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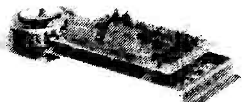

OMP100 Mk II Bi-Polar Output power 110 watts R.M.S. into 4 ohms, Frequency Response 15Hz - 30KHz —3dB, T.H.D. 0.01%, S.N.R. —118dB, Sens. for Max. output 500mV at 10K, Size 355 × 115 × 65mm.
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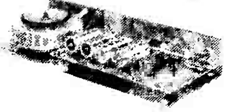

OMP/MF100 Mos-Fet Output power 110 watts R.M.S. into 4 ohms, Frequency Response 1Hz - 100KHz —3dB, Damping Factor 80, Slew Rate 45V/uS, T.H.D. Typical 0.002%, Input Sensitivity 500mV, S.N.R. —125dB. Size 300 × 123 × 60mm. PRICE
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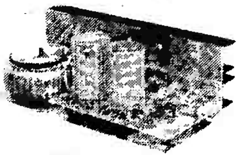

OMP/MF200 Mos-Fet Output power 200 watts R.M.S into 4 ohms, Frequency Response 1Hz - 100KHz —3dB, Damping Factor 250, Slew Rate 50V/uS, T.H.D. Typical 0.001%, Input Sensitivity 500mV, S.N.R —130dB, Size 300 × 150 × 100mm. PRICE
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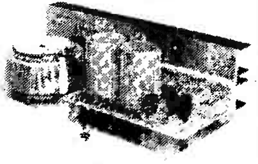

OMP/MF300 Mos-Fet Output power 300 watts R.M.S. into 4 ohms, Frequency Response 1Hz - 100KHz —3dB, Damping Factor 350, Slew Rate 60V/uS, T.H.D. Typical 0.0008%, Input Sensitivity 500mV, S.N.R. —130dB, Size 330 × 147 × 102mm. PRICE
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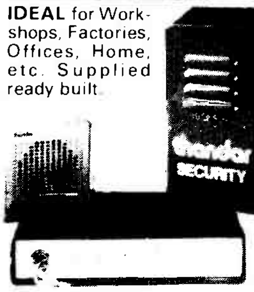

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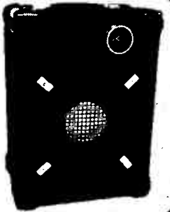

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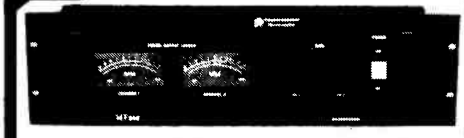

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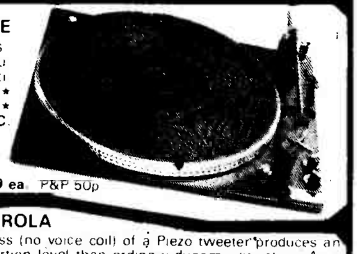

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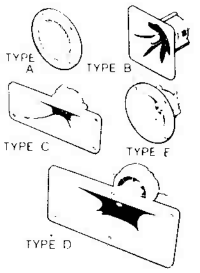

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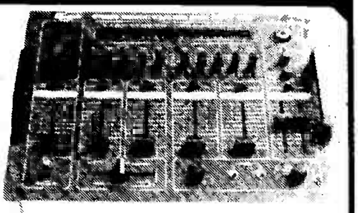

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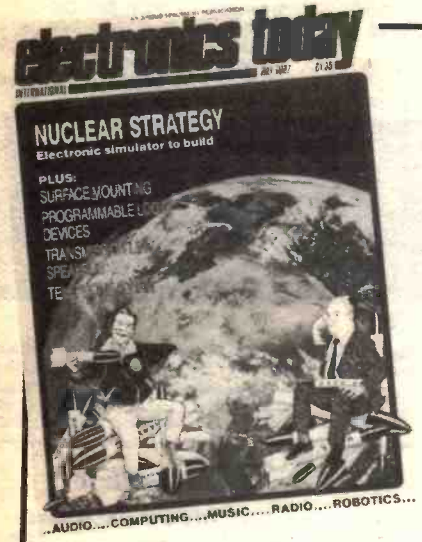

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PUBLISHED BY:
Argus Specialist Publications Ltd.,
1 Golden Square, London W1R 3AB.
DISTRIBUTED BY:
Argus Press Sales & Distribution Ltd.,
12-18 Paul Street, London EC2A 4JS.
(British Isles).
TYPESET BY:
Project Three.
PRINTED BY:
Adlard & Son Ltd, The Garden City Press.
COVERS PRINTED BY:
Loxley Brothers Ltd.

ISSN
0142-7229

ABC **Member of the Audit Bureau of Circulation**

■ Subscription Rates. UK: £18.10. Overseas: £22.50. USA: $29.50. Airmail: £49.50.

EDITORIAL AND ADVERTISEMENT OFFICE
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PHILIPS BM7502 12" Hi Res Green Screen	**£75** (a)
PHILIPS BM7522 12" Hi Res Amber Screen	**£75** (a)
Swivel Base for Taxan Monochrome fitted with Digital Clock	**£21** (c)

SPECIAL OFFER

2764-25	£2.50
27128-25	£2.75
6264LP-15	£2.80

ATTENTION

All prices in this double page advertisement are subject to change without notice.

ALL PRICES EXCLUDE VAT
Please add carriage 50p unless indicated as follows:
(a) £8 (b) £2.50 (c) £1.50 (d) £1.00

Serial Mini Patch Box

Allows an easy method to reconfigure pin functions without rewiring the cable assy.
Jumpers can be used and reused. **£22 (d)**

Serial Mini Test

Minitors RS232C and CCITT V24 Transmissions, indicating status with dual colour LEDs on 7 most significant lines.
Connects in Line. **£22.50 (d)**

GANG OF EIGHT INTELLIGENT FAST EPROM COPIER

Copies up to eight eproms at a time and accepts all single rail eproms up to 27256. Can reduce programming time by 80% by using manufacturer's suggested algorithms. Fixed Vpp of 21 & 25 volts and variable Vpp factory set at 12.5 volts. LCD display with alpha moving message. **£395(b).**

SOFTY II

This low cost intelligent eprom programmer can program 2716, 2516, 2532, 2732, and with an adaptor, 2564 and 2764. Displays 512 byte page on TV — has a serial and parallel I/O routines. Can be used as an emulator, cassette interface.

Softy II	**£195(b)**
Adaptor for 2764/2564	**£25.00(c)**

UV ERASERS

All erasers with built in safety switch and mains indicator.

UV1B erases up to 6 eproms at a time	**£47(c)**
UV1T as above but with a timer	**£59(c)**
UV140 erases up to 14 eproms at a time	**£88 (b)**
UV141 as above but with a timer	**£88 (b)**

CONNECTOR SYSTEMS

I.D. CONNECTORS

(Speedblock Type)

No of ways	Header Plug	Receptacle	Edge Conn.
10	**90p**	**85p**	**120p**
20	**145p**	**125p**	**195p**
26	**175p**	**150p**	**240p**
34	**200p**	**160p**	**320p**
40	**220p**	**190p**	**340p**
50	**235p**	**200p**	**390p**

D CONNECTORS

No of Ways

	9	**15**	**25**	**37**
MALE:				
Ang.Pins	120	180	230	350
Solder	60	85	125	170
IDC	175	275	325	-
FEMALE:				
St Pin	100	140	210	380
Ang.pins	160	210	275	440
Solder	90	130	195	290
IDC	195	325	375	-
St Hood	90	95	100	120
Screw Lock	130	150	175	-

TEXTOOL ZIF

SOCKETS			
28-pin	**£9.00**	24-pin	**£7.50**
		40-pin	**£12**

EDGE CONNECTORS

	0.1"	0.156"
2 × 6-way (commodore)	—	300p
2 × 10-way	150p	—
2 × 12-way (vic 20)	—	350p
2 × 18-way	—	140p
2 × 23-way (ZX81)	175p	220p
2 × 25-way	225p	220p
2 × 28-way (Spectrum)	200p	—
2 × 36-way	250p	—
1 × 43-way	260p	—
2 × 22-way	190p	—
2 × 43-way	395p	—
1 × 77-way	400p	500p
2 × 50-way(S100conn)	600p	—

EURO CONNECTORS

DIN 41612	**Plug**	**Socket**
2 × 32 way St Pin	**230p**	**275p**
2 × 32 way Ang Pin	**275p**	**320p**
3 × 32 way St Pin	**260p**	**300p**
3 × 32 way Ang Pin	**375p**	**400p**
IDC Skt A + B		**400p**
IDC Skt A + C		**400p**

For 2 × 32 way please specify spacing (A + B, A + C).

MISC CONNS

21 pin Scart Connector	**200p**
8 pin Video Connector	**200p**

AMPHENOL CONNECTORS

	Solder	**ZDC**
36 way plug	500p	475p
36 way skt	550p	500p
24 way plug IEEE	475p	475p
24 way skt IEEE	500p	500p

PCB Mtg Skt Ang Pin
24 way 700p 36way 750p

GENDER CHANGERS

25 way D type

Male to Male	£10
Male to Female	£10
Female to Female	£10

RS 232 JUMPERS

(25 way D)

24" Single end Male	£5.00
24" Single end Female	£5.25
24" Female Female	£10.00
24" Male Male	£9.50
24" Male Female	£9.50

4-way	**90p**	6-way	**105p**
8-way	**120p**	10-way	**140p**

RIBBON

(grey/metre)

10-way	40p	34-way	160p
16-way	60p	40-way	180p
20-way	85p	50-way	200p
26-way	120p	64-way	280p

DIL HEADERS

	Solder	IDC
14 pin	**40p**	**100p**
16 pin	**50p**	**110p**
18 pin	**60p**	-
20 pin	**75p**	-
24 pin	**100p**	**150p**
28 pin	**160p**	**200p**
40 pin	**200p**	**225p**

TECHNOLINE VIEWDATA SYSTEM

Using 'Prestel' type protocols for information and orders phone 01-450 9764. 24 hour service, 7 days a week.

74 SERIES

7400	30p
7401	30p
7402	30p
7403	30p
7404	36p
7405	30p
7406	40p
7407	40p
7408	30p
7409	30p
7410	30p
7411	30p
7412	30p
7413	50p
7414	70p
7416	36p
7417	40p
7420	30p
7421	60p
7422	36p
7423	36p
7425	40p
7426	40p
7427	40p
7428	43p
7430	30p
7432	36p
7433	30p
7437	30p
7438	40p
7439	40p
7440	40p
7441	80p
7442A	70p
7443A	100p
7444	110p
7445	70p
7446A	100p
7447A	100p
7448	120p
7450	36p
7451	35p
7453	38p
7454	38p
7460	55p
7470	50p
7472	55p
7473	55p
7474	50p
7475	60p
7476	45p
7480	65p
7481	180p
7483A	105p
7484A	125p
7485	110p
7486	42p
7489	210p
7490A	55p
7491	70p
7492A	70p
7493A	55p
7494	110p
7495A	60p
7496	80p
7497	290p
74100	180p
74107	50p
74109	75p
74110	75p
74111	55p
74116	170p
74118	110p
74119	170p
74120	100p
74121	55p
74122	70p
74123	60p
74125	65p
74126	55p
74128	55p
74132	75p
74136	70p
74141	60p
74142	250p
74143	270p
74144	270p
74145	110p
74147	170p
74148	140p
74150	175p
74151A	70p
74153	80p
74154	140p
74155	80p
74156	100p
74157	80p
74159	225p
74160	110p
74161	80p
74162	110p
74163	110p
74164	120p
74165	110p
74166	140p
74167	400p
74170	200p
74172	420p
74173	140p
74174	110p
74175	105p
74176	100p
74178	150p
74179	150p
74180	100p
74181	340p
74182	140p
74184	180p
74185A	180p
74190	130p
74191	130p
74192	110p
74193	115p
74194	110p
74195	80p
74196	130p
74197	110p
74198	220p
74199	220p
74221	110p
74251	100p
74259	150p
74265	380p
74273	200p
74276	140p
74278	170p
74279	80p
74283	105p
74285	320p
74290	90p
74293	90p
74298	150p
74351	200p
74365A	80p
74366A	80p
7436A	80p
74367A	80p
74368A	70p
74376	160p
74390	110p
74393	112p
74490	140p

74LS SERIES

74LS00	24p
74LS01	24p
74LS02	24p
74LS03	24p
74LS04	24p
74LS05	24p
74LS08	24p
74LS09	24p
74LS10	24p
74LS11	24p
74LS12	24p
74LS13	34p
74LS14	50p
74LS15	24p
74LS20	24p
74LS21	24p
74LS22	24p
74LS24	50p
74LS26	24p
74LS27	24p
74LS28	24p
74LS30	24p
74LS32	24p
74LS33	24p
74LS37	24p
74LS38	24p
74LS40	24p
74LS42	50p
74LS43	150p
74LS47	80p
74LS48	90p
74LS49	100p
74LS51	24p
74LS54	24p
74LS55	24p
74LS73A	30p
74LS74A	35p
74LS75	45p
74LS76A	36p
74LS83A	70p
74LS85	75p
74LS86	35p
74LS90	48p
74LS91	90p
74LS92	55p
74LS93	54p
74LS95B	75p
74LS96	90p
74LS107	40p
74LS109	40p
74LS112	45p
74LS113	45p
74LS114	45p
74LS122	70p
74LS123	80p
74LS124/	629/140p
74LS125	50p
74LS126	50p
74LS132	65p
74LS133	50p
74LS136	45p
74LS138	55p
74LS139	55p
74LS145	95p
74LS147	175p
74LS148	140p
74LS151	65p
74LS152	200p
74LS153	65p
74LS154	180p
74LS155	65p
74LS156	65p
74LS157	50p
74LS158	65p
74LS160A	75p
74LS161A	75p
74LS162A	75p
74LS163A	75p
74LS164	75p
74LS165A	110p
74LS166A	150p
74LS168	130p
74LS169	100p
74LS170	140p
74LS173A	100p
74LS174	75p
74LS175	75p
74LS181	200p
74LS183	180p
74LS190	75p
74LS191	75p
74LS192	80p
74LS193	80p
74LS194A	75p
74LS195A	75p
74LS196	80p
74LS197	80p
74LS221	90p
74LS240	80p
74LS241	80p
74LS242	90p
74LS243	90p
74LS 244	70p
74LS 245	90p
74LS247	110p
74LS248	110p
74LS249	110p
74LS251	75p
74LS253	75p
74LS256	90p
74LS257A	70p
74LS258A	70p
74LS259	120p
74LS260	75p
74LS261	120p
74LS266	80p
74LS273	125p
74LS279	70p
74LS280	190p
74LS283	80p
74LS290	80p
74LS 292	£14
74LS293	80p
74LS295	140p
74LS 297	£14
74LS298	100p
74LS299	220p
74LS321	370p
74LS323	300p
74LS324	320p
74LS348	200p
74LS352	120p
74LS353	120p
74LS356	210p
74LS363	180p
74LS364	180p
74LS365	50p
74LS366	50p
74LS367	60p
74LS368A	50p
74LS 373	70p
74LS 374	70p
74LS375	75p
74LS377	130p
74LS378	95p
74LS379	130p
74LS381	450p
74LS385	325p
74LS390	60p
74LS393	100p
74LS395A	100p
74LS399	140p
74LS445	180p
74LS465	120p
74LS467	120p
74LS490	150p
74LS540	100p
74LS541	100p
74LS608	700p
74LS 610	£25
74LS 612	£25
74LS624	350p
74LS626	225p
74LS628	225p
74LS629	125p
74LS640	200p
74LS640-1	300p
74LS641	150p
74LS642-1	300p
74LS643	250p
74LS643-1	300p
74LS644	350p
74LS645	200p
74LS645-1	400p
74LS668	90p
74LS669	90p
74LS670	170p
74LS682	250p
74LS684	350p
74LS687	350p
74LS688	350p
4LS 783	£16

74S SERIES

74S00	50p
74S02	50p
74S04	50p
74S05	50p
74S08	50p
74S10	50p
74S11	75p
74S20	50p
74S22	50p
74S30	50p
74S32	60p
74S37	80p
74S38	80p
74S40	50p
74S51	45p
74S64	45p
74S74	70p
74S 85	550p
74S86	100p
74S112	150p
74S113	120p
74S114	120p
74S124	300p
74S132	100p
74S133	60p
74S138	180p
74S138	180p
74S139	180p
74S140	100p
74S151	150p
74S153	150p
74S157	200p
74S158	200p
74S163	300p
74S169	550p
74S174	360p
74S175	320p
74S188	180p
74S189	180p
74S194	300p
74S195	300p
74S196	350p
74S200	450p
74S201	320p
74S225	520p
74S240	400p
74S241	400p
74S 244	400p
74S251	250p
74S257	250p
74S258	250p
74S260	100p
74S261	300p
74S283	270p
74S287	225p
74S288	200p
74S289	225p
74S 299	450p
74S373	400p
74S374	400p
74S387	225p

