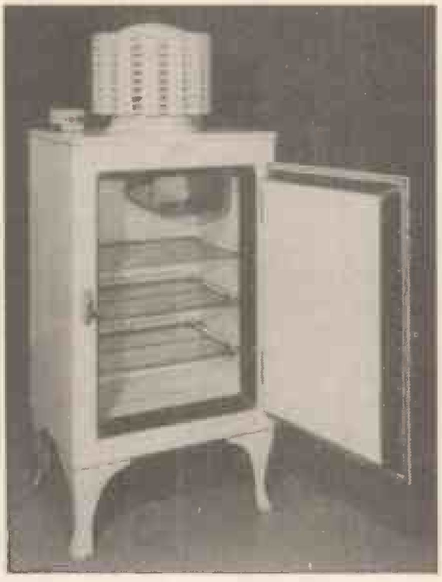
Things were rather different in the USA however, even before the Great War. The Americans had always been fascinated by labour-saving devices (much to Europe's amusement) largely because servants had never been plentiful outside the slavery states of the old South. In fact, most Americans had come to America precisely in order to escape from a life of semi serfdom in the Old World. Electric powered vacuum cleaners began to appear in the States around 1912 as the production line techniques of Ford Motors were applied to other items, and since purchasing power was far more evenly distributed there than in Europe they soon found a mass market. Within a few years the same sort of social changes were on the way on the other side of the Atlantic as well. The munitions factories of 1914-18 had given working class girls a line of escape from the hated position of domestic slavery and in addition they had given them wages unimaginable in 1914 — much to the disgust of their betters. When the War ended they were unwilling to re-enter domestic service for the sort of pay which had been usual in peacetime and as a result the pages of *Punch* were filled with sour little jokes about "the servant problem".

The consequence of this sudden dearth of cheap labour was that interest in electric home aids blossomed almost overnight at the beginning of 1919. American-style mass production soon appeared in Britain and by 1920 the price of a vacuum cleaner had come down to six pounds from about twenty six pounds in 1913, which put it well within the reach of a skilled working class home. By 1926 the Hoover company had captured the UK market to such an extent that "hoover" made its way into the Oxford Dictionary as noun and verb. Washing machines soon followed and by the mid-1930s the consumer durables industry was well established in Britain, making a major contribution to dragging the country out of the Depression and leaving as its monuments a series of Babylonian- and Egyptian-style factories scattered around the western suburbs of London.

Not only was the burden of housework immeasurably lightened and the working housewife becoming a possibility: the change was already under way towards a new economic world largely geared to the production of consumer goods rather than heavy capital equipment. In time this would be christened the Affluent Society, or the Consumer Society, or Mr. MacMillan's famous "You've Never Had it So Good" society. It would even make its way into the Communist world, in a dingy and semi-competent form, causing no end of trouble as people's expectations of washing machines and vacuum cleaners and electric sewing machines grew far beyond socialised production's capacity to fulfil them.

For the time being though the effects were restricted to the home as electricity finally ousted gas from its position as domestic service number one, so that today a household without electricity is almost unthinkable. The next step? Probably a situation in which all the domestic work will again be controlled by servants, but electronic servants in the form of robots and computers, and housework as such will become a part of history. **HE**

This Hotpoint machine, from 1937, was probably the equivalent of the modern-day nappy boiler.



The Dalek-like crest on top of this 1932 refrigerator contains the motor and heat-sink.

The classic upright 'Hoover' from 1936. How many of these, we wonder, are still doing good service?

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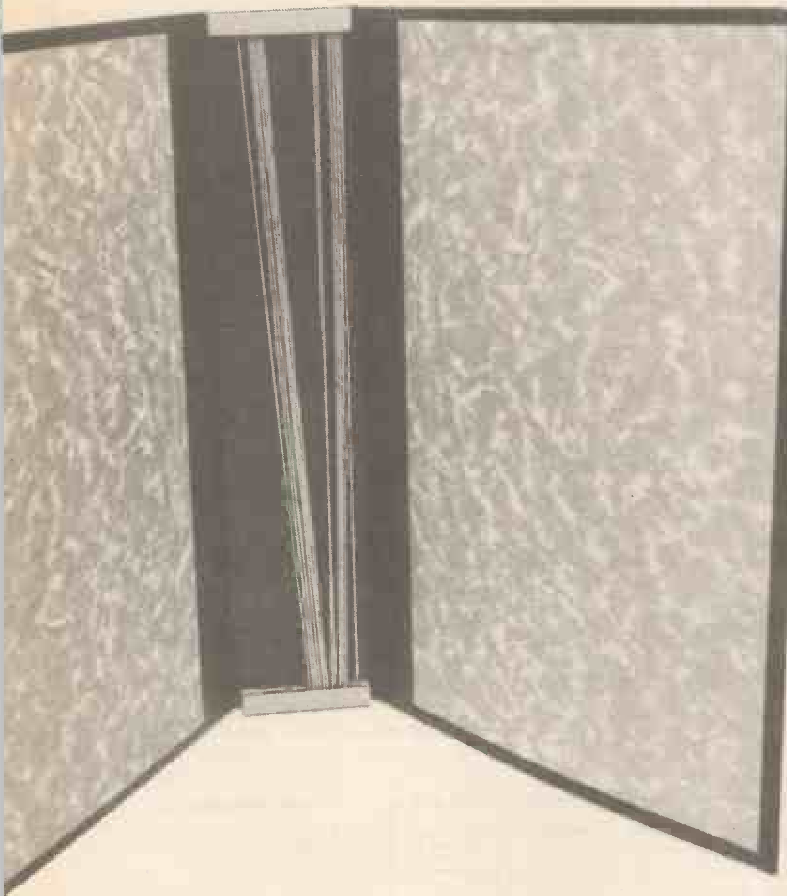