4000 SERIES

4000	20p
4001	24p
4002	25p
4006	70p
4007	25p
4008	80p
4009	45p
4010	60p
4011	24p
4012	25p
4013	36p
4014	60p
4015	70p
4016	36p
4017	55p
4018	60p
4019	80p
4020	80p
4021	60p
4022	70p
4023	30p
4024	48p
4025	24p
4026	90p
4027	40p
4028	80p
4029	75p
4030	36p
4031	125p
4032	160p
4033	125p
4034	250p
4035	70p
4036	70p
4037	110p
4038	100p
4039	250p
4040	60p
4041	55p
4042	50p
4043	80p
4044	60p
4045	100p
4046	60p
4047	60p
4048	55p
4049	36p
4050	35p
4051	65p
4052	80p
4053	80p
4504	80p
4055	80p
4056	85p
4059	400p
4060	70p
4063	85p
4066	40p
4067	230p
4068	25p
4069	24p
4070	24p
4071	24p
4072	24p
4073	24p
4075	24p
4076	65p
4077	25p
4078	25p
4081	24p
4082	25p
4085	60p
4086	75p
4089	120p
4093	36p
4094	80p
4095	90p
4096	80p
4097	270p
4098	75p
4099	90p
4501	30p
4502	55p
4503	36p
4504	85p
4505	360p
4506	90p
4507/4030	36p
4508	120p
4510	55p
4511	55p
4512	55p
4513	150p
4514	110p
4515	110p
4516	55p
4517	220p
4518	48p
4519	32p
4520	60p
4521	115p
4522	80p
4526	70p
4527	80p
4528	55p
4529	100p
4531	75p
4532	65p
4534	380p
4536	250p
4538	75p
4539	75p
4541	90p
4543	70p
4551	100p
4553	240p
4555	36p
4556	50p
4557	240p
4560	140p
4566	140p
4568	240p
4569	170p
4572	45p
4583	90p
4584	48p
4585	80p
4724	150p
14411	750p
14412	750p
14416	300p
14419	280p
14490	420p
14495	450p
14500	650p
14599	200p
22100	350p
22101	700p
22102	700p
40014/4584	
40106	48p
40085	120p
40097	36p
40098	40p
40100	150p
40101	125p
40102	130p
40103	200p
40104	120p
40105	160p
40106	48p
40107	55p
40108	320p
40109	20p
40110	225p
40114	225p
40147	280p
40183	100p
40173	120p
40174	100p
40175	100p
40192	100p
40244	150p
40245	150p
40257	180p
40373	180p
40374	180p
80C95	75p
80C97	75p
80C98	75p

LINEAR ICs

AD7581	£15
ADC0808	1190p
AM7910DC	[illegible]
AN103	280p
AY-1-5050	160p
AY-3-1350	450p
AY-3-8910	450p
AY-3-8912	550p
CA3019A	100p
CA3028A	110p
CA3046	70p
CA3059	325p
CA3080	80p
CA3080E	70p
CA3086	60p
CA3089E	210p
CA3090AQ	375p
CA3130E	90p
CA3130T	130p
CA3140E	40p
CA3140T	100p
CA3160E	90p
CA3161E	200p
CA3162E	600p
CA3189E	270p
CA3240E	100p
CA3280G	270p
D7002	£8
DAC1408-8	300p
DAC0800	300p
DAC0808	300p
DG308	300p
HA1388	180p
ICL7106	675p
ICL7611	90p
ICL7650	400p
ICL7660	250p
ICL8038	400p
ICM7555	80p
ICM7556	140p
LC7120	300p
LC7130	300p
LC7137	300p
LF347	120p
LF351	60p
LF353	90p
LF355	90p
LF356N	110p
LF357	100p
LM10C	400p
LM301A	30p
LM307	45p
LM308CN	70p
LM310	225p
LM311	60p
LM318	100p
LM319	100p
LM324	45p
LM334Z	115p
LM335Z	130p
LM336	180p
LM339	40p
LM348	60p
LM358P	50p
LM377	300p
LM380N-8	100p
LM380	100p
LM381N	300p
LM382	300p
LM383	325
LM384	220
LM386N-1	100p
LM387	270p
LM391	180p
LM392N	110p
LM393	300p
LM394CH	400p
LM709	30p
LM710	40p
LM711	100p
LM723	60p
LM725CN	400p
LM733	90p
LM741	22p
LM747	70p
LM748	30p
LM1011	400p
LM1014	180p
LM1801	300p
LM1830	250p
LM1871	300p
LM1872	300p
LM1886	600p
LM1889	400p
LM2917	300p
LM3302	50p
LM3900	90p
LM3909	100p
LM3911	100p
LM3914	300p
LM3915	340p
LM3916	340p
LM13600	100p
M51513L	230p
M51516L	400p
MB3712	300p
MC1310P	150p
MC1413	70p
MC1458	45p
MC1495L	300p
MC1496	70p
MC3340P	200p
MC3401	70p
MC3403	80p
MF10CN	400p
MK50240	900p
ML920	800p
ML922	400p
MM6221A	200p
NE531	120p
NE544	100p
NE555	22p
NE556	60p
NE564	400p
NE565	120p
NE566	150p
NE567	125p
NE570	400p
NE571	300p
NE592	80p
NE5532P	180p
NE5533P	180p
NE55334P	120p
NE5534AP	180p
OP-07EP	500p
PLL02A	500p
RC4136	55p
RC4151	300p
RC4558	55p
SAA1900	£16
SFF96364	800p
SL490	300p
SN76033N	300p
SN76489	400p
SN76495	400p
SP0256AL2	700p
TA7120	120p
TA7130	140p
TA7204	150p
TA7205	90p
TA7222	180p
TA7310	150p
TBA231	120p
TBA800	90p
TBA810	90p
TBA820	80p
TBA820M	75p
TBA920	200p
TBA950	220p
TC9109	800p
TCA940	175p
TDA1010	225p
TDA1022	400p
TDA1024	110p
TDA1170S	300p
TDA2002	325p
TDA2003	180p
TDA2004	340p
TDA2006	320p
TDA2020	320p
TDA2030	200p
TDA2593	500p
TDA3810	750p
TDA7000	300p
TEA1002	700p
TL061CP	40p
TL062	80p
TL064	90p
TL071	40p
TL072	70p
TL074	110p
TL081	30p
TL082	55p
TL083	75p
TL084	100p
TL094	200p
UA759	320p
UA2240	150p
UCN5801A	600p
ULN2003A	75p
ULN2004A	75p
ULN2068	200p
ULN2802	180p
ULN2803	180p
ULN2804	180p
UPC575	275p
UPC592H	200p
UPC1156H	300p
UPC1185H	500p
XR210	400p
XR2206	400p
XR2207	375p
XR2211	575p
XR2216	675p
XR2240	120p
ZN409	180p
ZN414	80p
ZN419P	175p
ZN423E	130p
ZN424E	130p
ZN425E8	350p
ZN426E	300p
ZN427E	600p
ZN428E	450p
ZN429E8	225p
ZN447E	£9.50p
ZN448	750p
ZN449E	300p
ZN450E	750p
ZN459CP	300p
ZN1034E	200p
ZN1040E	600p
ZNA134H	£23
ZNA234E	950p

VOLTAGE REGULATORS

FIXED PLASTIC

1A		+ve		+ve	
5V		7805	45p	7905	50p
6V		7806	50p	7906	50p
18V		7808	50p	7908	50p
12V		7812	45p	7912	50p
15V		7815	50p	7915	50p
18V		7818	50p	7918	50p
24V		7824	50p	7924	50p
5V	100mA	78L05	30p	79L05	45p
6V	100mA	78L06	30p		
12V	100mA	78L12	30p	79L12	50p
15V	100mA	78L15	30p	79L15	50p

OTHER REGULATORS

Fixed Regulators		
LM309K	1A 5V	140p
LM323K	3A 5V	250p
78H05KC	5A 5V	575p
78H12	5A 12V	750p
Variable Regulators		
LM305AH		250p
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68000-LB	£36
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8039	420p
80C39	700p
8080A	750p
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8087-5	£120
8087-8	£160
80C85A	900p
8086	£22
8088	1750p
8741	£12
8748	£12
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TMS9995	£18
V20-8	£10
V30-8	£10
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Z80B	550p
Z80CMOS (CMOS Z80)	750p

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8282	300p
8284	400p
8287	300p
8288D	650p
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TMS9901	500p
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TMS9911	£18
TMS9914	£14
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Z80APIO	250p
Z80BPIO	500p
Z80CTC	250p
Z80ACTC	275p
Z80BCTC	500p
Z80DART	650p
Z80ADART	700p
Z80DMA	700p
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Z80BP10	500p
Z80BCTC	500p
Z80DART	900p

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6850	180p
68B50	300p
6852	250p
6854	650p
68B54	800p
6875	500p
8154	650p
8155	300p
8156	300p
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8212	200p
8216	160p
8224	300p
8226	425p
8228	550p
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8250	£12
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8255AC-5	320p
8256	£18
8257C-5	400p
8259C-5	400p
8275	£29

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2516-35	550p
2532	450p
2532 30	980p
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2708	400p
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2716-35	550p
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2732A-35	£7
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CRT5037	£12
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75113	120p
75114	140p
75115	140p
75121	140p
75122	140p
75150P	120p
75154	120p
75159	220p
75160	800p
75161	650p
75162	750p
75172	400p
75182	150p
75188	60p
75189	60p
75365	150p
75450	50p
75451	50p
75452	50p
75453	70p
75454	70p
75480	150p
75491	65p
75492	65p
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4416-15	300p
4532-20	250p
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5514	450p
5516	400p
5517	400p
6116LP-3	400p
6264-15	700p
6264LP-15	340p
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4.00	140p
4.194	150p
4.43	100p
4.608	250p
4.9152	200p
5.000	150p
6.00	140p
17.734	200p
7.00	150p
7.168	175p
8.00	150p
8.867	175p
10.50	250p
10.70	150p
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12.00	150p
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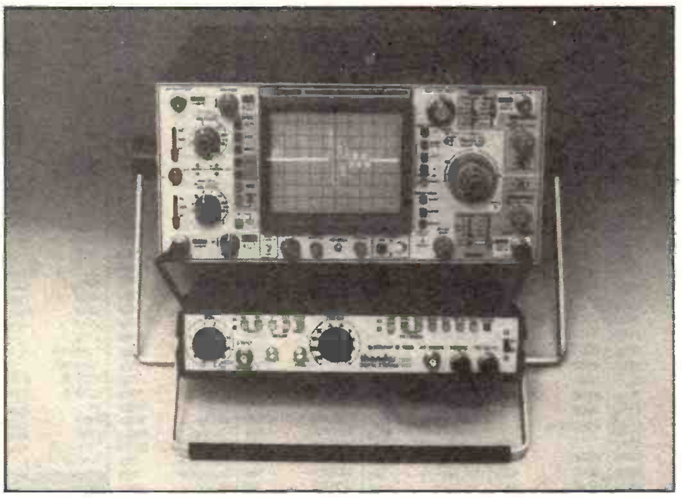
- **Greenweld is planning to celebrate summer by having a clear out of all its old 'Bargain List' stock. From June 15th there will be big price reductions on many items with some on sale for half price. Those who already have a Greenweld catalogue can obtain a sale price list free-of-charge while new customers will have to pay £1.00 for the catalogue and price list. Greenweld Electronics Ltd, 443 Millbrook Road, Southampton S01 0HX. Tel: (0703) 772 501.**

- Test equipment specialist Alpha Electronics has issued its Spring 1987 catalogue. Its six pages list a selection of analogue and digital multimeters plus attenuators, leads, pocket electrical testers and probes measuring temperature and rotational speed. The catalogue is free from Alpha Electronics Ltd, Unit 5, Linstock Trading Estate, Wigan Road, Atherton M29 0QA. Tel: (0942) 873 434.

- *The City & Guilds of London Institute is an examining body which offers qualifications in a wide range of craft and technical subjects, most of which can be taken on day release as well as on full-time courses. A new pamphlet from the Institute lists the qualifications available in subjects such as electronics, electrical installation and computing and explains how these are recognised by industry and professional bodies. A helpful graph shows how students progress through the various levels of qualification and there are some brief case histories of people who are taking or have taken CGLI courses. The City & Guilds of London Institute, 76 Portland Place, London W1N 4AA.*

- We often tell you about companies publishing guides to their product lines but here's one publishing a guide to the guides. Axiom distribute Motorola products and they have put together a complete guide to the literature available on Motorola devices. For details contact Axiom Electronics Ltd, Turnpike Road, Cressex Industrial Estate, High Wycombe, Buckinghamshire HP12 3NR. Tel: (0494) 442 181.

- **The range of control knobs and accessories manufactured by Sifam Ltd is described in a 16-page A4 colour catalogue recently issued by the company. Collet, push-on and slide potentiometer knobs are among the types covered and the catalogue also lists knob caps, dials, pointers, assembly tools and push-button switch caps. Contact Sifam Ltd, Accessories Division, Woodland Road, Torquay, Devon TQ2 7AY. Tel: (0803) 63822.**



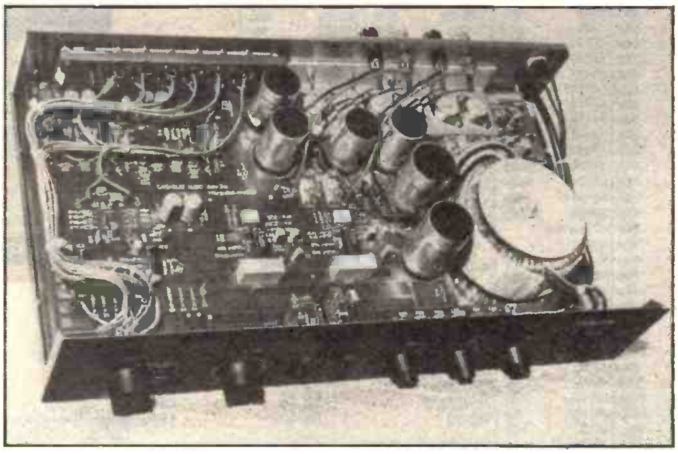
Digital Storage Scope Add-On

Thandar Electronics has introduced a portable, low-power digital storage unit which allows waveforms to be captured and stored on an ordinary real-time oscilloscope.

At its minimum sampling rate the unit can capture slowly-changing waveforms lasting more than an hour whilst the maximum rate of 200kHz allows it to capture fast transients and similar events. The operating modes available are real-time, refresh, roll and single-shot and the trigger facilities allow the unit either to start sampling when a trigger signal is received or to sample continuously and use the trigger pulse to define the mid-point or end of the sampling period.

The unit has variable input sensitivity down to 5mV and uses a 1K memory to store data. Operation is from batteries or from the mains via an AC adaptor and data stored in the memory can be retained for up to four years when batteries are fitted.

The TD201 costs £195 plus VAT and is available from Thandar Electronics Ltd, London Road, St. Ives, Huntingdon, Cambridgeshire PE17 4HJ. Tel: (0480) 64646.



Hi-Fi Kit Claims High Performance

Gatehouse Audio says its new Gate One amplifier is no ordinary kit design.

Selling for £161, the amplifier is said to provide a sound quality equal to that of amplifiers in the £300-£400 class while sacrificing nothing in terms of facilities or appearance.

The Gate One provides 40 watts per channel into 8R (80 watts into 4R) and accepts inputs from moving-coil cartridges and CD players as well as from moving magnet cartridges, tuners and tape recorders. Features include a tone cancel switch which removes the treble and bass controls from circuit when not required, a subsonic filter to remove noise on discs and a bass boost facility for use with loudspeakers which have a poor bass response.

Full instructions are included and the PCB is screen printed with component numbers and locations to simplify assembly. The amplifier is also available ready-built for £201.25. Prices include carriage and VAT.

Gatehouse Audio, 105 High Street, Evesham, Worcestershire WR11 4EB. Tel: (0386) 48873.

IC Firms Fight Health Scare

Electronics companies in America's Silicon Valley are fighting to retain their non-union working policies following the publication of a report which highlights increasing health problems among female workers.

The report was drawn up by researchers at the University of Massachusetts and catalogues the health problems of female production workers at a DEC semiconductor plant. Labour and womens' rights groups have seized on the findings and used them to challenge the safety of semiconductor manufacturing plants around the world.

Worried by the bad publicity, some companies have refused to employ women on production tasks. Women's rights groups insist this is discrimination and say the companies should concentrate on finding the cause of the problems.

A coalition of concerned groups wrote to the heads of 15 major semiconductor manufacturers and invited them to meet and discuss the report. Many refused, believing that to respond to the letter would confer recognition on the groups as workers' representatives and so open up the way to unionisation. This would remove the manufacturers' ability to cut costs rapidly when necessary simply by sacking thousands of workers.

Instead, the industry has responded with an attempt to discredit the report, describing it as 'too small to make it applicable to the industry as a whole'. An internal report is being planned by the Semiconductor Industry Association (SIA) to determine how best to mount a health study. However, many people are critical of the SIA's decision not to accept an offer of help from the University of California, widely recognised as a centre of excellence in occupational health matters.

TV Sound In The Balance

The BBC and the IBA are planning to conduct a series of tests to investigate the intelligibility of dialogue in television programmes.

The initiative follows comlaints from people with hearing difficulties who say they cannot follow dialogue easily when it is accompanied by background music, sound effects or audience noises. A working party set up by the two organisations will assess the intelligibility of dialogue both for people with hearing difficulties and those with normal hearing.

Z80 Features, Sixteen Bits

Following the success of the 8-bit Z80 microprocessor, Zilog has introduced a CMOS 16-bit version which offers full compatibility and improved performance.

The Z280 can operate in 8 or 16-bit mode, allowing it to use all existing Z80 applications software and to be interfaced easily with Z80 peripherals. In 16-bit mode it can be used with Zilog's family of Z-BUS peripherals.

Improved features include clock speeds from 10 to 25MHz, a 16M byte on-chip memory management unit and a 256 byte instruction and data cache which can be used in conjunction with the burst mode access facility on modern DRAMs. A number of functions which would previously have been carried out by peripheral devices have been built-in to the Z280 including three 16-bit counter/timers, a full duplex UART and four channels of DMA.

Zilog claims to have captured over 35% of the 8-bit market with the Z80 and says the library of software available for the device is the most extensive in the world. The Z280 will allow companies to preserve the value of their investment in Z80 hardware and software while gaining the benefits of improved performance, higher levels of integration and low power consumption.

The Z280 is available now and costs about $27 in quantities of a thousand.

Zilog, 1315 Dell Avenue, Campbell, California 95008, United States of America.

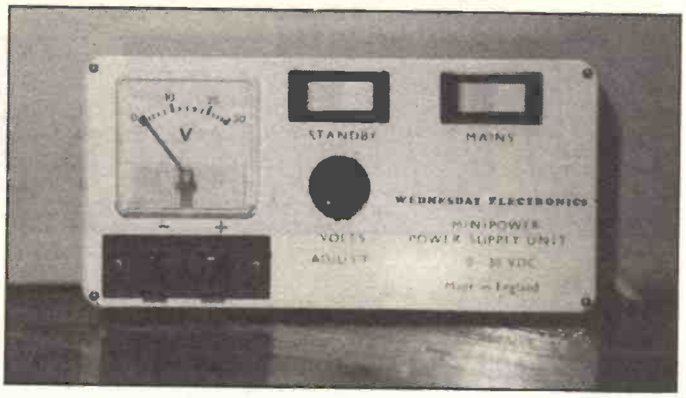
A Job — If You're Quick Enough

Students who don't start job hunting until they have finished their studies are taking an unnecessary risk according to a new report from PA Personnel Services.

Competition for graduates has been building up for several years, and employers now start recruiting as early as October in the final year in order to secure the best students.

Those studying shortage subjects such as electronic engineering or computer sciences may still be able to find jobs once the exams are over, but in general employers are only taking the best and those who show real initiative. Late entry into the employment market is inadvisable in today's climate of high unemployment, the report says.

The Pay Research Unit, PA Personnel Services, Hyde Park House, 60A Knightsbridge, London SW1X 7LE. Tel: 01-235 6060.



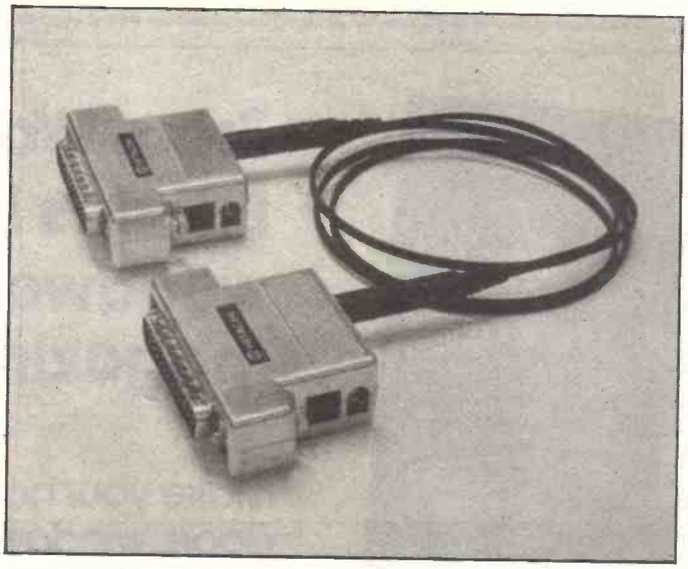
Small PSU For Small Budgets

The Minipower PSU is a single-rail bench power supply which has been designed to offer good performance at a low price.

At just over £30 inclusive, the Minipower is expected to prove popular with schools and colleges, hobbyists, model-makers and any individual or organisation operating on a tight budget.

The Minipower provides a regulated DC voltage which is continuously variable between 0 and 30V (35V absolute maximum) at currents up to 1.5A. An automatic current limiting circuit protects the supply from overload. The output voltage remains constant to within 0.01% from zero to full load, line regulation is to within 0.3% and the total output noise level is 150uV.

The Minipower PSU costs £31.70 including VAT and postage and is available from Wednesday Electronics, 4 Church Street, Offenham, Worcestershire WR11 5RW. Tel: (0386) 40314.



Optical Communications The Easy Way

A new data communication link from Hitachi offers all the advantages of fibre optic cable but is as easy to use as an ordinary digital serial interface.

The HAC105 cable has two fibre optic cores to allow full duplex operation and has all the necessary transmit and receive circuitry built into the moulded plugs at each end. A simple PCB-mounting socket allows the cable to be connected directly to logic circuit boards while an active adaptor is available to enable the cable to be used with RS232 links.

The cable is available in standard lengths of 5, 10 and 20 metres with other lengths available to order in suitable quantities. Power for the cable circuitry is derived from the board circuitry where a PCB socket is used or from a mains power unit when the RS232 adaptor is being used.

The cable and adaptors are only available in large quantities at present but Hitachi hope to arrange dealerships which will make them available in smaller quantities. A one-off price of around £30 is anticipated for the cable with the ADPRSI RS232 adaptors costing around £65.

A brochure giving full technical details of the system is available from Hitachi Electronic Components (UK) Ltd, 21 Upton Road, Watford, Hertfordshire WD1 7TP. Tel: (0923) 46488.

- **The latest edition of Ferranti's MOSFET handbook contains over 340 pages of data on the company's range of enhancement mode N and P channel devices. Surface mounting types are now included along with the more traditional TO-92, TO-39 and TO-220 packages and the handbook also features a comprehensive cross reference list of industry part numbers. Copies are available free-of-charge from Ferranti Electronics Ltd, Fields New Road, Chadderton, Oldham, Lancashire OL9 8NP. Tel: 061-624 0515.**

- *A new 44-page colour brochure from PKS-Digiplan Ltd contains a wealth of information on motion control techniques as well as describing the company's range of motor drive and control modules. The topics covered include open and closed loop control of DC and stepper motors, motor and drive selection criteria, torque calculation and inertia matching. There are also worked examples for a variety of different applications. PKS-Digiplan Ltd, 21-22 Balena Close, Creekmoor, Poole, Dorset BH17 7DX. Tel: (0202) 690 911.*

- Omni Electronics is a recently-established, family-run company which supplies electronic components, kits, tools and accessories. Everything listed in their catalogue is normally available by return of post and the company will also try to obtain 'difficult' components to order. The catalogue costs 38p inclusive from Omni Electronics, 174 Dalkeith Road, Edinburgh EH16 5DX. Tel: 031-667 2611.

- **A potentially serious bug has been found in the 32-bit multiplier logic of Intel's 80386 microprocessor. About 100,000 of the devices have already been sold but most have been used in 16-bit DOS applications where the bug is not apparent. However, Intel believes that many companies are now planning to use the 80386 in more critical applications and reckons it has about nine months to correct the fault. The cost of field-replacement for faulty devices could run as high as $30 million, a heavy blow for the company which has just returned to profitability after a period of heavy losses.**

- Yes, we know, the supposed safety problem with Amstrad's PC1512 IBM clone was the absence of a mains *earth*, not the absence of a mains *lead* as we reported last month. A suitable revenge awaits our news writer should we ever find him again, but just at the moment he seems to have gone to ground.

NEXT MONTH

AN ARGUS SPECIALIST PUBLICATION
electronics today
INTERNATIONAL

CARS CARS CARS

The August issue of ETI contains a whole bundle of stuff for the motorist and the DVLC has graciously decided to bring out a new registration number prefix (E for ETI) in August in our honour.

Keith Brindley has been taking a look at the world of auto electronics. Although high technology has been comparatively slow to filter through to the conservative car industry it looks like things are changing at last.

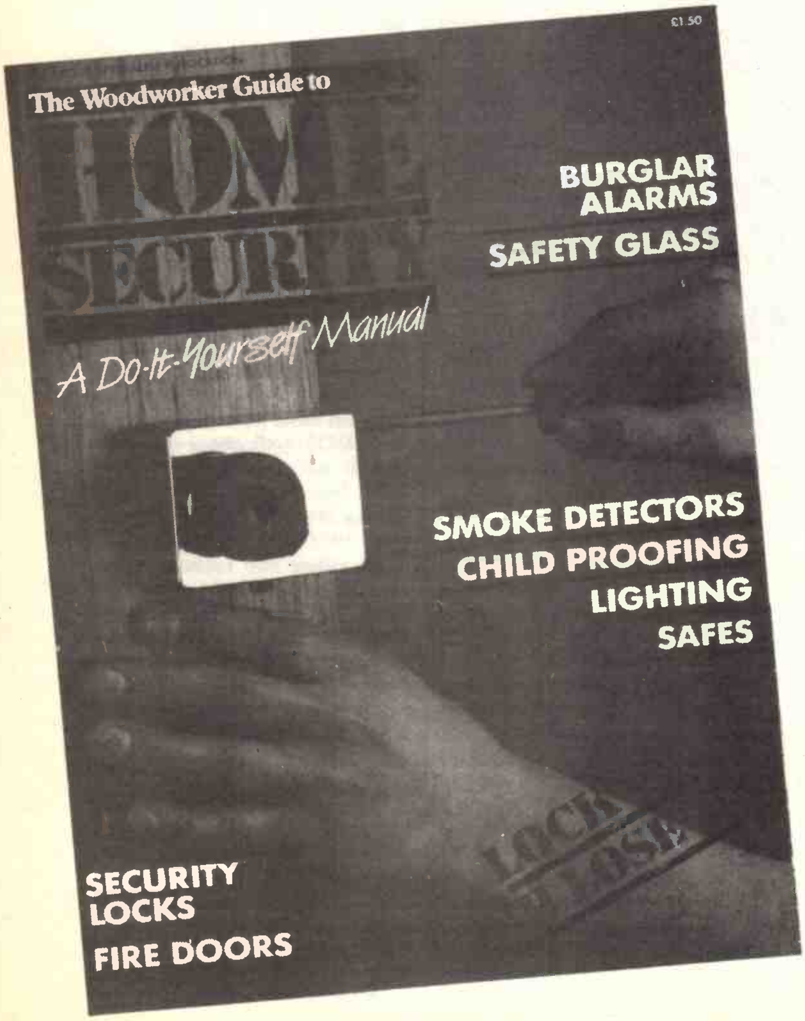
There's several short and easy projects for the DIY motorist in the August issue too — everything from a car alarm to a very novel rev counter.

PLUS

For readers reliant on public transport, next month's ETI has all the old favourites which go to make up Britain's best loved magazine for the electronics enthusiast. There's projects, features, news, diary, Tech Tips, ads, special offers, letters and so much more.

THE AUGUST ISSUE OF ETI — OUT 3rd JULY
MISS IT AT YOUR PERIL!

All the articles listed are in an advanced state of preparation but circumstances beyond our control may prevent publication.



The Italian Collection

West Hyde has extended its range of instrument cases with the introduction of several new low-cost designs from Teko of Italy.

They come in free-standing and wall-mounting varieties, in a range of colours and can be specified with lacquered aluminium front panels, internal PCB mounting slots and many other features. Contact West Hyde Developments Ltd, 9-10 Park Street, Aylesbury, Buckinghamshire HP20 1ET. Tel: (0296) 20441.

- 'Nuclear Power In The UK' is the latest in a series of energy factsheets produced by the Public Affairs Board of the IEE. It aims to provide basic technical information at a level suitable for the intelligent layman and covers such topics as the history of nuclear power in this country, the physical principles underlying reactor operation, the question of safety and the economics of nuclear energy. Copies may be obtained free-of-charge from the PAB Secretariat, IEE, Savoy Place, London WC2R 0BL. Tel: 01 - 240 1871.

Changing Attitudes To Information Technology

Britain is in a good position to take advantage of information technology and meet the challenges of the 21st century, according to a new report from the National Economical Development Office.

However, if we are to take up the challenge we need to pay far more attention to education and training and we need to change many of our attitudes.

The report considers the changes likely to result from the application of information technology in Britain in the period up to the year 2010. As well as taking such a long-term view it takes account of values.

To bring about positive changes we need to overhaul our educational system. The report describes education as 'massively under-resourced' and calls for expansion coupled with a shift of emphasis from theory to practical application. The present policy of providing science and engineering places at the expense of arts places is rejected by the authors who feel our society will need more of both types of student in the future.

The report is entitled IT Futures . . . IT Can Work and costs £20 inclusive from NEDO Books, Millbank Tower, Millbank, London SW1P 4QX. Tel: 01-211 5989.

- *If you hadn't heard of Clare Instruments until you saw the ST300 Clamp Tester in last month's News Digest (you did see it, didn't you?) now is your chance to find out more. The company has issued a catalogue covering its complete range of ELCB testers, high voltage flash testers, 500V megohmeters and other specialised safety equipment plus more general items such as watt-meters, resistance bridges and milliohmeters and of course, clamp ammeters. Contact Clare Instruments Ltd, Woodsway, Goring-by-Sea, Worthing, West Sussex BN12 4QY. Tel: (0903) 502 551.*

DIARY: DIARY: DIARY: DIARY: DIARY: DIARY: DIARY: DIARY:

UK Telecommunications Networks: Present & Future — June 2-3rd
IEE, London. Conference. Contact the IEE at the address below.

CableSat '87 — June 2-4th
Metropole Hotel, Brighton. Exhibition and conference. Contact Online at the address below.

International ISDN Conference — June 15-18th
London. Conference on the Integrated Services Digital Network. Contact Online at the address below.

Networks '87 — June 16-18th
London. For details contact Online at the address below.

Scottish Technology Week — June 16-18th
Scottish Exhibition Centre, Glasgow. Single event combining the Scottish Electronic Technology Show & Conference, the Scottish Factory Efficiency Show & Conference and OEM Scotland. Contact Cahners at the address below.

Radio Frequency Techniques — July 19-24th
University of Bradford. Vacation school organised by the IEE. Contact them at the address below.

Condition Monitoring For Safety — June 25th
Regent Crest Hotel, London. Seminar and Exhibition. Contact ERA Technology on (0372) 374 151.

Satellite Communication Systems — July 26-31st
University of Surrey. Vacation school organised by the IEE. Contact them at the address below.

Designing For Electromagnetic Compatability — September 13-18th
University of Sussex. Vacation school organised by the IEE. See address below.

7th International Display Research Conference — September 15-17th
The IEE, London. Conference covering all aspects of electronic display research. Jointly organised by a number of professional bodies. Contact the Institute of Physics on 01-235 6111.

Design Engineering Show — September 15-18th
NEC, Birmingham. Exhibition and conference covering all areas of engineering including electronics and CAD/CAM. Contact Cahners on 01-891 5051.

IDEX '87 — September 21-23rd
Metropole Exhibition Halls, Brighton. See April '87 ETI or contact Nutwood Exhibitions on (04848) 25891.

Semiconductor International — September

NEC, Birmingham. Covers materials, design assembly and testing of semiconductors. Contact Cahners at the address below.

Internepcon — October 6-8th
Metropole Convention Centre, Brighton. Exhibition and conference covering wire, cables, power supplies, components and racks/cases. Contact Cahners at the address below.

Automotive Electronics — October 12-15th
The IEE, London. International conference organised by the IEE in conjunction with many other professional bodies. Contact them at the address below.

Conference For Young Engineers — October 16-18th
Strand Palace Hotel, London. Weekend conference on commercial awareness and business skills for young engineers (under 30) of all disciplines. Events include an engineering company simulation game which tests the ideas under discussion. Contact the IEE at the address below.

Radar '87 — October 19-21st
Kensington & Chelsea Town Hall, London. International conference on civil and military systems organised by the IEE and the American IEEE. Contact the IEE at the address below.

International Video & Communications Exhibitions — October 18-21st
Metropole Exhibition Centre, Brighton. Exhibition with seminar programme covering video equipment, services, programme production, etc. Contact Peter Peregrinus Ltd at the IEE address below.

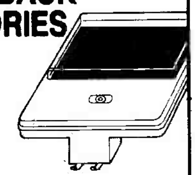
Testmex '87 — October 20-22nd
Business Design Centre, London. Exhibition covering all areas of electronic test and measurement. Contact Network Events on (0280) 815 226.

Addresses:
Cahners Exhibitions Ltd, Chatsworth House, 59 London Road, Twickenham TW1 3SZ. Tel: 01-891 5051.

Institute of Electrical Engineers, Savoy Place, London WC2 0BL. Tel: 01-240 1871.

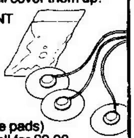
Online Conferences Ltd, Pinner Green House, Ash Hill Drive, Pinner, Middlesex HA5 2AE. Tel: 01-868 4466.

BIO-FEEDBACK ACCESSORIES



A METER MOVEMENT which can be built into your bio-feedback monitor to make it a completely self-contained instrument. Don't worry if you've already drilled the terminal holes – the meter will cover them up!

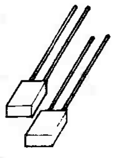
SENSITIVE METER MOVEMENT ONLY £1.90!



SPARE ELECTRODES AND GEL

5 sets of electrodes (10 electrode pads) and a sachet of conductive gel, all for £2.90.

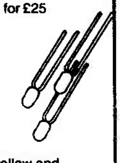
LEDs



RECTANGULAR LEDs

Green rectangular LEDs for bar-graph displays.

50 for £3.50 100 for £6 500 for £25 1000 for £45



DIGITAL AND AUDIO EQUIPMENT LEDs

Assorted 3mm LEDs: red, green, yellow and orange. 25 of each (100 LEDs) for **£6.80**

PROJECT BOX

WITH BATTERY COMPARTMENT

As used in our tachometer and bio-feedback kits. This attractive/and versatile case can be used to house the experimenter kit projects, or your own battery operated projects.

PROJECT CASE WITH PP3 BATTERY COMPARTMENT ONLY £2.60!

LEDSCOPE

FEATURED IN ETI JANUARY 1987

Tony Ellis's famous LED oscilloscope. The most important bench instrument for any electronics enthusiast must be a 'scope , and at this price anybody can afford one! The Ledscope also acts as a voltmeter and ohm-meter. It's got everything!