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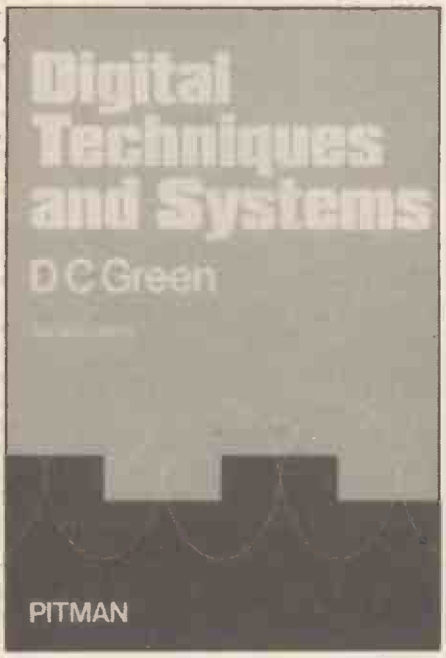
BOOK REVI

The theory of digital systems and the practice of home security are the subjects under scrutiny this month.



Digital Techniques and Systems (2nd Edition) by D. C. Green.
Published by Pitman Books Ltd., London, October 1982. £5.95.
Reviewed by **Owen Bishop**.

This is a course book for examinations of the Technical Education Council but, despite being a seriously intentioned 'textbook', it is attractively laid out and much of its subject matter is of interest to the hobbyist.

The book is really two books under one cover. The first part (88 pages) deeal with digital logic circuits, and the second part (87 pages) deals with data transmission. There are also twenty-six pages of appendices and index.

After a brief introductory chapter, the first part looks first at logic gates, describing the logical action and functions of AND, OR, NOT, NAND, NOR exclusive-OR, and exclusive-NOR in detail. The presentation assumes no previous knowledge of the subject and introduces new concepts in clear language in an easily understood way. Textbook pages often appear to be too cluttered with text and diagrams to appeal to the general reader, but the pages of this book avoid this, even though there is plenty of information to digest on each page.

It is copiously illustrated with line diagrams. The logic diagrams conform to the BS3939 standard throughout. This is a requirement for many electronics examinations and may at first glance be unfamiliar to many of our readers. Curiously, most popular magazines in the UK use the unofficial so-called 'British' symbols for gates, or the US symbols. The British Standards Institute has gone to great lengths to prepare a very workable standard and its seems strange that it should not have been adopted by the amateur.

The chapter on gates includes truth tables, and a summary of Boolean algebra with a useful table of Boolean logic rules. This leads on to a clear discussion of Karnaugh maps and how they may be used to design logic networks.

There are plenty of illustrative examples, and sets of questions. No answers are given, except to those numerical exercises which appear in the second half of the book. The lack of answers is no disadvantage with regard to logic circuits. When you have worked out your answer, get out a breadboard and a few logic ICs, wire up the circuit and find out in a practical way if your answer is correct. Presumably the author intends readers to do something of this kind, for the book is exclusively a theoretical one, with no practical exercises included. That is not to say it lacks a practical approach for the text is full of references to the many applications of digital electronics.

It also takes a more than usual interest in the internal details of the logic ICs. You will find the circuit digram and a full explanation of the working of TTL gates such as NAND, NOR, AND-OR-INVERT, and AND. Schottky and low-power Schottky gates are also explained. Those readers who have come into electronics as a hobby and who have been content to accept logic gates as 'black boxes' with inputs and outputs and goodness-knows-what inside, will be interested to find out just how these gates work. Manufacturers' data sheets provide so little information on this subject, and are full of unfamiliar jargon such as 'propagation delay', 'fan out', 'open collector outputs', and 'noise immunity' without ever explaining clearly what they mean or how they relate to the circuit on the chip. This book explains all about TTL gates, and CMOS gates, and touches briefly on ECL.

The book then deals with the stock types of medium-scale integrated logic circuit — flip-flops, counters, Schmitt (not Schmidtt, the only error I have found in the book!) triggers, and shift registers. Once again, we are taken right inside the chips, with full descriptions of what they do and how to use them.

The section dealing with logic circuits concludes with a chapter on computer memory. Here the emphasis is strongly on main-frame computer memory with a detailed description of ferrite cores, but less on PROMs and RAM than the average electronics/microcomputer enthusiast would like to know. This is no doubt the result of the slant imposed by the TEC syllabus.

The first part of the book is intended to cover the Digital Techniques IIIA and B half-units of the TEC scheme, and appears to do so thoroughly and at an appropriate level. The scheme is listed in an appendix and beside each point is a helpful page reference to the text. The second part of the book covers the Transmission Systems III half-unit.

Transmission Systems is concerned with the transmission of digital data over lines. This includes sending data from one computer to another or the transmission of digitised speech and similar signals over a telephone network. The emphasis is once again on main-frame computers. This section gives an interesting overall account of the main methods of data transmission and the problems inherent in this operation. Those of our readers who wish to expand their general knowledge of this topic would find this readable and of interest. It describes the distortions which alter the shape of a digital pulse when sent along a line and describes how the pulse may be regenerated on arrival at its destination.