The complete parts set includes a smart brushed aluminium case, PCB, all components, pots, knobs, switches, and full instructions.

LEDSCOPE PARTS SET, WITH CASE

ONLY £59.95!

SUITABLE PROBE SET £7.95

BIO-FEEDBACK

FEATURED IN ETI DECEMBER 1986

A *complete* parts set for the ETI bio-feedback monitor. Previously offered at £14.55, the last few sets to clear at **£9.99!** We will also supply a free meter movement for the monitor.

The complete parts set includes case, PCB, all components, meter and full instructions.

YOUR LAST CHANCE

BIO-FEEDBACK PARTS SET ONLY £9.99!

~~£14.55~~ £9.99

ONLY UNTIL APRIL 30th

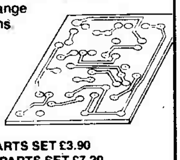
WITH *FREE* METER!

HI-FI POWER METER

FEATURED IN ETI MAY 1987

Measure the output power of your hi-fi with the ETI power meter The meters can be back-lit for effect – the scale and 'power' legend will glow green to contrast with the red pointer. Two switched ranges give readings of 0-10W and 0-100W.

The parts set consists of meter movement, PCB, all components, range switch and full instructions



MONO POWER METER PARTS SET £3.90
STEREO POWER METER PARTS SET £7.20
SUITABLE CASE £7.50

TACHOMETER AND DWELL METER

FEATURED IN ETI JANUARY 1987

MOTORISTS QUIZ

You are driving along the road one day when the sound of a horn makes you look behind The driver of a milk float is cursing you for driving so slowly A while/later, an invalid carriage overtakes you, and just as you turn into your drive you hear a tractor driver mutter 'At last I can get out of first gear!'

Do you:

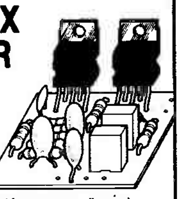
a) Fit a £500 Pie-in-ear in-car stereo with digital flexi-woofers and 24-band ramification?
b) Buy a set of fluffy dice and sticker saying 'My other car is a Macaroni'?
c) Give your car in part exchange for a milk float/ invalid carriage/ tractor?
d) Tune your engine.

The combined tachometer and dwell meter parts set contains: case with battery compartments; printed circuit board; all components; switches; plug, socket and test leads; battery connector; full instructions. The answer to the quiz, by the way, is: e) Buy a bright red Lotus Esprit.

TACHOMETER AND DWELL METER PARTS SET

£12.90 (with terminals for external meter)
£16.40 (with self contained meter)

MATCHBOX AMPLIFIER



FEATURED IN ETI, APRIL 1986

No ordinary amplifiers, these When our first customers took an interest, it was for the diminutive size (both modules will fit in a matchbox!), the total disregard for power supplies and speaker impedances, and the impressive power output from these little amplifiers. When they re-ordered, it was for the sound quality.

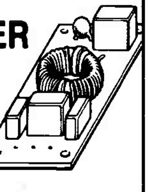
Two amplifier modules were described, both based on the powerful L165V IC The single IC version will deliver over 20 Watts with a suitable speaker and power supply. The bridge version can provide up to 50W! Although the specified supply voltage and speaker impedance must be used to achieve maximum power, both modules are quite happy to work from any voltage between 12V and 32V, and will accommodate any type of speaker. The bridge version is ideal for giving a boost to car Hi-Fi systems, driving two 4 Ohm speakers in parallel on each channel for best effect.

Both designer-approved parts sets consist of a roller tinned printed circuit board and all components The L165V ICs are also available individually, with a free mini data sheet giving specifications and suggested circuits.

SINGLE IC 'MATCHBOX AMPLIFIER' SET (20W into 4 Ohms)	BRIDGE AMPLIFIER SET (50W into 8 Ohms)	L165V IC, with data,
£6.50	**£8.90**	**£3.90**

Complete Parts Sets for ETI Projects

MAINS CONDITIONER



FEATURED IN ETI, SEPTEMBER 1986

It is astonishing how many people buy or build top-flight hi-fi equipment, and then connect it to a noisy, spiky mains supply. Rather like buying a Ferrari and trying to run it on paraffin, you might think. Expecting crystal clear sound, the poor music enthusiast ends up with a muddy, confused mush, and feels that he has somehow been cheated. 'Is this hi-fi? My music centre sounded just as good!'

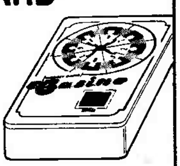
The domestic mains supply is riddled with RF interference, noise, transient spikes, and goodness knows what else. Computers crash, radios pop and crackle, tape recordings are spoiled and hi-fi sounds 'not quite right'. Why put up with it when the solution is so simple? The ETI mains conditioner is the lowest cost upgrade you will ever buy, and probably the most effective!

Our approved parts set consists of PCB, all components, toroid*, enamelled wire, fixing ties, fast response VDR*, and full instructions.

ETI MAINS CONDITIONER|PARTS SET ONLY £4.60!

***Note:** the toroid and VDR supplied are superior to the types specified in the article.

CREDIT CARD CASINO



FEATURED IN ETI, MARCH 1987

This wicked little pocket gambling maching measures only 3"x2"x½". It will play all kinds of casino games, including:

- Roulette
- Craps
- Pontoon

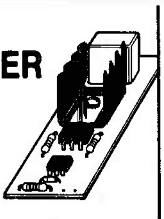
Our approved parts set comes complete with case; self-adhesive fascia; tinned and drilled printed circuit board; all components; hardware; full instructions and three different games to play!

CASINO PARTS SET ONLY £5.90!

SPECIAL OFFER

Five extra games FREE with all orders received before ~~March 31st~~ April 30th

MAINS CONTROLLER



FEATURED IN ETI, JANUARY 1987

Have you ever wondered what people *do* with all those computer interfaces? 'Put your computer in control,' say the ads. 'The Spectrabeeb has eight TTL outputs.' What on earth can you control with a TTL output? A torch bulb?

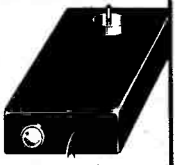
The ETI Mains Controller is a logic to mains interface which allows you to control loads of up to 500W from your computer or logic circuits An opto-coupler gives isolation of at least 2,500V, so the controller can be connected to experimental circuits, computers and control projects in complete safety. Follow your computer interface with a mains controller and you're *really* in business with automatic control!

The mains controller connects directly to most TTL families without external components, and can be driven by CMOS with the addition of a transistor and two resistors (supplied).

Your mains controller parts set contains: high quality roller tinned PCB; MOC3021 opto-coupler; power triac with heatsink, mounting hardware and heatsink compound; all components, including snubber components for switching inductive loads; transistor and resistors for CMOS interface, full instructions.

MAINS CONTROLLER PARTS SET £6.20

POWERFUL AIR IONISER



FEATURED IN ETI, JULY 1986

Ions have been described as 'vitamins of the air' by the health magazines, and have been credited with everything from curing hay fever and asthma to improving concentration and putting an end to insomnia. Although some of the claims may be exaggerated, there is no doubt that ionised air is much cleaner and purer, and seems much more invigorating than 'dead' air.

The DIRECT ION ioniser caused a great deal of excitement when it appeared as a constructional project in ETI. At last, an ioniser that was comparable with (better than?) commercial products, was reliable, good to build . . . and fun! Apart from the serious applications, some of the suggested experiments were outrageous!

We can supply a matched set of parts, fully approved by the designer, to build this unique project. The set includes a roller tinned printed circuit board, 66 components, case, mains lead, and even the parts for the tester. According to one customer, the set costs 'about a third of the price of the individual components'. What more can we say?

Instructions are included

DIRECT ION PARTS SET £9.50

MATCH BOX AMPLIFIERS

20W Single IC parts set £6.50

50W Bridge Amplifier parts set £8.90

L165V Power Amplifier IC, with data, £3.90

LM2917 EXPERIMENTER SET

Consists of LM2917 IC, special printed circuit board and detailed instructions with data and circuits for eight different projects to build. Can be used to experiment with the circuits in the 'Next Great Little IC' feature (ETI, December 1986).

LM2917 Experimenter Set £5.80

RUGGED PLASTIC CASE,

suitable for mains conditioner and mains controller.

ONLY £1.65

SPECIAL OFFER

Our best selling ioniser kit is now available with an elegant white case.

WHITE IONISER PARTS SET ONLY £9.80!

Orders should be sent to Specialist Semiconductors at the address below including 60p towards postage and packing. Please allow up to 14 days for delivery. There is no telephone service at the moment, but all letters or requests for lists will be answered (at top speed if you send SAE!)

Specialist

FOUNDERS HOUSE REDBROOK MONMOUTH GWENT

READ/WRITE

Missing MIDI

I am considering building the MIDI Master Keyboard from the May issue and I have had difficulty in contacting Clef Products for the keyboard mechanism.

It seems that this company is no longer trading. Is there another suitable source for the key switches?

Jonathan Templar
Richmond, Surrey.

Cleff Products do seem to have ceased trading but suitable keyboard mechanisms are available elsewhere. Maplin can supply the keyboard mechanics and the individual contact springs and bus bars. Unfortunately the mechanics are only available in 49 and 61 note versions but a 72 note keyboard could easily be constructed from two of these cut down (wasteful but a good source of spares!).

WEM (Tel: 01-761 6568) can provide two octave keyboard mechanics (which can be joined end to end), complete with bus bars. These may require a little modification but cost only £8 a time.

Radio Activity

My hobby has always been constructing and experimenting with VHF broadcast transmitters (88-108MHz). I have built and quite often use a stereo FM transmitter with 120W output from solid state devices. The response from listeners over 40 miles away is fascinating.

Perhaps this subject is a bit taboo but I would be pleased to hear from others who tinker with broadcasting equipment.

Paul Smith
(Address supplied).

The Department of Trade and Industry would be most pleased to hear from likeminded people too! This activity is not at all taboo, it's just downright illegal. Although low power transmitters are legal in some other European countries and plans for similar legislation here have been made (and shelved) it is still against the law to transmit in this way without a licence (which will not be granted for this kind of use).

If you get caught (which should not be difficult for the DTI as you must stick out like the radio equivalent of a sore thumb) the DTI will come down on you like the proverbial ton (or even tonne) of bricks with a hefty fine or a spell at Her Majesty's pleasure and confiscate all your gear.

If any other readers still want to get in touch with Mr. Smith they can write to him care of ETI (enclose a stamped envelope) but don't say we didn't warn you!

Decline And Fall

With less children today interested in an electronics career and talent scouts with cheque books from the States awaiting our graduates, I had hoped the recent budget would have done more for our homebased science and technology.

Are we going to see a repeat of the hospitals where a nurse finds a more lucrative career serving in a shop nine to five?

The new Silicon Glen in Scotland is very impressive but when you tour this country and see the wilderness of the forgotten heroes, listen to their despair in Durham, Sheffield and Lincoln, you realise every city needs a Silicon Valley of new industries.

Incidentally, I very much enjoyed Anna Paczuska's contribution on 'Bad Health in Electronics' back in the August 1986 ETI. More please! With man pushing the frontiers of Electronics Technology to unknown limits for space travel and defence it is extremely interesting to read the problems behind the science of man's capabilities.

However, the limits of the science were clearly realised recently when a friend accidentally wired a 10µ 63V capacitor the wrong way across a 50V power supply. He nearly lost an eye and the metal top of the radial lodged in the ceiling tiles nine feet up. He now leaves the room before switching on!

Keith Lawrence
Ilkley, West Yorkshire.

We couldn't agree more. Interest in electronics as a hobby has certainly declined over the last few years and government funding for research and development and for investment in industry seems set to do its best to kill off what is left of the British electronics manufacturing base.

Any millionaire ETI readers should find a local electronics firm to invest in immediately.

Shock, Horror, Probes

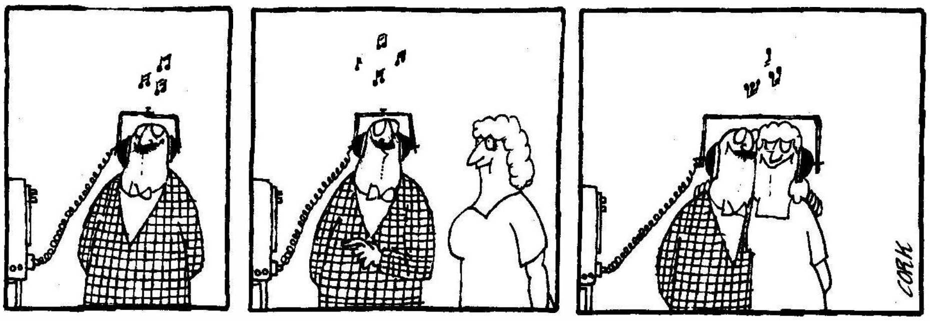
What a surprise you would get if you held the ends of the probes from a resistance meter and got the reading I did. Please explain this one.

C. Ford

Easy one this, for any regular reader of ETI. If you're not a regular reader go and stand in the corner immediately. If you are a regular reader but didn't read the pieces on biofeedback and galvanic skin response back in the November and December 1986 issues, go and stand in two corners (at once).

Skin has a fairly low resistance — anything from about 5k0 to 1M0. The variations in resistance tell you all sorts of interesting things about your body and state of mind. In the ETI office we go around the whole time with probes sticking into bits of our anatomy just to see if we're still awake!

CORK



The ETI post room staff are planning to walk around China at the end of the year in aid of the campaign to save the South Yorkshire Mongoose and so they need plenty of training lugging heavy mail sacks. All ETI readers are formally requested to send in one interesting letter each for this page. Write to:

Electronics Today International
1 Golden Square
London W1R 3AB.

ETI

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POWER STROBE KIT

Designed to produce a high intensity light pulse at a variable frequency of 1 to 15Hz this kit also includes circuitry to trigger the light from an external voltage source (eg. a loudspeaker) via an opto isolator. Instructions are also supplied on modifying the unit for manual triggering, as a slave flash in photographic applications or as a warning beacon in security applications. The kit includes a high quality pcb, components, connectors, 5Ws strobe tube and full assembly instructions. Supply: 240V ac. Size: 75x50x45
XK124 STROBOSCOPE KIT £12.50

HIGH SECURITY LOCK KIT

Designed for use with our lock mechanism (701 150) this kit will operate from a 9V to 15V supply drawing a standby current of only 50uA. There are over 5000 possible 4-digit combinations and the sequence can be easily changed. To make things even more difficult for an unauthorised user an alarm can be sounded after 3 to 9 incorrect entries - selectable by means of a link. The alarm can sound for a few seconds to over 3 minutes during which time the keyboard is disabled preventing further entries. A latched or momentary output is available making the unit ideal for door locks, burglar alarms, car immobilisers, etc. A membrane keyboard or pushbutton switches may be used and a beep sounds when a key is depressed. Kit includes high quality PCB, all components, connectors, high power piezo buzzer and full assembly and user instructions.

XK121 LOCK KIT	£15.95
350 118 Set of Keyboard Switches	£4.00
KB12S 12-Way Membrane Keyboard	£9.98
701 150 Electric Lock Mechanism	£16.50

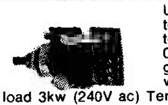
VERSATILE REMOTE CONTROL KIT

This kit includes all components (+ transformer) to make a sensitive IR receiver with 16 logic outputs (0-15V) which with suitable interface circuitry (relays, triacs, etc - details supplied) can be used to switch up to 16 items of equipment on or off remotely. The outputs may be latched (to the last received code) or momentary (on during transmission) by specifying the decoder IC and a 15V stabilised supply is available to power external circuits.

Supply. 240V AC or 15–24V DC at 10mA
Size (excluding transformer) 9 x 4 x 2 cms.
The companion transmitter is the MK18 which operates from a 9V PP3 battery and gives a range of up to 60ft. Two keyboards are available MK9 (4-way) and MK10 (16-way), depending on the number of outputs to be used

MK12 IR Receiver (incl. transformer)	£14.85
MK18 Transmitter	£7.50
MK9 4-Way Keyboard	£2.00
MK10 16-Way Keyboard	£5.95
601 133 Box for Transmitter	£2.60

PROPORTIONAL TEMPERATURE CONTROLLER KIT



Uses "burst fire" technique to maintain temperature to within 0.5°C. Ideal for photography, incubators wine-making, etc. Max. load 3kw (240V ac) Temp. range up to 90°C. Size: 7x4x2.5cms.
MK4 £7.10

DISCO LIGHTING KITS

DL1000K This value-for-money 4-way chaser features by-directional sequence and dimming. 1kW per channel. £17.50
DLZ1000K – A lower cost uni-directional version of the above. Zero switching to reduce interference £9.85
Optional opto input allowing audio 'beat'/light response (DLA/1) 70p
DL3000K –3-channel sound to light kit features zero voltage switching, automatic level control and built-in microphone. 1kW per channel. £14.25

DL8000

The **DL8000K** is an 8-way sequencer kit with built in opto-isolated sound to light input which comes complete with a pre-programmed EPROM containing EIGHTY - YES 80 different sequences including standard flashing and chase routines. The KIT includes full instructions and all components (even the PCB connectors), and requires only a box and a control knob to complete. Other features include manual sequence speed adjustment, zero voltage switching, LED mimic lamps and sound to light LED and a 300W output per channel. And the best thing about it is the price: **ONLY £28.50.**

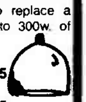
ELECTRONIC GUARD DOG KIT

NEW

One of the best deterrents to a burglar is a guard dog and this new kit provides the barking without the bite! The kit when assembled can be connected to a doorbell, pressure mat or any other intruder detector and will produce a random series of threatening barks making the would be intruder think again and try his luck elsewhere. The kit is supplied complete with high quality PCB, transformer, all components and instructions. All you need is a mains supply, intruder detector and a little time. The kit even includes a horn speaker which is essential to produce the loud sound required. The 'dog' can be adjusted to produce barks ranging from a Terrier to an Alsation and contains circuitry to produce a random series of barks giving a more realistic effect.
XK105 Complete kit of parts £21.95

HOME LIGHTING KITS

These kits contain all necessary components and full instructions and are designed to replace a standard wall switch and control up to 300w. of lighting.