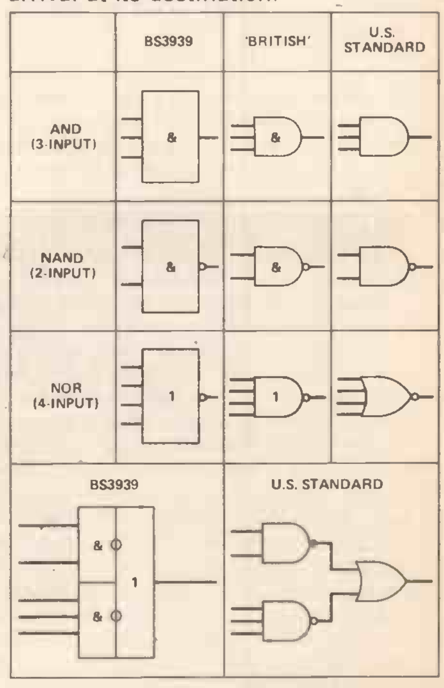


Figure 1. Gate symbol standards compared: see above.

EWS

There are chapters on digital modulation, data links, pulse code modulation and the use of optical fibre links. There are plenty of block diagrams to illustrate the many systems of transmission described, but no circuit diagrams of the equipment employed. While this section is essential to the TEC student and covers this need fully, it is unlikely to be of interest to the more practical-minded of our readers. The description of modems, for example, would not be of much help to anyone wishing to build and use a modem to send data from one home computer to another.

The book ends with a number of appendices, listing the more frequently used TTL and CMOS logic ICs. One gives a complete explanation of binary arithmatic. Another cross-references the text pages to the TEC syllabuses. Finally there is a set of forty multiple choice questions (with answers) which cover the subject-matter of the whole book.

Conclusions: This is a well written and illustrated book which fulfils its stated purpose of providing for the TEC student of Digital Techniques III A and B and Transmission Systems III. If electronics is your hobby and you want to know more about how to handle logic circuits and what goes on inside them, it is worth while adding this book to your collection. Even if you are not particularly interested in data transmission, the book is still worth the money, just for its extensive treatment of logic circuits. If you are also interested in finding out more about the principles of data transmission, then this is a bonus and you should certainly buy it.

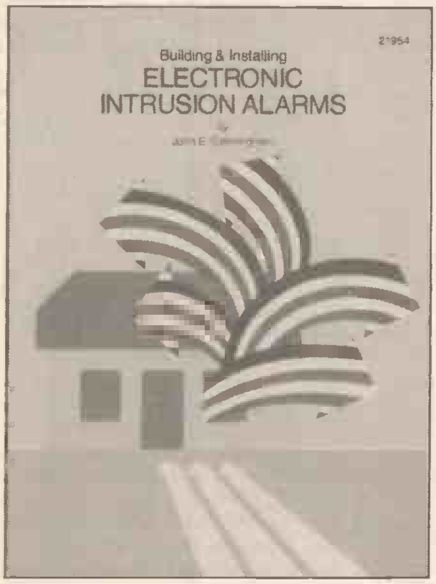
Building and Installing Electronic Intrusion Alarms (3rd Edition) by John E. Cunningham.
Published by Howard Sams and Co., Inc., Indianapolis, USA, August 1982. Distributed by Prentice/Hall International, Hemel Hempstead. £8.20
Reviewed by **Owen Bishop.**

This book shows the electronics hobbyist how to protect his home and car from the ravages of would-be intruders and thieves. As the title suggests, the emphasis is on raising a resounding alarm as soon as entry or theft is attempted, with the intention of scaring away the miscreant before he or she has had time to place even a finger upon the prospective loot.

The author makes the important point that commercially installed systems are usually highly expensive and that a great deal of money can be saved by building it yourself. Against this must be set the fact that wiring a perimeter loop to protect all the windows and doors of your house takes a long time. It is typical of the practical approach of the book that the author discusses at some length the points in favour of and against building your own system or having one fitted by the professionals.

It appears that the hobbyist can produce something every bit as reliable and effective as the commercial system, provided that the basic electronics are understood and the constraints of operating such a system are taken into account. There is the bonus that, if you install your own system, nobody else knows how it works. A burglar may know how to by-pass the more widely-used commercial systems, but the home-brew variety may have all sorts of pitfalls for the intruder and this feature in itself is a strong deterrent.

Before buying this book, which for its modest size (16pp, 136 x 216mm) is relatively though not excessively expensive, you should consider whether you feel able to plan, build and maintain a system which will reliably protect your house or car.



If you are a regular reader of this magazine and have built some of the projects and got them to work, the answer to this is probably 'yes', for none of the projects described in the book is complicated to build and detailed circuit diagrams are given. However, strip-board layouts or PCB designs are not given, so you need to be able to translate a circuit diagram into practical form. If you do decide to buy the book and use it, you will find that the price is reasonable for the amount of expertise and information packed into it.

A list of components is given for each circuit, in which each item is fully described. Thus, if it happens that certain types of component are not readily available in this country (as is almost inevitable when a book is of US origin), you should be able to use the descriptions in the components list to find a suitable substitute. Most of the circuits are based on discrete components, so eliminating the problem of obtaining obscure types of integrated circuit. A few circuits use the 555 timer and the LM3909 oscillator. There are two circuits employing a combination-lock IC. The LS7225 required for one of these is not widely available from UK suppliers, but is stocked by Ambit International. I have not been able to find a supplier for the other IC, the LS7220, used in one of the car alarm circuits.

The author has a clear style and leaves very little unexplained. On the general level, he has some interesting points to make concerning the mode of operation and hints for using thyristors, unijunction transistors and the 555 IC. Some of his novel circuits are interesting too, particularly the electronic system based on two UJTs, and the voltage-sensitive system used for protecting a car.

The book describes about thirty circuits altogether, including a variety of trigger circuits, photoelectric intrusion alarms, proximinty alarms, audio-triggered alarms, shock and vibration alarms, proximity alarms, audio-sounding devices, and car alarms. A few of these are not really feasible or even permissible in UK (for example a radio warning link, and various connections to the public telephone system) but these take up only a small part of the book. Apart from the circuits there is copious detail of the many kinds of switches, pressure-pads and other triggering hardware that is available, and how to incorporate these into your system most effectively. The author considers power supplies, coming down heavily in favour of battery-power, which topic is fully investigated.

The final chapter deals with the vexatious question of false alarms, the bane of so many security systems, both amateur and professional. If your system is prone to false alarms you might just as well have no system at all, for neighbours and others will simply ignore its warnings. Fortunately this aspect of alarm systems is well taken care of the author. He has obviously had much experience in dealing with this kind of fault and explains the many causes of false triggering in great detail, with useful hints on running down the source of trouble and how to cure it.

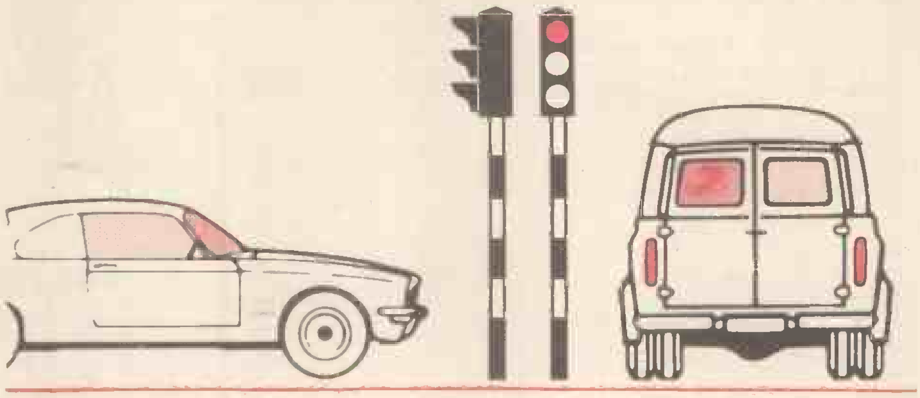
Conclusion: This is a well-written, fully illustrated book of workable, inexpensive (mainly) and thoroughly practicable circuits for the moderately experienced home constructor. There is plenty of helpful advice and information on setting up a home security system geared to your own circumstances and requirements. The majority of the book is applicable to conditions in UK. If you intend to set up your own system and have the ability to do it, this book is good value for money. If you are thinking about having a system installed commercially, the cost of the book is small in relation to what the system will cost, and it's worth buying in order to give yourself enough background knowledge to be able to define your requirements, keep the 'experts' on their toes and generally ensure that you obtain satisfaction.

HE

Traffic Light Toy

Andy Armstrong

A project ideal as a present for youngsters



THIS PROJECT, which makes a perfect toy for very young drivers, is a touch-operated traffic light that is stepped through the standard sequence of red, red/amber, green, amber by pressing touch sensitive contacts. There is no worry about the batteries dying quickly, either, as the circuit switches itself off after a short time unless the sequence is stepped.

Traffic Circuits

The CMOS gate IC1a is one quarter of the 4093 device, a NAND gate with Schmitt trigger inputs, wired as an inverter. Normally the voltage on the inputs is above the switching threshold so that the output is 'low'. When the contacts are shorted by touching them, the inputs go momentarily to OV and the output switches to 'high' for as long as the contacts are being handled.

The positive-going clock pulse is used simultaneously to drive a two-bit binary counter, formed from a dual D-type flip-flop IC2, and a second Schmitt trigger NAND gate set up as a retriggerable monostable.

The clock pulse is gated to the monostable inputs via D1 and begins to charge up C1; when the voltage on the capacitor goes above the trigger threshold level, the output of the gate will rapidly switch to a logic 'low' state; this signal is then used to enable the LED driver gates IC3a,b,d.

The monostable on-time is set, by the value of C1, to allow a reasonable length of time between operations of the touch switch. If the lights are not changed during the on-time, the output of IC1d goes high, inhibiting the driver gates. However if the switch is touched while IC1d output is still high, the monostable is re-triggered so that the timing period starts anew.

A D-type flip flop has the property that, when it is clocked (by the output of IC1a in this circuit) its 'Q' output assumed whatever logic state was present on its 'D' input at the time of the positive-going clock edge. Since the 'D' input is here connected to the corresponding '$\overline{Q}$' output, every time a positive clock edge occurs IC2a will flip (or flop, as the case may be). However IC2b is clocked by positive going transition of the $\overline{Q}$a output, so that it receives only one positive-going edge for every two produced by operating the touch switch.