TDR300K	Remote Control Dimmer	£16.45
MK6	Transmitter for above	£4.95
TD300K	Touchdimmer	£8.50
TS300K	Touchswitch	£8.50
TDE/K	Extension kit for 2-way switching for TD300K	£2.70
LD 300K	Light Dimmer	£4.35

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60	11.51	2.31
100	13.43	2.59
200	19.03	3.10
250	23.01	3.24
500	35.45	3.66
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50V		25V	£	P&P
0.5	A	1	5.01	1.76
1	M	2	6.09	1.90
2	P	4	10.84	2.20
3	S	6	12.54	2.25
4		8	17.16	2.58
6		12	21.84	2.79
8		16	30.89	3.15
10		20	36.66	3.60
12		24	43.87	3.80

PLEASE ADD 15% VAT TO ALL ITEMS AFTER P&P

30/15V or 15.0-15V
2×15V TAP SECS

30V		15V	£	P&P
0.5		1	3.86	1.41
1		2	5.24	1.70
2		4	8.47	1.92
3		6	9.82	2.10
4	A	8	11.72	2.20
5	M	10	14.49	2.31
6	P	12	16.40	2.55
8	S	16	21.95	2.60
10		20	25.32	2.84
12		24	28.07	2.95
15		20	31.66	3.51
20		40	43.22	5.95

60/30V or 30-0-30V
2×30V TAP SECS

60V		30V	£	P&P
0.5		1	5.69	1.85
1	A	2	8.67	1.91
2	M	4	11.15	2.20
3	P	6	16.12	2.34
4		8	18.38	2.55
5		10	23.23	2.78
6		12	26.50	3.02
8		16	37.25	3.62
10		20	43.37	3.99
12		24	49.98	4.65

24/12V or 12-0-12V
2×12V Secs. Pri. 240V

12V		24V	£	P&P
0.3		0.15	2.92	1.10
0.5		0.25	3.08	1.60
1	A	0.5	3.70	1.60
2	M	1	5.15	1.70
4	P	2	5.94	1.90
6	S	3	9.31	2.05
8		4	10.89	2.10
12		6	13.20	2.25
16		8	15.73	2.60
20		10	21.17	3.04
30		15	26.31	3.10
40		20	37.56	3.75
60		30	53.92	4.90
83		41	62.09	5.65

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500	16.12	2.68
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1500	34.17	3.68
2000	51.09	4.62
3000	86.88	5.72
4000	112.78	OA
5000	131.33	OA
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250	17.87	3.02
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ALL ABOVE BOARD

Mike Bedford takes a look at surface mounting components and techniques — the miniature future of electronics.

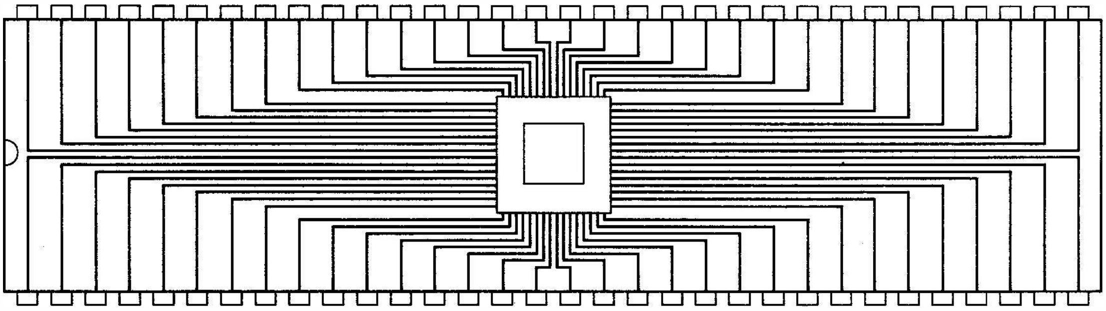


Fig. 1 Poor space utilisation on a typical 64 pin DIL device.

Throughout the realm of electronics and especially in digital applications, one type of component has become increasingly predominant over the past 15 years or so — the 'chip' or integrated circuit housed in one of the various DIL packages.

Of course it is a misnomer to refer to a DIL package as a chip. The actual chip is a small square of silicon embedded inside. The plastic or ceramic housing is provided for purely mechanical reasons. An unpackaged chip could be difficult to handle, prone to damage by environmental factors and impossible to make connections to by conventional manufacturing methods.

Although in the early days the space overhead of DIL packaging was not very significant (most devices requiring only 14 or 16 external connections) this can no longer be said for todays VLSI devices requiring 40 or 64 pins. Figure 1 shows how in a typical 64 pin DIL package, there is a very high area ratio of packaging to silicon.

Clearly this is inefficient in PCB space and recent moves in IC packaging are providing much greater economy of space. The new ICs also require a departure from conventional PCB assembly methods.

Traditionally, components are mounted through holes in the board making solder connections to the copper tracks on the opposite side to the components. Newer packaging methods are intended for surface mounting which, as the name suggests, means the components are mounted on the surface of the PCB and the solder contact is made on the same side of the board as the components. Figure 2 illustrates the two mounting methods.

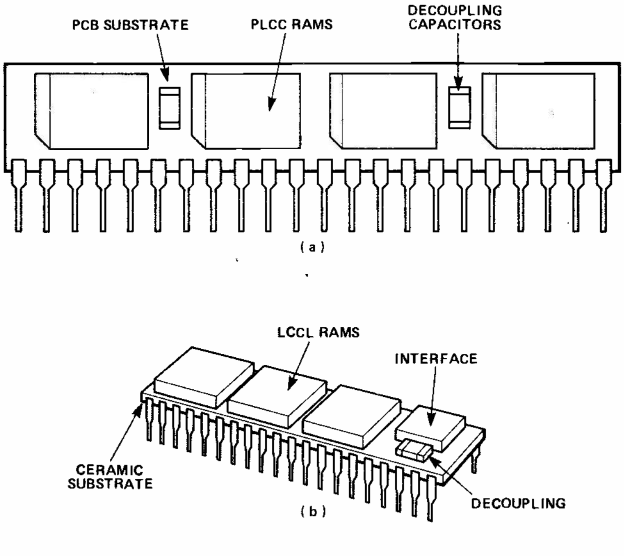
Advantages

The most notable advantage of surface mounting is the space saving achieved. This is a result of two factors. Surface mounting packages take up less room than their DIL counterparts. This is not an inherent advantage of surface mounting but results from the fact that a need for efficient board utilisation was a major consideration when the new packages were designed.

Surface mounting devices can also be fitted to both sides of a board.

SIL and DIL Modules

When is a surface mounting package not a surface mounting package? When it is a SIL or DIL *module*. These forms of packaging provide a means of taking some advantage of the space saving achieved by using surface mounting without the initial capital outlay required to convert to true surface mounting assembly. A SIL module is a small PCB with PLCC packages already mounted on it by the semiconductor manufacturer and pins spaced at 0.1in along its edge. This board can be through mounted on a conventional PCB as a single component. Dynamic RAMs are currently available in this format, a typical SIL pack containing, say, eight 64K × 1 devices giving a capacity of 64K × 8. A DIL module on the other hand is a ceramic substrate with pins along two edges allowing it to match the standard DIL footprint. LCCC packages are mounted on the ceramic substrate and this format is often used for static RAMs.



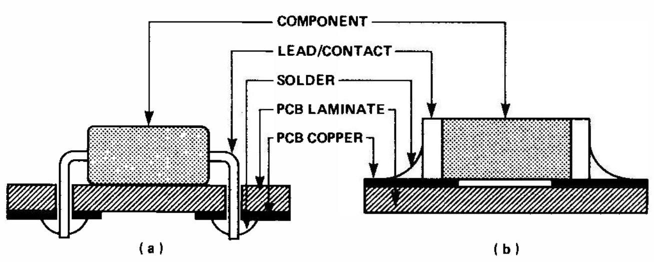


Fig. 2 (a) Through hole construction. (b) Surface mounting.

To the home constructor, a slightly larger PCB is not usually a problem but in a commercial environment PCB 'real estate' is a very valuable commodity. Quite apart from the extra cost of a larger board, there is the possibility the required circuitry will not fit onto a single board. If two boards have to be used in place of the one, costs really escalate as expensive and potentially troublesome interconnections have to be made. If the increased size results in the need for a larger case, space saving becomes even more significant.

As well as allowing smaller printed circuit boards, surface mounting also results in PCBs which are less expensive than expected from the size comparison alone. This is because the manufacturing cost of PCBs depends on a number of factors, a major one being the number of holes to be drilled. PCBs for surface mounting are not devoid of holes since there is still a requirement for through plated holes to connect between the two sides of a double sided board but there will clearly be a marked reduction in their number.

The assembly of boards may be slightly more difficult when surface mounting components by hand (a much smaller soldering iron bit and a steady hand are required) but when automated PCB assembly is considered there are significant gains of speed and costs to be achieved. Although the actual copper pads on the PCB are smaller for surface mounted components, the need for accurately placing leads through small holes is obviated. A moderate degree of inaccuracy in terms of position and rotation of components can be tolerated. A further consideration is that pre-forming passive component leads prior to fitting into holes is no longer required.

Conventional assembly equipment is no longer applicable and so there is a capital outlay requirement on first adopting the technology. However, a long term saving is still achieved.

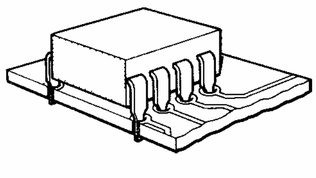
Surface mounting also claims the advantages of increased reliability (especially where the circuit board is subject to vibration), improved frequency response and decreased immunity to electromagnetic radiation. Of course these later two points are directly attributable to the smaller package size which allows shorter track lengths both within the IC package and on the PCB.

Surface mounting has necessitated improved methods of PCB printing and etching to be developed to cope with the narrower tracks and decreased gaps. Current technology has reduced track widths and spacings to 0.15mm and the through holes to 0.3mm which is sufficient for current surface mounting packages but a further reduction to 0.075mm and 0.1mm respectively will be required for some proposed new packages. Heat dissipation is also a potential problem and is exagerated by the reduced surface area of the new packages. Some manufacturers have attempted to reduce this problem by incorporating fins onto the packages but the general concensus is that overheating is better avoided than cured. Accordingly many manufacturers are converting to CMOS for the new devices.

Packaging

For well over a decade there has been a high degree of standardisation as far as IC packaging is concerned. ICs for through hole mounting will usually be standard DIL packages.

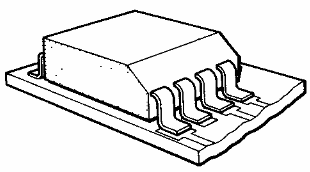
Surface mounting components are available in a bewildering array of different packages. Clearly there is a need for standardisation in this area and for one or two package types to be accepted as the standard in the same way as the DIL package has been for many years.



DIL Package

The DIL package is currently the standard IC package for through hole PCB assembly. All packages have straight pins spaced at 0.1in in two rows. The row spacing is dependent on the total number of pins in the package. Devices with up to 20 pins use a 0.3in row spacing. For 22 pins the spacing is 0.4in, for 24-40 pins it's 0.6in and for larger devices the row spacing is 0.8in.

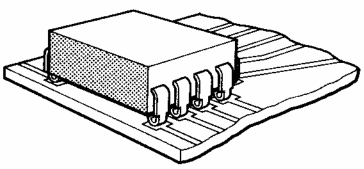
New packages (such as the 'skinny DIP' with a row spacing of 0.3in for all ICs, the shrink DIP with pin spacing reduced to 0.07in and the pin grid array used for high pin count ICs with a grid of pins on 0.1in centres) all represent attempts to reduce PCB space but are less effective than surface mounting techniques.



SOP or SOIC

The Small Outline Package (SOP) or Small Outline Integrated Circuit (SOIC) tend to be used for pin counts up to 24 — the range in which they are most efficient in terms of board space occupied. SOICs have the same pin arrangement as DIPs but on a smaller scale, pins being separated by 0.05in and the two rows by 0.15in for 8-16 pins and 0.3in for larger pin counts.

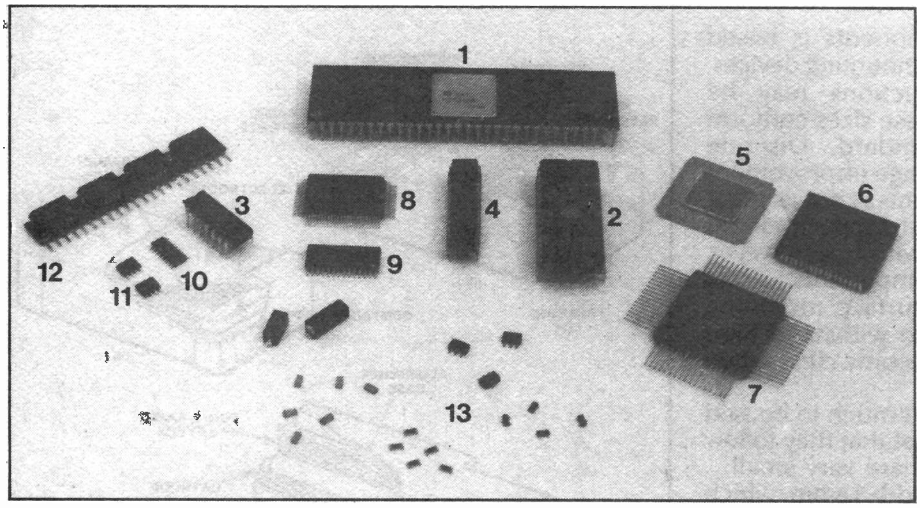
Standard TTL and CMOS logic families are now available in SOP and since these packages have a clear similiarity to DIPs, the pin outs are identical. Some analogue devices are also available in this format. In order to allow them to be surface mounted, SOICs have so called 'gull wing' pins.



PLCC

The Plastic Leaded Chip Carrier (PLCC) is a greater departure from DIL packaging having leads on all four sides of a square or rectangle. Like SOICs, the leads are spaced at 0.05in, half the distance of DIPS, but unlike SOICs, the leads are bent under the plastic package in what is referred to as a J-bend.

Pin counts available in PLCC are 18, 20, 28, 44, 68 and 84. Currently, logic families, memories, microprocessors, peripherals, gate arrays and analogue devices are available in PLCC format.



1) 64 pin DIL
2) 28 pin DIL
3) 14 pin DIL
4) 24 pin skinny DIL
5) 68 pin LCCC
6) 68 pin PLCC
7) 68 pin flat pack
8) 80 pin FPP
9) 28 pin SOIC
10) 16 pin SOIC
11) 8 pin SOIC
12) SIL module
13) Discrete components

Size Considerations

Surface mounting components are significantly smaller than their DIL counterparts. Figure 3 illustrates this more quantitatively, comparing the surface area of DIL, SOIC, FPP and chip carrier (PLCC or LCCC) packages. (See the box for explanations). Although this graph shows how a very significant saving in board area is achieved, it should be borne in mind that whereas the surface area increases with the square of the linear dimensions, the volume and hence the weight increase with the cube. In other words, the saving in weight will be even more significant so long as we compare similar packaging materials (both plastic or both ceramic).

Discrete Components

As the advantages to be gained by surface mounting integrated circuits would be considerably reduced if discrete components still had to be through mounted, most discrete components are either already available in surface mounting packages or under development. Resistors, capacitors, inductors, diodes and transistors may now be obtained in the surface mounting format from a number of suppliers. Connectors and variable components, on the other hand, are yet to make their

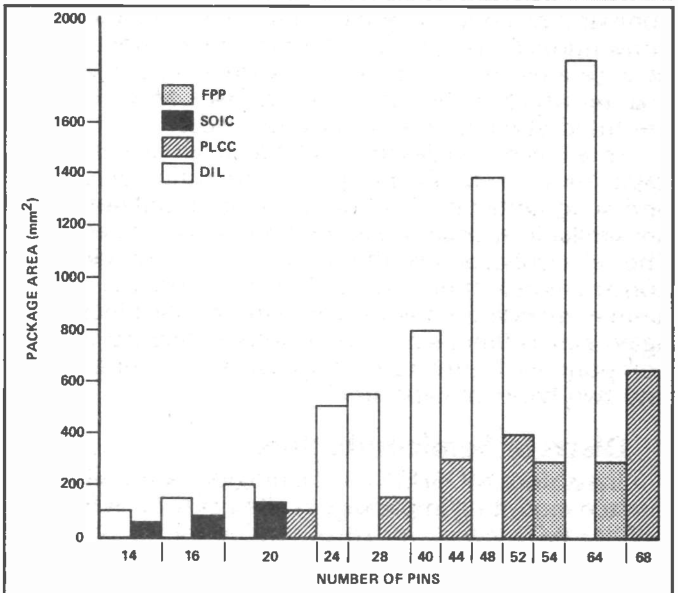
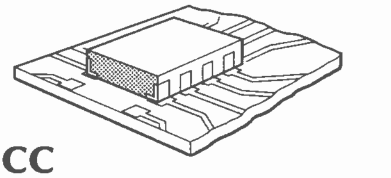


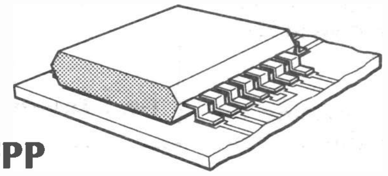
Fig. 3 Size comparison of DIL and various surface mounting devices.