Two counter outputs, $\overline{Q}$a and Qb, directly feed the LED gates for the Red and amber LEDs, while Qa and $\overline{Q}$b are

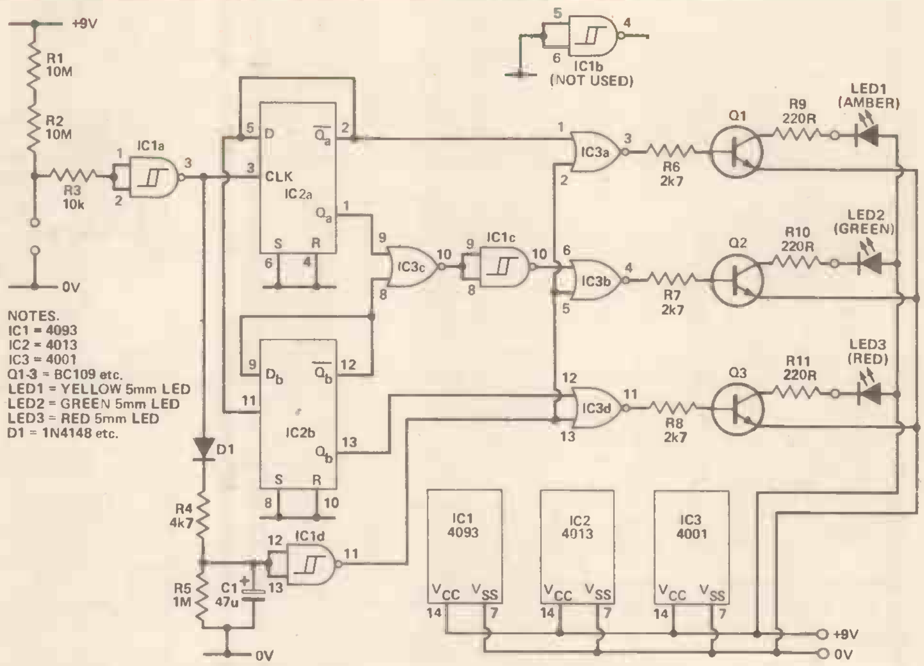


Figure 1. The circuit.

decoded by IC3c and drive the Green LED via IC1c (which is used as an inverter) and gate IC3b. As can be seen from **Figure 2**, which shows the timing sequence of the circuit, the Green LED is on for only one quarter of the time—which is exactly your experience of traffic lights, isn't it!

The Truth Tables in **Figure 3** show that the NOR gates, IC3a,b,d, are enabled when any one input is held 'low'; then any change at the other input will appear, inverted, at the gate output. If any one input is held 'high', though, the output is held 'low', so the gate is disabled (inhibited).

One input of each gate is wired to the output of the re-triggerable monostable, IC1d, so that when its output is 'low' (touch switch operated), the NOR gates are enabled. Then, if $\overline{Q}$a, Qb or the output of IC1c goes low, the appropriate gate output will go 'high', turning on Q1, 2 or 3 and lighting its LED. However when the monostable times out, the NOR gate outputs are held 'low' so that the transistors are biased off, and the LEDs turn off too. The power consumption of the CMOS logic in this state is so low that the battery life is virtually its stated shelf-life!

Construction Talk

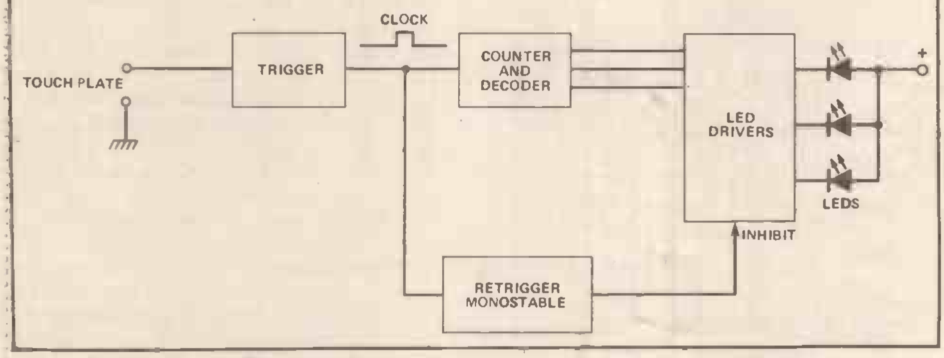
Experienced model-makers will find no difficulty in the mechanical assembly of the Traffic Light Toy, whether they use the proverbial tobacco tin that the prototype was built into, or a plastic case.

Since pipe-smoking relatives are fewer, these days, and a plastic case is in any event safer and easier to use, it might be better not to go scrounging but to buy a small standard enclosure. It must be large enough to take the PCB and a PP3 battery; the PCB measures 70 x 58mm and a PP3 is 49 x 27 x 16mm, so the case will need to be around 70 x 85mm or 91 x 58mm, depending on which way round the battery is mounted.