LCCC

The Leadless Ceramic Chip Carrier (LCCC) is similar to the PLCC but has no leads at all, the J-bend leads of the PLCC being replaced by metal contacts moulded into the ceramic body. As LCCCs are thinner than corresponding PLCCs and they lack leads protruding from the package, they are more robust and easily handled by automatic placement equipment. However, they are the most expensive surface mounting package and tend to be used primarily for military applications.

Non military uses are mostly microprocessors and EPROMs where a quartz window is required. There are a number of different variants of the LCCC package to accommodate chips of different shapes. For example, there is both a square and a rectangular version of the 28 pin LCCC.



FPP

The Flat Plastic Package (FPP) has probably achieved less overall acceptance than the other three packages but nevertheless is used quite extensively by some manufacturers. Having gull wing leads on all four sides, spaced at even smaller gaps than SOIC, PLCC and LCCC packages, the FPP is well suited for large pin counts.

Currently, FPPs are available with up to 100 pins and the 200 pin package is under development. FPPs have various different pin spacings: 1.0mm, 0.8mm and 0.65mm versious being available and a move to a 0.55mm (0.02in) spacing looking likely.

As the pin spacing decreases as the pin count increases, packages up to 100 pins are all the same size. Clearly a major application of FPPs will be in semi-custom chips, gate arrays, etc — an area in which pin out has traditionally been a major limitation.

Other Packages

Further types of surface mounting package abound and include leaded ceramic chip carriers (which are not a ceramic version of the PLCC), PLCC variants (in which the pin count is increased by having two rows of pins in a castelated arrangement) and flat packs which can have leads protruding directly out of the sides of the pack. They can, however, have their leads pre-formed for either through hole or surface mounting assembly.

A further packaging strategy developed by British Telecom uses neither plastic nor ceramic but, in an attempt to overcome problems of thermal mismatch and strain between board and component, it uses epoxy glass PCB laminates as the chip carrier. Essentially, this is a surface mounting version of the pin grid array.

appearance in large numbers.

My information on discrete components is based mainly on the Mullard range of surface mounting devices. Although different internal constructions may be adopted by other manufacturers, the case sizes conform to an internationally accepted standard. Discrete components are small but the percentage improvement over through hole mounting components is not as great as with integrated circuits. Since most modern circuit boards are predominently populated with ICs, however, size is not as critical with discrete components.

One important characteristic of surface mounting discrete components is their ability to withstand high temperatures. The need for this will become clear when we consider assembly.

From a user point of view, there isn't much to be said about a surface mounting resistor except that they follow the accepted E24 range of values and are very small.

The length is only 3.2mm and the width 1.6mm, which compares to a body length of 5mm for a comparable ¼W conventional resistor. The internal construction consists of a ceramic block on which is deposited a resistive coating which is then trimmed by laser. Metal contacts are fitted at each end in place of leads.

Three technologies are available in surface mounting capacitors — ceramic multilayer, aluminium electrolytic and solid tantalum. The multilayer and tantalum types are similar in appearance to the resistors described above. The electrolytics on the other hand are closer in construction to their through hole counterparts with the aluminium cylinder then encased in a plastic block. Once again small dimensions are a notable feature of these components. Figure 4 shows a surface mounting resistor and two types of capacitor.

Discrete Semiconductors

Transistors, MOSFETS and Darlingtons are available for surface mounting in packages called SOT-23, SOT-89 and SOT-143 (SOT stands for small outline transistor). These SOT packages are very similar in appearance to a diminutive SOIC package with 3 or 4 pins. The SOT-23 and SOT-43 packages are only 3.5mm × 2.7mm and the SOT-89 is a little larger as it tends to be used for Darlington transistors which require a greater heat dissipation. The package used for diodes is the SOD-80. Some typical discrete semiconductors are shown in Fig. 5.

Assembly Methods

Conventional assembly involves first inserting the components through holes in the board either by hand

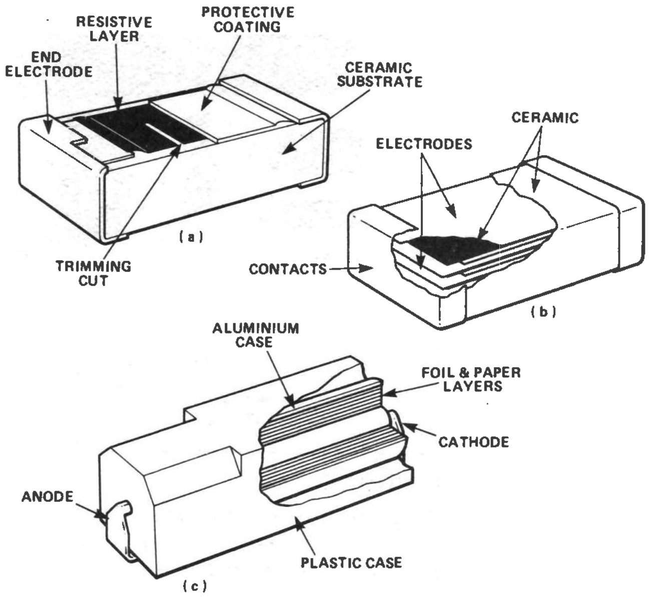


Fig. 4 Passive components. (a) Resistor (b) Multilayer capacitor (c) Electrolytic capacitor.

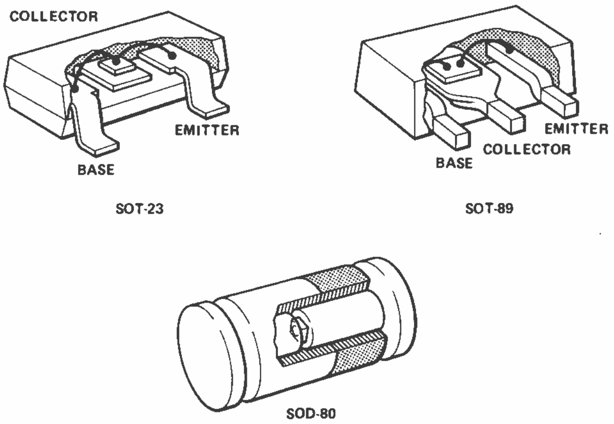
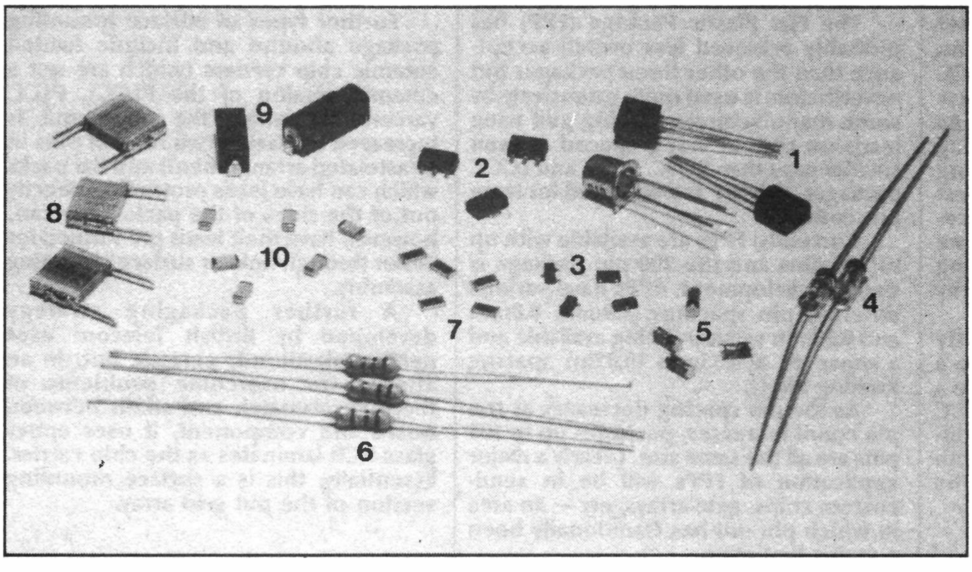


Fig. 5 Discrete semiconductor packages.



1) Conventional transistors
2) SOT-89 transistors
3) SOT-23 transistors
4) Conventional diodes
5) SOD-80 diodes
6) Conventional resistors
7) Surface mounting resistors
8) Conventional capacitors
9) Electrolytic SM capacitors
10) Ceramic SM capacitors

or by automatic insertion equipment and then passing the PCB through a wave soldering machine.

As the component leads pass through holes in the board the components are held in place while soldering is taking place. This would clearly not be the case with surface mounting components. In this case, some form of adhesive has to be used to secure the components until they are finally soldered. The adhesives used for this purpose fall into two categories — inert adhesive and solder paste.

Ordinary adhesive is used simply to fix the package to the board and is obviously applied to an area of the component well away from its electrodes (for example in the centre of a LCCC package). This type of adhesive is used with wave soldering, but an obvious difference between this and the wave soldering used with through-mounting components is that the solder wave is applied to the component side of the board. This explains why surface mounting packages are designed to withstand high temperatures. Figure 6 illustrates the solder wave method of PCB assembly.

The other type of adhesive (solder paste) is used with a family of assembly methods known as reflow methods. Solder paste is a form of adhesive which actually contains a high proportion of solder powder. This paste is applied to the copper pads of the PCB and the component is fixed to the board by its electrical contacts. The board is then heated to about 260°C at which temperature the solder in the paste melts and forms a solder joint between PCB and component.

Various methods are used for this reflowing. The most widely accepted is vapour phase. In this, the board is placed in the vapour of a boiling inert liquid, usually a fluorinated hydrocarbon. The advantage of vapour phase over other reflow methods is that it enables the reflowing to be carried out at a comparatively low temperature. A constant temperature is achieved without the need for complex control circuitry and the use of an inert atmosphere eliminates the possibility of oxidation. Figure 7 shows a typical arrangement for vapour phase reflow soldering.

Other methods used for reflow heating are infrared, convection, hot air jets, laser and pulse heated solder tools. Of these only infrared and possibly convection offer a viable large scale alternative to vapour phase, the other methods being used for small volume production or repair.

It will be obvious that both board and components are raised to a high temperature during soldering and subsequently both return to room temperature. If the materials used for the PCB and the components have different co-efficients of expansion, there is a very real possibility of stress being placed on the assembly.

In the case of the LCCC and most passive components, this is exagerated due to the lack of leads which would allow some degree of flexibility. For this reason, a great deal of research has been carried out to find new and more suitable materials for the PCB. New materials used for PCBs for the surface mounting of ceramic chip carriers and which have similar co-efficients of expansion include ceramics and insulated aluminium or copper.

The Future

There is no doubt that surface mounting is the way ahead in the electronics industry, the only questions are *How much?* and *How soon?*. Today a relatively small percentage of applications have gone to surface mounting due mostly to a resistance to change, the capital outlay required and the higher cost of surface mounting components.

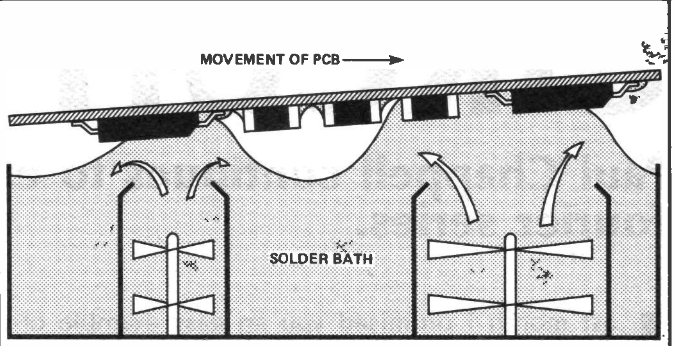


Fig. 6 Dual wave soldering.

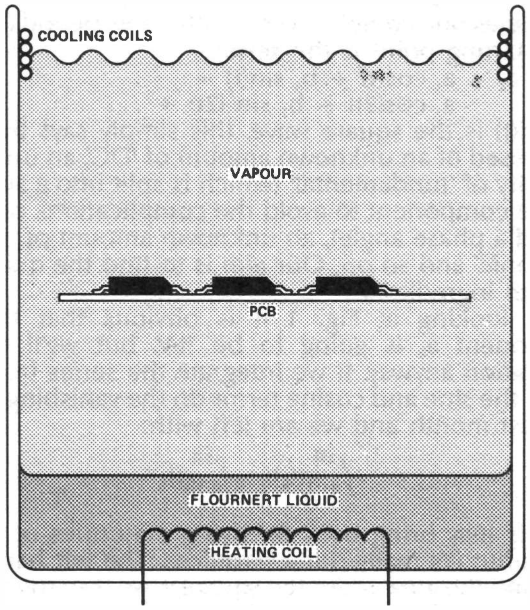


Fig. 7 Vapour phase reflow soldering.

It is generally considered that this price premium is only a short term situation and that by the end of the decade it will be the DIL components which are the more expensive. It is also significant that even now some of the new microprocessor peripherals coming onto the market are only available in PLCC or LCCC packages. Despite these factors, however, the move to surface mounting is perhaps not taking place quite as rapidly as predicted only a couple of years ago.

Japan is the current world leader in this technology, being the first country to use it on a large scale in cameras and other consumer goods where space saving is important. About 30% of electronics manufacturing used surface mounting during 1985 in Japan and it is suggested that this will rise to about 50% by 1990.

On the other hand, it looks as if Europe will be using only 35% by the end of the decade. Indications are that it is in the area of active components that the changeover will be most apparent.

Already the world usage of passive components is about 25% surface mounting but the vast majority of transistors used are still leaded. By 1990 it is predicted that the figure for transistors will be approaching 75%.

Certainly time will tell but in the meantime it could be worthwhile getting in some practice with a very small soldering iron and a very steady hand! **ETI**

CIRCUIT THEORY

Paul Chappell continues to explore the labyrinth of the Fourier series.

Last month I promised you an easy example of a Fourier Series. In all good textbooks (and bad ones for that matter) it is *de riguer* to begin with a square wave. Since the calculations are easy, I'll do the same!

In the calculations of the Fourier coefficients, the integrations are carried out over the interval 0 to 2π, so to make things really easy let's have a square wave which completes one complete cycle within this period (Fig. 1a). Our starting point is the series:

$f(t) = a_0 + a_1 \cos(t) + b_1 \sin(t) +$
$a_2 \cos(2t) + b_2 \sin(2t) + \ldots$

If f(t) is the square wave, this simply says that it is composed of an unknown amount of 'DC', an unknown quantity of 'fundamental' (which is split into a sine and cosine component to avoid the complications of trying to find a phase angle), an unknown amount of 'second harmonic' and so on. Our aim is to find the quantities of each ingredient.

By looking at Fig. 1 it is obvious that the DC component a_0 is going to be ½V, but we'll do the calculation anyway. If we integrate the series from 0 to 2π all the sine and cosine terms do the vanishing act we saw last month and we are left with:

$$\int_0^{2\pi} f(t)dt = \int_0^{2\pi} a_0 dt$$

This may bring back terrifying memories of school maths but it's really quite harmless. The left hand side says 'find the area under the square wave over the interval 0 to 2π'. Looking at Fig. 1, this is going to be 1 x π .

The right hand side says 'find the area under a straight line of 'height' a_0 over the interval 0 to 2π'. From Fig. 1b, it's going to be a_0 x 2 . The 'equals' sign in the middle says 'make the two areas the same'. Once again, it's obvious that the value of a_0 which will make the two areas the same is ½.

Although it's obvious what the result will be, we'll press on regardless. Replacing f(t) with the square wave it represents, the result is:

$$\int_0^{\pi} (1)\, dt + \int_{\pi}^{2\pi} (0)\, dt = \int_0^{2\pi} a_0\, dt$$

What has happened now is that the area under the square wave has been replaced by the area under it when it's equal to 1 (over the first half of the interval from 0 to π) plus the area under it when it's equal to zero (over the second half of the interval from π to 2π), which I'm sure you'll agree is the same thing.

Now we do the integrations and end up with:

$$\pi + 0 = a_0 \times 2\pi => a_0 = \frac{\pi}{2\pi} = ½$$

We knew it all along, but doesn't it boost your confidence to see the maths trot out the same answer? No? Well, can't please everyone I suppose!

Finding the other coefficient is just as easy. Take b_1 as an example. Again, start with the series:

$f(t) = a_0 + a_1 \cos(t) + b_1 \sin(t) +$
$a_2 \cos(2t) + b_2 \sin(2t) + \ldots$

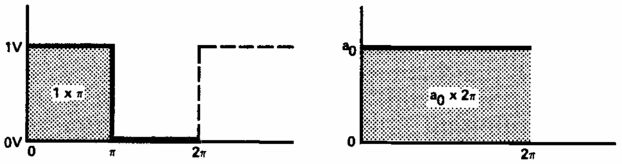


Fig. 1 Integrating the square wave Fourier series. (a) The square wave itself. (b) the first term of the series.