The construction methods has been lifted directly from the technique used to

How It Works

THE block structure of the Traffic Light Toy is shown below: briefly, the trigger senses when the touch switch is operated and produces a positive clock pulse while the fingers are still in contact with the touch plate. This positive edge steps the counter to its next stage and simultaneously triggers the monostable; the output from this holds open the LED driver circuits, allowing the decoded counter outputs to drive the appropriate signal LED. If the monostable is not re-triggered within a short time (by once again operating the touch switch), its output goes 'high' and the drive circuits are inhibited, turning off the LEDs to conserve the battery. However, the circuit maintains the previous CMOS logic levels so that the next time the device is used, it steps to the next traffic light state immediately the touch switch is operated. In the 'standby' condition the current consumption is the very small amount drawn by the CMOS gates.



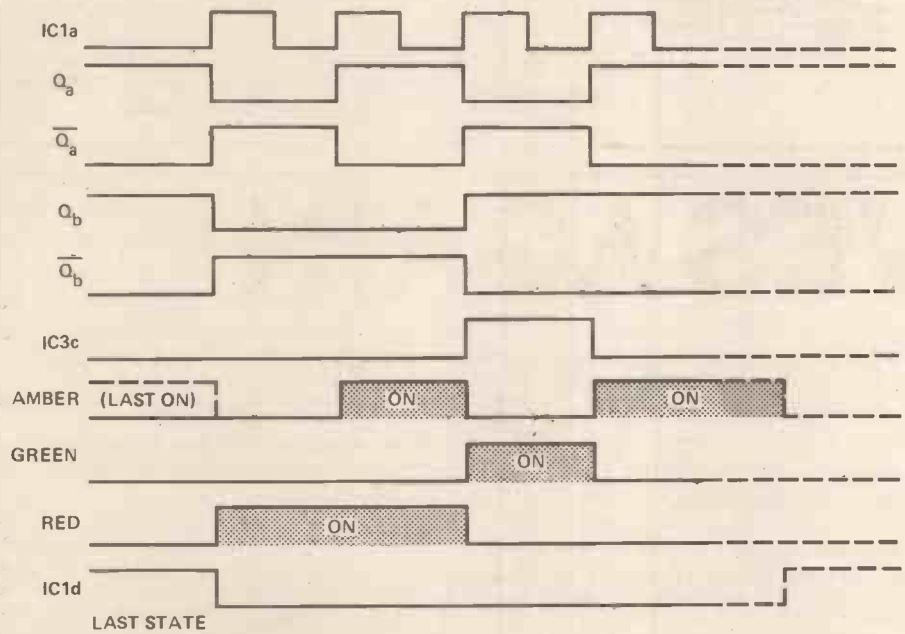


Figure 2. Timing sequence for the Traffic Light.

build the model rail signalling lights in the September 1982 issue of Hobby Electronics. The details are shown in **Figure 4**.

The materials are readily available from any modelling shop, or even the local ironmonger, if you have one. The bracket holding the LEDs can be cut from 18SWG copper or brass shim, drilled to take the LEDs and then attached to the post by bending the bottom flange and either soldering or glueing it in place.

The light cowlings are formed from copper tube with an inside diameter of 5mm. The post is a length of 6mm (¼") copper tube; drill a hole in the lid of the case, insert the tube till it projects slightly below the bottom surface and fix it with epoxy glue. A rear cover for the lights can be fashioned from another small piece of 18SWG copper or brass shim, but must not be attached to the LED bracket yet!

The printed circuit board can be easily assembled by following the layout shown in **Figure 5**; it is always advisable to insert the CMOS ICs last to reduce the risk of static damage; in any case treat them with care! Once the board is complete, temporarily connect up the LEDs and the battery; then, by touching or momentarily shorting the touch switch pads, you should be able to step the LEDs through their ordained sequence (not that when power is first applied the logic state of the circuit will be random, so any light or lights may be on).

Next comes the touch-plate; this is

A	B	$\overline{A+B}$	$\overline{A+B}$	A·B	$\overline{A \cdot B}$
0	0	0	1	0	1
0	1	1	0	0	1
1	0	1	0	0	1
1	1	1	0	1	0

Figure 3. Truth Tables for IC3, a 4001B quad NOR gate.

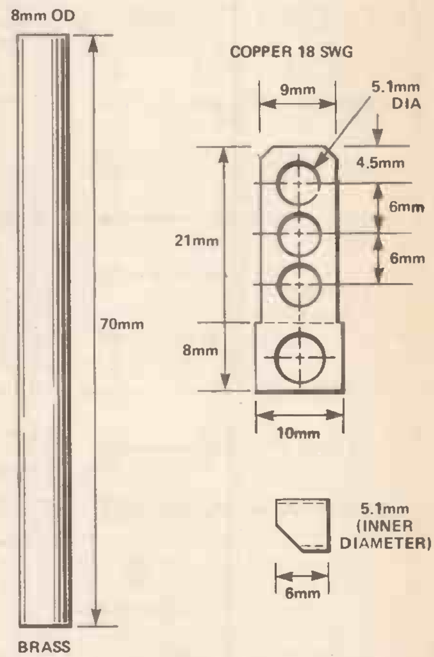


Figure 4. Construction measurements for the post and cowling.

Parts List

RESISTORS
(All ¼ watt 5% carbon)
R1,2 .... 10M
R3 .... 10k
R4 .... 4k7
R5 .... 1M
R6,7,8 .... 2k7
R9,10,11 .... 220R

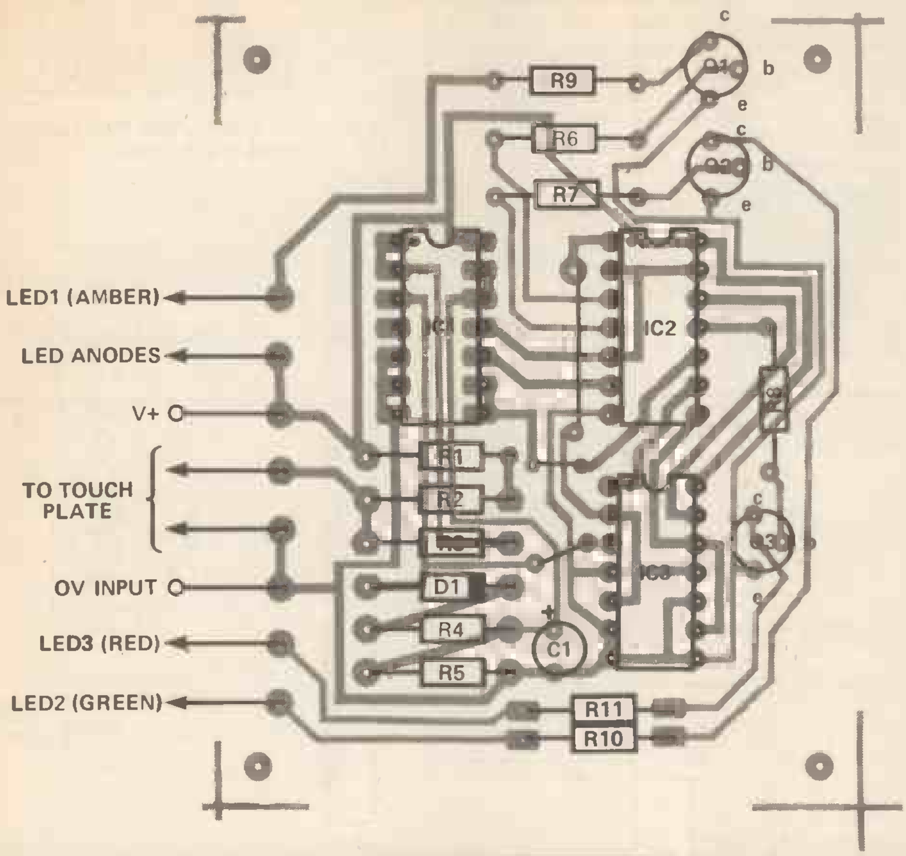
CAPACITORS
C1 .... 47u
25V radial electro

SEMICONDUCTORS
IC1 .... 4093B
quad Schmitt trigger NAND
IC2 .... 4013B
dual D-type flip-flop
IC3 .... 4001B
quad NOR
Q1,2,3 .... BC109
or similar
D1 .... 1N4148
or similar
LED1 ....5mm yellow LED
LED2 ....5mm green LED
LED3 ....5mm red LED

MISCELLANEOUS
PCB; case (see Buylines); PP3 battery and connector; PCB pins; wire, solder etc; metalwork for stand (see text).

BUYLINES ....page 34

Figure 5. PCB overlay: insert the CMOS ICs last.



easily made from a small piece of Veroboard with alternate tracks linked. After drilling a small hole in the lid of the box and leading through the wires, the touch plate should be fixed to the lid using dabs of epoxy glue. Mount the PCB and battery in the bottom of the case (double sided sticky pads, two or three layers thick, will do here) and connect up the touch plate wires. It is worth checking at this stage that the touch switch works; it can sometimes fail if your fingers are sticky from perspiration (leaving behind a thin film of conducting fluid) or if they are bone dry. Make sure these are not the causes of failure before you write to the editor!

If you have not already constructed the signal stand, do this now. The LEDs should be connected to the PCB by lengths of colour-coded wire led down the post and through the lid of the case. Take care when soldering the LEDs as they are easily damaged. Solder the wires to the relevent PCB pads (the coloured wires are so you can tell which is which—use red wire for the red LED, yellow and green for the other two and black, say, for the anode connection) and then screw down the lid of the case. Now attach the rear cover to the back of the LED mounting bracket.

Next paint the completed Traffic Light Toy. Various colour schemes can be used—why be boring—and then you have it. Now all you have to watch out for are the toy traffic police!

HE

HE PCB SERVICE

Ready made 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.