Now, somehow we have to get rid of all the terms in the series (Fig. 2a) except for the one involving b_1 (the coefficient we're concentrating on for the moment). If the series is multiplied throughout by sin(t), the result is shown graphically in Fig. 2b. It results in all the components having equal areas above and below the axis except for the $\sin^2(t)$ part. If we now integrate over one period, the areas above and below the axis cancel out, so all the terms disappear except for the one we're interested in. So, first we multiply through by sin(t):

$f(t) \sin(t) = a_0 \sin(t) + a_1 \cos(t) \sin(t) + b_1 \sin^2(t) + a_2 \cos(2t) \sin(t) + b_2 \sin(2t) \sin(t) + \ldots$

Now we integrate from 0 to 2π (Fig. 2c):

$$\int_0^{2\pi} f(t) \sin(t)\, dt = \int_0^{2\pi} a_0 \sin(t)\, dt + \int_0^{2\pi} a_1 \cos(t) \sin(t)\, dt + \int_0^{2\pi} b_1 \sin^2(t)\, dt + \ldots$$

Since all the terms except the one involving b_1 are zero (Fig. 2d) this leaves:

$$\int_0^{2\pi} f(t) \sin(t)\, dt = \int_0^{2\pi} b_1 \sin^2(t)\, dt$$

Finally, replacing f(t) by the square wave it represents, the left hand side follows sin(t) for half a cycle, then becomes zero for the rest:

$$\int_0^{\pi} \sin(t)\, dt = \int_0^{2\pi} b_1 \sin^2(t)\, dt$$

Now, the left hand side of this equation says 'find the area under one cycle of a half-wave rectified sine', the right hand side says 'find the area under $b_1 \sin^2(t)$ (the two mountain peaks, or whatever else your imagination may make of them, in Fig. 2d). The 'equals' sign says 'make the two areas equal'. This time it's not obvious what value of b_1 is needed to make the two areas equal, so we'll have to continue with the maths.

There's no need to 'do' the integration on the right hand side — from the orthogonality properties of sines we already know that $\int_0^{2\pi} \sin^2(t)\, df = \pi$
The result is:
$[-\cos(t)]_0^{\pi} = b_1 \pi => 2 = b_1\ \pi => b_1 = \frac{2}{\pi}$

The other coefficients are calculated in exactly the same way, so there's nothing to be gained by going through another in detail (but do try one for yourself). To save time, I'll do all the rest at once:

$$\int_0^{\pi} \sin(nt)\, dt = b_n \int_0^{2\pi} \sin^2(nt)$$

The left hand side is the result of multiplying the square wave by sin(nt). It's equal to sin(nt) over the first half of the interval (0 to) and zero thereafter. The right hand side is the remaining term after all except the one involving b_n have vanished.

$$\left[-{}^{1}/_{n}\cos nt\right]_0^{\pi} = b_n\pi \Rightarrow b_n = \begin{cases} 0 \text{ for n even} \\ \frac{2}{n\pi}\text{for n odd} \end{cases}$$

A similar calculation for the cosine coefficients shows that every single one of them is zero, so the Fourier expansion of a 0.5Hz, 1V square wave is:

$f(t) = \frac{1}{2} + {}^{2} (\sin (t) + \frac{1}{3} \sin 3t + {}^{1}/_{5} \sin (5t) + \dots)$

So, a square wave has a DC component and a series of sine components which diminish with frequency. There are no even harmonics at all.

What happens if we want to find the spectrum of a higher frequency square wave? Or a higher amplitude one? Or one centred on 0V instead of above it? Do we need to do the calculations all over again?

You'll be relieved to hear that having found the spectrum for one square wave, we've found them all. Because integration is a linear operation (double the amplitude of a wave and you double the area under it, for instance) all we need to do is scale the coefficients. The time axis can also be scaled for different frequencies. I said earlier that the 0 to 2π interval represents 2π seconds, but I could equally well have said 2π milli-seconds, or any other scale I happened to choose.

When calculating a Fourier series it is usual to choose the easiest possible values to work with, which generally means an angular frequency of 1 radian per second and a peak value of 1V. The use of *normalised* values (easy values which can be scaled afterwards to suit your purposes) is very common in linear circuit theory. (It doesn't work with non-linear maths or circuits because the values can't be scaled!)

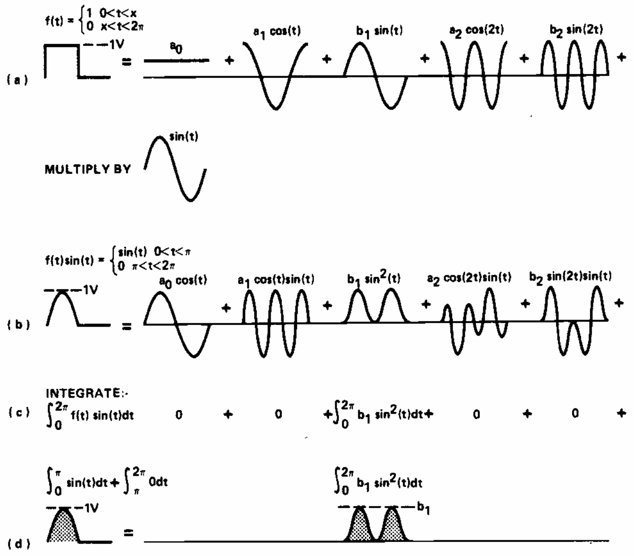


Fig. 2 Calculating a term in the Fourier series. (a) The series. (b) Multiply by sin(t). (c) Integrate. (d) All the other terms vanish allowing the coefficient to be easily calculated.

As an example, to find the Fourier expansion of an 8V peak-to-peak square wave at 1kHz, varying between —2V and +6V, first multiply the coefficients by 8:
$f(t) = 4 + {}^{16} (\sin(t) + \frac{1}{3} \sin(3t) + \dots)$
(this wave is of frequency 0.5 Hz, 0 to 8V). Scale up the frequency from 0.5Hz to 1,000Hz (increase frequency by a factor of 2000π)
$f(t) = 4 + {}^{16} (\sin(1000\pi t) + \frac{1}{3} \sin(3000\pi t) + \dots)$
(this is 1kHz wave, 0 to 8V). Finally, adjust the DC level — the whole wave is shifted 'downwards' by 2V, so the mean level will also be 2V lower:
$f(t) = 2 + {}^{16} (\sin(1000\pi t) + \frac{1}{3} \sin(3000\pi t) + \dots)$
(this is 1kHz wave, —2V to +6V.

A question I raised last month, but left unanswered, was the range of functions which can be expanded as a Fourier series. In the broadest sense of the question it seems clear that since all the harmonic components repeat after each interval of 2π the series is only appropriate to continuous, repetitive waveforms. Euler (who derived the 'Fourier series' before Fourier did) would have agreed. Fourier himself, with his cavalier attitude to the niceties of maths had no difficulty in accepting that if he could make the series fit over the length of his iron bar, what it did elsewhere was irrelevant.

It's a notion we feel comfortable with today, but to the mathematicians of Fourier's time it was a huge conceptual stumbling block. If we *do* care what the series does beyond the interval of interest, it's a job for the Fourier integral, which is a story for another day.

On another level, what guarantee do we have that the Fourier series actually matches the initial waveform? Last month I showed graphically how adding extra sines in the correct proportions brought the *partial sum* (the sum of the harmonic components 'so far') closer and closer to a square wave — for the first three at least. Could there be a series in which adding extra sines takes the waveform further and further from the original?

The process of getting a better approxmation as more terms are added is called *convergence*. If the approximation gets worse as more terms are added, the series is said to *diverge*. The notions of 'better' and 'worse' are too loose to work with but think about this for a moment.

Suppose I choose some point along the time axis ($\pi/2$, say) for the square wave of Fig. 1, and note the value at that point (it will be 1). Now I'll take the Fourier series for the square wave and calculate the first few partial sums at that point. Taking only the first term, the DC component, it's ½. 50% out! Not too good so far. Add in the next term, which is $2/\pi$ sin(t). At $\pi/2$ this will have a value of roughly 2/3. Adding to this the first term gives 1/2 + 2/3 = $1^{1}/_{6}$. 1/6 too high. The next term has a value of roughly —2/9 at $\pi/2$; adding this in gives 17/18. The value is low again, but only 1/18 out.

With each successive term, the partial sum oscillates about the required value, but the general trend is to get closer to it quite rapidly. From a 50% error to a little over 5% in three terms is not too bad! If this happens for every single point on the square wave and the partial sums remain within any arbitrarily small distance from the true value if enough terms are taken, the series can certainly be said to converge.

The notion of a series converging at every single point is called (naturally enough) *pointwise convergence*. This aspect of the Fourier series was investigated in detail by Dirichlet (1805-1859). He concluded that a Fourier series will match any continuous waveform with a finite number of turning points. (It can have a million billion of them, a googolplex of them, a moser of them, as many as you like as long as it's finite). If the waveform also has a finite number of discontinuities, it will have a Fourier series which matches it everywhere *except* at the discontinuities, where it will have a value half way between the points on either side.

An example of a waveform with discontinuities is the square wave. We are used to seeing square wave approximations displayed on 'scopes, where they have 'vertical sides' from a finite rise and fall time, but really a square wave should be drawn as in Fig. 3a. A true square wave leaps instantaneously from one value to another — this is known mathematically as a discontinuity. Dirichlet's claim is that the Fourier series for the square wave actually adds in spurious points as in Fig. 3b!

It's easy to see that the series will indeed add in these points. Think about the point $t=\pi$ where Fig. 1 drops from 1 to 0. Here, every single sine term will have a value 0, so all that remains is the constant term of ½, which puts in a point smack in the middle of the two square wave values!

What's going on here! For practical purposes the appearance of a single extra point at each transition makes no difference. After all, a single point lasts for exactly no time at all, so no circuit will ever notice it. But it's still rather disconcerting to find that the maths is wrong. Thanks to Dirichlet it's predictably wrong, but wrong all the same.

This is by no means the end of the story. Take the wave in Fig. 3c, for example. It is a square wave except for a few odd points which have gone astray. The Fourier series for this is exactly the same as for a perfect square wave! The common sense reason is that since the Fourier coefficients are calculated by integration, the points have no area beneath them and are therefore 'invisible' to the process.

It's interesting to see how far this notion can be pushed. Clearly, any finite number of points (a million billion, a googolplex, a moser — you name it) will be invisible to the integration. If one point has no area beneath it, a million points will have no area beneath them. There are even some infinite sets of points which will do the trick. If the square wave goes astray on every point in the interval which can be expressed as a rational number (a 'fraction') the Fourier coefficients will still turn out with the same values. To see how outrageous this is, consider that any interval, however small, has a rational number in it. There is not the tiniest portion of the modified square wave where its Fourier series matched it at every point!

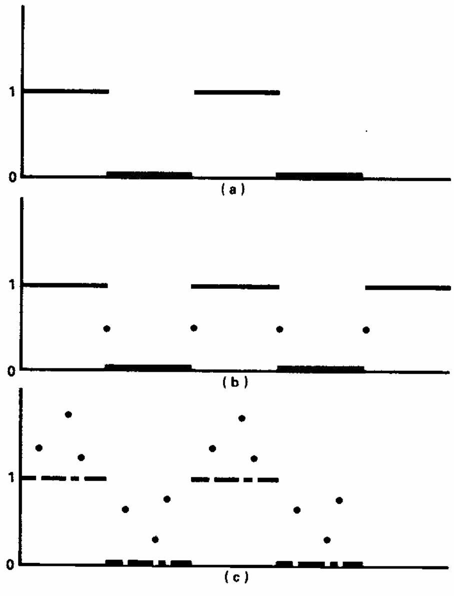


Fig. 3 (a) A true representation of a square wave. (b) A square wave with spurious points 'added' by the Fourier series. (c) A square wave with more spurious points.

Joseph Fourier
1786-1830

Fourier would probably have thought of himself as a politician rather than a physicist (although he should not be confused with Charles Fourier, the utopian socialist, who was born and died within a few years of J. Fourier). Today he is remembered almost exclusively for his 'Theorie Analytique de la Chaleur' (Analytic Theory of Heat) published in 1822.

Fourier's study of heat conduction led him to believe, by physical rather than mathematical reasoning, that the temperature distribution in a rectangular bar could be expressed as a series of sines and cosines.

He then set off on a most bizarre calculation which involved a Taylor series expansion of functions which didn't actually have one and division by (in effect) infinity. He ignored everything that didn't correspond to his preconceived idea of what the answer ought to be!

Fourier was not the first person to propose sine wave expansions or even to calculate what we now call the Fourier coefficients (Euler had done it some 45 years previously). His outstanding contribution was to recognise the full extent of the validity of the expansion. It had previously been supposed to apply to only a very limited range of functions.

For this insight, Fourier was awarded the Grand Prize of the Academy without having proved a single correct result about the series that bears his name!

At this stage there are two options. You can say 'Enough of this nonsense!' and refuse to admit that square waves with points scattered here and there have a Fourier series at all. Alternatively, you can shift the goal posts — devise a new definition of convergence which allows for the fact that it seems to be possible to derive a Fourier series for some very bizarre functions.

Mathematicians, needless to say, have taken the latter course. Research into Fourier series is still a fertile area to this day and a definitive answer to the question of which functions do and do not have a Fourier expansion is still not in sight. **ETI**

HARDWARE DESIGN CONCEPTS

Mike Barwise takes a look at programmable logic devices and finds they are not exclusively the province of commercial designs.

Programmable logic devices (PLDs) are frequently considered a great mystery. There is a myth that they are very difficult to use, possibly due to their requirement for programming equipment beyond the pocket of most amateurs.

Designing with PLDs is in fact extremely easy and several suppliers of these devices now run programming services at quite moderate cost (a £25 setup charge is typical) and so the use of PLDs in logic design no longer has to be solely the domain of manufacturing industry.

PLDs come in three basic official categories, PAL, PLE and PLA. It is, however, seldom pointed out that the now familiar EPROM is also a programmable logic device. The assumption that EPROMs only store PROGRAMS is a very limited view of their potential.

I have been asked to mention at this point that PAL and PLE are trademarks of Monolithic Memories, who arguably invented the PAL concept.

Conventional Logic

I do not intend to go into the theory of Boolean algebra here, as there are many good textbooks available. The fundamental concept behind PLDs is worth stating though. The concept is: *Any logic function can be reduced to a sum-of-products expression.* A sum-of-products expression is a formula equating an output with a set of inputs via the operators AND, OR and NOT. For example the EXCLUSIVE-OR function can be expressed as:

$$Y=A*\bar{B}+\bar{A}*B$$

where A and B are two inputs, Y is the output, * means AND, + means OR, the bar means NOT (invert) and = means equals! This relationship is shown as logic gates in Fig. 1.

This axiom holds true for both combinatorial (gates only) and sequential (clocked logic), the only difference being that race conditions establish the timing of combinatorial networks, whereas the outputs of sequential circuits are synchronised by the clock. The conventional symbol for *equals* in sequential logic equations is := (colon-equals) which is interpreted as *results in after clock.*

PAL, PLE, PLA: The Differences

Assuming that a finished logic network is constructed according to the axiom given above, there will be considerable variation in the interconnection density at the different levels according to the nature of the logic function implemented. Some functions may need lots of inputs to each AND gate while others need few inputs per AND term but lots of OR inputs from a large AND array. To accommodate these differing requirements, the three types of device have been produced — PAL, PLE and PLA. See Fig. 2.

PAL consists of a programmable AND array with true and inverting inputs to each AND gate, coupled to one fixed OR array per output (Fig. 3). PAL is the most useful when you are designing AND intensive circuits like counters and shift registers. The range of alternative matrix configurations is greater than that of PLE (this is necessary as there is a limited number of AND terms allocated to each OR/output term due to pinout and programming constraints), and many parts have additional 'higher level' functions built in, such as registers with feedback into the AND array, or exclusive-OR networks at the inputs to provide additional terms to the array.

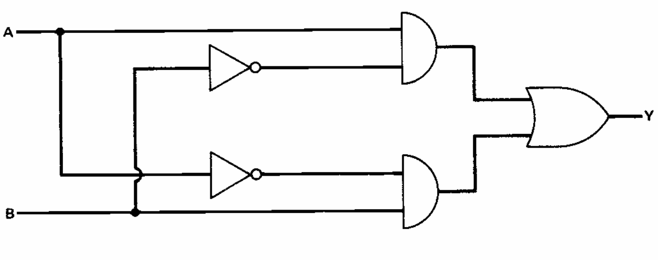


Fig. 1 The 'sum-of-products' representation of an exclusive OR gate.

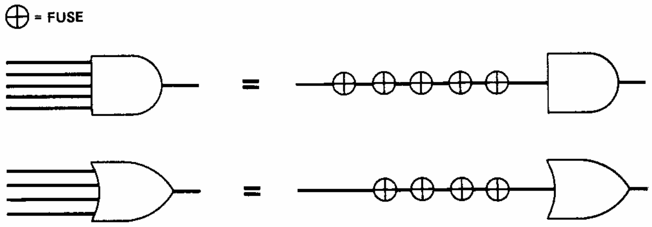


Fig. 2 The graphic convention for PLD gate arrays.

PLE is the logic designers' definition of the familiar PROM. It has a fixed, exhaustively decoded AND array (all possible combinations of all inputs available and no 'don't care' inputs) and a programmable OR array. This is beneficial when you want a complex random logic sequence, or for random block decoders, in fact anywhere your number of alternative output states is the measure of complexity.

Some PLE devices are available with output registers, allowing safe feedback into the PLE or its own outputs. If you can handle the brain strain, this is a method of generating surprisingly complex logic sequences and is the basis of microcontroller design. It is quite possible to cause fed back inputs to conditionally modify the output sequence by gating them externally with real world stimuli.

The PLA is the most complex of the three to work with, but arguably the ultimate in versatility. It has both programmable AND and programmable OR arrays, and is the next best thing to a fully custom chip layout (Fig. 5). However, design tools for PLA tend to be expensive and flashy (in the £1000-plus bracket) so we won't give these devices much further attention at the moment.