May 81		
HE/8105/1	Voice Operated Switch	£1.67
HE/8105/2	Organ 1	£4.64
June 81		
HE/8106/1	Envelope Generator	£1.87
HE/8106/2	Organ 2	£2.53
July 81		
HE/8107/1	Organ 3	£6.00
HE/8107/2	Organ 4	£6.00
HE/8107/3	Ultrasound Burglar Alarm	£2.53
August 81		
HE/8108/1	RPM Meter	£1.77
HE/8108/2	Thermometer	£1.67
September 81		
HE/8109/1	Power Pack	£1.69
HE/8109/2	Reaction Tester Game	£1.71
HE/8109/3	'Diana' Metal Detector	£3.31
October 81		
HE/8110/1	Combination Lock	£2.65
November 81		
HE/8111/1&2	Sound Torch (Set of Two)	£5.31
December 81		
HE/8112/1	Pedalboard Organ	£5.64
January 82		
HE/8201/1	Intelligent NiCad Charger	£2.83
February 82		
HE/8202/1	Relay Driver	£2.07
HE/8202/2	Mast-Head Amp	£1.08
March 82		
HE/8203/1	Digital Dice	£1.40
April 82		
HE/8204/1	Digital Capacitance Meter	£4.02
HE/8204/2	Dual Engine Driver	£3.27
HE/8204/3	Bike Alarm	£2.45
May 82		
HE/8205/1&2	Digital Thermometer (Set of Two)	£4.62
HE/8205/3	Echo-Reverb	£5.63
HE/8205/4	Cable Tracker	£1.85
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HE/8206/1	Power Supply Design	£2.48
HE/8206/2	Auto-Wah	£3.08
HE/8206/3	Auto Greenhouse Sprinkler	£3.45
HE/8206/4&5	Telephone Timer (Set of Two)	£6.50
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HE/8207/3	Computer PSU	£7.68
HE/8207/4	Solar Radio	£1.98
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HE/8208/3&4	Audio Analyser (Set of Two)	£11.55
September 82		
HE/8209/1&2	Signal lights	
	Main Module	£1.96
	Junction Module	£1.70
HE/8209/3	ZX Interface	£3.34
HE/8209/4	Slot Car Controller	£1.98
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HE/8210/2	Negative Voltage Generator	£1.49
HE/8210/3	Squelch Unit	£2.52
November 82		
HE/8211/1	Pedometer/ Odometer	£2.13
December 82		
HE/8212/1	Phase Four	£2.83
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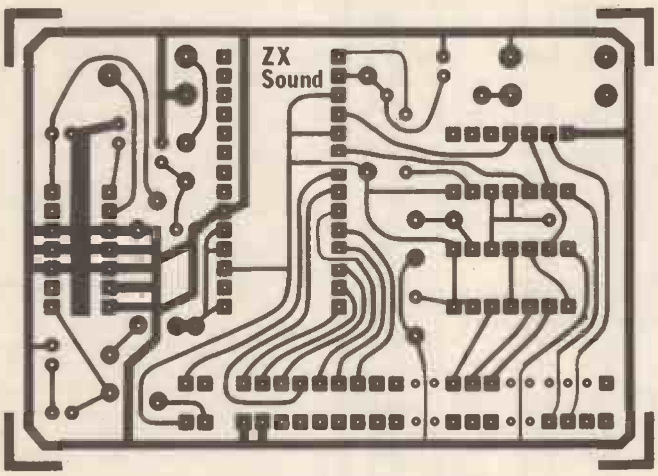
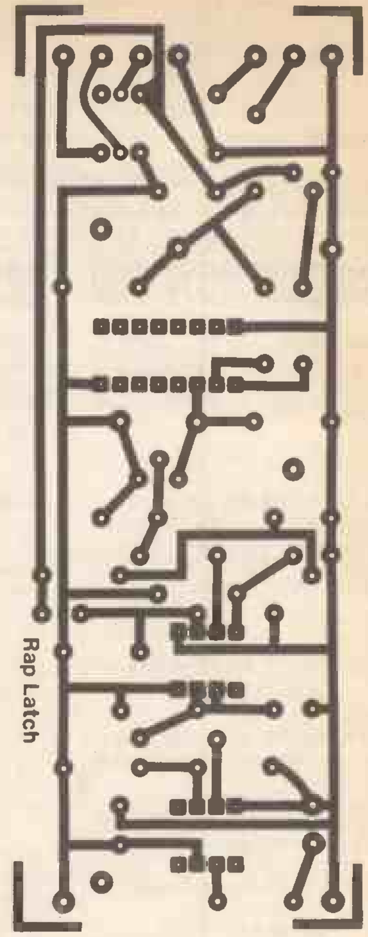
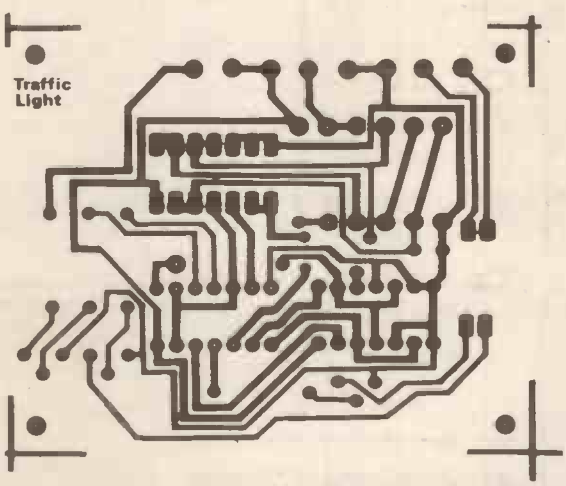


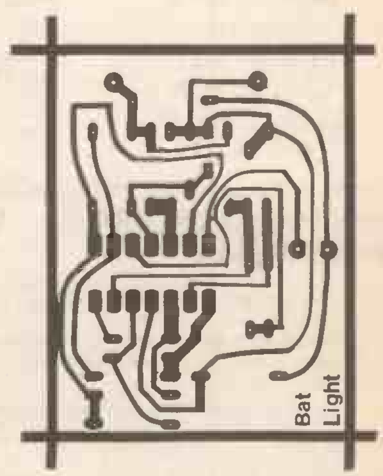
Above: The foil pattern of the Sinclair Sound Board.



Above: Make the Rap Latch printed circuit board from this foil pattern.



Above: Track-side view of the Traffic Light Toy printed circuit board. The design can easily be transferred to stripboard if necessary.



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