Designing Your Logic'

Let us take a very simple problem to start with. Suppose we want to create our own 1-of-8 decoder equivalent to the TTL 74LS138. It can be implemented in a PROM (PLE, EPROM) very easily. There are two common routes to the solution. One is to write out an exhaustive truth table (the whole size of your PROM!) of the data for all addresses (including those not actually required) and then key the PROM output data into a programming file.

The other method is to express the problem as a set of Boolean equations (one for each of the eight PROM outputs) and let a PLE assembler generate the actual programming data. In fact, the limited number of states required (nine) suggests that the latter is the only sensible approach.

The first task is to define the input and output requirements. We must:

- Recognise eight unique input patterns of three bits but only if all enable signals are active.
- Provide a standard null output for all other input patterns.
- Provide eight unique outputs which correspond to the literal binary values of 0-7 in accordance with the relevant inputs.

Supposing we want a direct replication of the 74LS138, we have two low enables and one high enable. However, let us make a small improvement and add another high enable. This gives us three address inputs and four enable inputs (a total of seven) which dictates a PROM size of 128 bytes. We also need eight outputs, so the minimum device is a 128×8 PROM. The sensible EPROM solution is a 2716 (2K×8) with the three high address lines grounded.

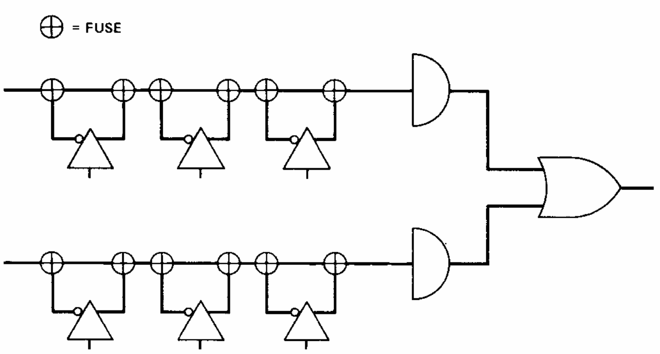


Fig. 3 A simplified view of PAL architecture.

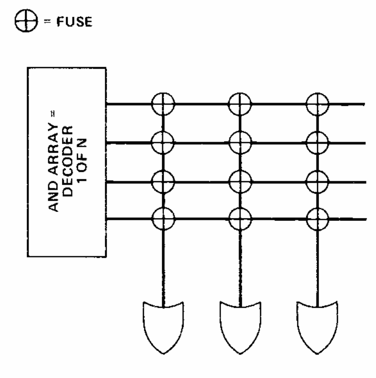


Fig. 4 A simplified view of part of a PLE (a PROM).

If we design our decoder in EPROM by the truth table method, it is necessary to consider the best choice of address pin for each input. If, for example, the enables were allocated to low address lines (A0, A1, A2, A3) the active data in the EPROM would be widely distributed throughout its memory map (consecutive control bytes 16 addresses apart) which would make data entry very tricky.

The alternative (selection of inputs to simplify the generation of the PROM table) could make the resultant device less easy to connect up in use. A PLE assembly tool such as MMI's Pleasm would automatically handle this problem. As there are no design tools for EPROM, however, we must be our own PLE assembler and we must find a short cut if we want to minimise the possibility of errors and optimise the resultant device. Any short cut will become obvious as soon as the equations for our decoder have been generated, so let's do that next.

The Boolean Solution

The description of the 1-of-8 decoder in sum-of-products form is really very simple. We consider each output in isolation. First we must declare our input and output signals (the constants and variables in our equations).

Let us call our inputs HE1, HE2 (the active high enables), LE1, LE2 (the active low enables), A0, A1, A2 (the three address inputs), and our outputs M0-M7 (memory chip selects).

The universal condition for operation is that all enables are active. So there is a common term to all eight output equations, which is:

$$\mathrm{ACT}=\mathrm{HE1}*\mathrm{HE2}*\overline{\mathrm{LE1}}*\overline{\mathrm{LE2}}$$

where ACT is a macro name (a shorthand reference) for the right hand expression. This can be used to reduce the typing burden and improve readability in the remaining equations. The active low enables have been negated to demonstrate their active low status.

Whenever ACT is TRUE (HE1 and HE2 are high and LE1 and LE2 are low) the decoder will generate one of the selectable outputs. ACT is only a theoretical term (the full right hand expression will always by substituted for it eventually) so it can be considered as active high (the default) for convenience.

The equation for M0 (the lowest addressed output) is thus:

$$\overline{\mathrm{M0}}=\mathrm{ACT}*\overline{\mathrm{A2}}*\overline{\mathrm{A1}}*\overline{\mathrm{A0}}$$

so M0 will go LOW when all enables are active and all three addresses are LOW).

The remaining equations are:

$$\overline{\mathrm{M1}}=\mathrm{ACT}*\overline{\mathrm{A2}}*\overline{\mathrm{A1}}*\mathrm{A0}$$
$$\overline{\mathrm{M2}}=\mathrm{ACT}*\overline{\mathrm{A2}}*\mathrm{A1}*\overline{\mathrm{A0}}$$
$$\overline{\mathrm{M3}}=\mathrm{ACT}*\overline{\mathrm{A2}}*\mathrm{A1}*\mathrm{A0}$$
$$\overline{\mathrm{M4}}=\mathrm{ACT}*\mathrm{A2}*\overline{\mathrm{A1}}*\mathrm{A0}$$
$$\overline{\mathrm{M5}}=\mathrm{ACT}*\mathrm{A2}*\overline{\mathrm{A1}}*\mathrm{A0}$$
$$\overline{\mathrm{M6}}=\mathrm{ACT}*\mathrm{A2}*\mathrm{A1}*\overline{\mathrm{A0}}$$
$$\overline{\mathrm{M7}}=\mathrm{ACT}*\mathrm{A2}*\mathrm{A1}*\mathrm{A0}$$

Note that the outputs are labelled with the NOT symbol to indicate that they are active LOW. All the equations are interpreted in a similar manner to the first.

When this set of equations (which exhaustively describes the 1-of-8 decoder) is fed into a PLE (PROM) assembler, all the internal mapping and address correlation is automatically taken care of and the user only has to specify which device pins he has chosen to perform each function. Similarly, the EPROM user has to decide which pins are which but instead of working out and then keying the whole table into an EPROM programmer, we use our short cut. This consists of

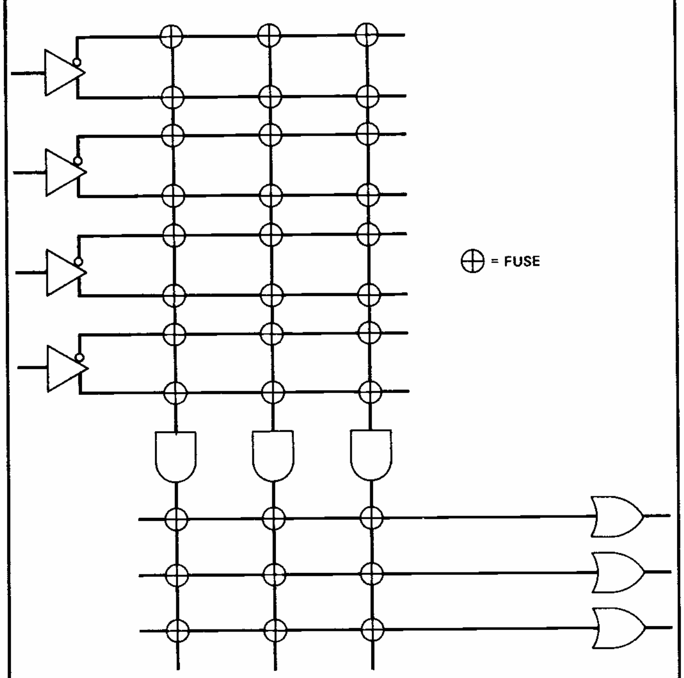


Fig. 5 A portion of a theoretical PLA.

referencing the chosen inputs and outputs to their theoretical binary weight.

Mapping Into The EPROM

First you choose a convenient input pin for each device input in terms of the physical layout of the final device. You might, for example, want all your enables together at the top left of the chip, and your address inputs below them. At this point you must also decide which inputs are to be used. Note that any EPROM enables must be considered as unused, as these tri-state the device, which we don't want. We are concerned here with *address inputs* and *data outputs* only.

Having defined the function of all inputs, you proceed similarly with the outputs. A table of the result of this process demonstrates that each active pin has been assigned a 'binary weight' resulting from its conventional EPROM AD or D values (Table 1). By substitution of these binary weights into both sides of each equation in turn, you arrive at a data byte expected at each of eight unique input addresses (Fig. 6).

Poking these bytes into a table the full size of your EPROM (2K) will produce the desired result (Fig. 6). The large number of 'non-active' states (when the enable term ACT is not true) can be handled by pre-writing the whole EPROM table with FFh. This equates in logic terms to 'all outputs high'.

Any truly 'don't care' inputs (spare address lines) can be hard wired to ground to minimise the size of the required table, otherwise the equations you create must include them as phantom terms. If, for example, eight address lines were present and you have chosen to use the low seven (A0-A6) the table you generate must be duplicated in both the upper and lower halves of the EPROM (selected by A7) unless A7 is assumed hard wired to ground, when only the lower table is needed.

Do not expect much *performance* from the EPROM decoder. It is really a demonstration rather than a viable option. However the same process applied to a 128×8 or 256×8 bipolar PROM yields a perfectly useable device.

PLE or PAL?

While the 128×8 PROM (PLE) version of the decoder is quite adequate, the number of used terms (in particular the lack of OR terms) makes this decoder a prime candidate for implementation in a PAL.

A PAL is chosen for a given implementation, after the Boolean equations have been written, according to the following criteria:

- How many input pins do you need?
- How many outputs pins do you need?
- How many OR terms per output? If this varies from output to output, is the distribution of OR terms in a given PAL adequate?

This looks surprisingly like the decision set for choice of PLE (PROM), doesn't it! The major difference is the third item. The number of OR terms per output in PAL is fixed so the OR terms matter. Next month we will look in more depth at PAL implementation and consider some more complex examples where PAL scores heavily in terms of neatness and ease of use.

Function	EPROM pin	Binary Weight (hex)	Function	EPROM pin	Binary Weight (hex)
HE1	1 AD7	I 80	Vcc	24 Vcc	Vcc
HE2	2 AD6	I 40	GND	23 AD8	I 100
LE1	3 AD5	I 20	GND	22 AD9	I 200
LE2	4 AD4	I 10	Vcc	21 Vpp	Vcc
A2	5 AD3	I 8	GND	20 OE	GND
A1	6 AD2	I 4	GND	19 AD10	I 400
A0	7 AD1	I 2	GND	18 CS	GND
GND	8 AD0	I 1	M7	17 D7	Q 80
M0	9 D0	Q1	M6	16 D6	Q 40
M1	10 D1	Q 2	M5	15 D5	Q 20
M2	11 D2	Q 4	M4	14 D4	Q 10
GND	12 GND	GND	M3	13 D3	Q 8

Table 1 Binary Weight Table for 1-of-8 decoder in 2716 EPROM. I = input, Q = output, GND = NOT for weighted terms.

Boolean equation:
$\overline{\text{M0}}$=HE1*HE2*$\overline{\text{LE1}}$*$\overline{\text{LE2}}$ *A2*A1*A0

Assume all inputs/outputs default high:
Input pins AD7-AD0
Output pins D7-D0
Any included GND=NOT

Expand the equation:
M7*M6*M5*M4*M3*M2*M1*$\overline{\text{M0}}$=
HE1*HE2*$\overline{\text{LE1}}$*$\overline{\text{LE2}}$*$\overline{\text{A2}}$*$\overline{\text{A1}}$*$\overline{\text{A0}}$*$\overline{\text{GND}}$

Substitute EPROM pin names:
D7*D6*D5*D4*D3*D2*D1*$\overline{\text{D0}}$=
AD7*AD6*$\overline{\text{AD5}}$*$\overline{\text{AD4}}$*$\overline{\text{AD3}}$*$\overline{\text{AD2}}$*$\overline{\text{AD1}}$*$\overline{\text{AD0}}$

Sum the binary weights:
FE (hex) = CO (hex)

In other words, program EPROM byte CO (hex) with data FE (hex)

Fig. 6 Manual function mapping. An example substitution for M0.

ETI

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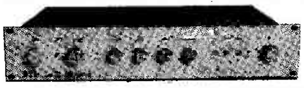

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RED CURRY

Helen Armstrong finds Chris Curry striving to get back in control.

Chris Curry was in the boardroom of General Information Systems wielding what looked like a twig covered in withered leaves. I remarked the plant did not look well. "On the contrary," Curry announced. "It's getting a chance to procreate". He shook a peppering of seeds from the dried pods into a used envelope, and handed the packet to an assistant with instructions to file it. Chris Curry, former Sinclair collaborator and leading light of Acorn, is still planting for the future.

When Acorn was losing money like a leaky sieve in the race for the cut price micro market and was bought out by Olivetti, co-founder Curry was free to try out a different line of enquiry which had attracted him even before the development of Acorn. He formed General Information Systems (GIS) and with a team of about a dozen people, many former Acorn colleagues, set out to develop and market microprocessor-controlled devices whose application was specific and practical.

Early Days

"When I was first selling microcomputer systems," says Curry, "it was before the micro boom and we were selling to people like ETI readers who already had an interest in technology. I was always asked 'what can I do with it?' This is the most difficult question in the world to answer. If I'd relied on market research, for instance, it would have shown there was no point trying to sell computers because there was no market! Fortunately, we don't all work by market research.

"Today the answer to that question is 'control, timing, energy management, word processing and desk diary'. Interactive control in the home was always talked about but never really achieved except by a few enthusiastic amateurs."

Curry's latest offspring are Red Boxes. Apart from their fire engine colour, Red Boxes could be a cryptic breed of distribution board. They plug into and operate down standard mains wiring and some of them double as mains outlets, but their real task is control.

The first generation of Red Boxes are marketed as add-ons for already popular home micros (BBC micro, Spectrum and Commodore 64) in the form of a £133 starter pack with a control module, a 13A switched outlet and a heat-sensitive movement detector. These are known respectively as Red Leader, Red One and Red Two. "Second World War RAF flying jargon," explains Curry.

Red Leader contains its own 6502 processor, ROM, RAM and modem. "The unit itself detects which computer it is connected to and downloads an appropriate terminal program to the micro. Once programmed, it is no longer dependent on the outside computer, which can be disconnected.

"Anybody with a home computer already has an advantage," says Curry. They are familiar with keyboard interfaces. There are three million micros out there — mostly Sinclairs, some BBCs and Commodores — which are mostly not being used. A machine which makes them useful again is good in a number of ways. Seeing a computer doing something practical, like switching, has great appeal and putting a discarded machine back into use is highly satisfying."

In The Future

That assumes centralised microprocessor control will be commonplace in the future. Few people have a clear idea of what they want from it in the home. The old question is still being asked: what do we do with it? "At the moment," maintains Curry, "the answers are energy management, security alarms, or simply automating — like an intelligent timer, but without fiddling with the mains wiring. It's interesting to notice home security systems are being installed at a rate of knots but they are inflexible. A floodlight is a good deterrent, but only at night. During the day something different (such as a siren) could automatically replace it on the same sensing and timing information. A system which expects different things at different times of the day or year would be even more useful." A siren (inevitably christened Red Alert) is on the way.

"The next really important step will be a modem which allows you to phone in and bleep the system to alter settings down the line. It will work both ways. It'll also phone you and indicate if it has received certain readings. No, it won't speak — we aren't using voice synthesisers yet! This is particularly important, because people like to be able to change the system remotely."

With the general extension of remote control into all areas of domestic and business life, the inviolability of these personalised systems has been an important consideration.

Interference

Potential problems of interference between two systems working on the same ring main, and the more sinister threat of accidental or deliberate data tresspass by outside mischief-makers has been forestalled by allocating an incredibly complex address code to each box.

"Anyone trying to break in would have a devil of a time. The data is encrypted in a number of ways. First, there is the large address. Secondly, when the data is sent out it is jumbled with an encryption with a key which is unique to that package of data. Even if they recorded the signal and tried to read it with an oscilloscope, it would remain jumbled. This is unique among mains borne comms systems."

As they stand, Red Boxes are aimed at micro owners. Programming experience is not required, but it helps. "The system has high programmabality at the moment. Red Basic is a bit like BBC Basic with extensions and there is a complete guide to Red Basic in the Basic manual for those who want to get to know the system inside out."

Eventually there will be a Red Box which is not connected to a computer, with a simple single-line display, a few buttons, and limited programming possibilities. Even so, will homes be a flourishing market for computer-based hardware in the immediate future? Curry's attitude is that although it is early days, his boxes have other outlets.

"You could divide Red Boxes into two concepts. On the one hand it is a mains modem, which actually allows you to send digital information along the mains wiring. On the other hand, it is quite a sophisticated communications protocol for point to point serial transmission of data, with a quite powerful control language to go with it. If you put the two things together there are some interesting industrial applications. I don't have any concrete examples to offer you because the product is too new but at exhibitions a lot of energy management engineers have been showing interest. Security people too. Even in a house, it costs from £500 to £1,000 to have a fairly simple system wired in."

"These are devices which people can build applications around, enabling devices for all kinds of purposes. People have the opportunity to use their imaginations.

Communication

General Information Services, says Curry, was set up to develop the processing of information and the use of computers in information technology. "Computers will be used more frequently for communications than anything else but the information to be carried is not yet available in the quality and quantity needed for the market."

With their other main project, the Communicator, GIS is looking at ways of introducing a desktop computer which is essentially a remote database terminal with local data manipulation facilities, built in modem and automatic telephony. It can receive Teletext and, with a small modification, Datacast, and can be built into a local area network. "This Communicator was developed by Acorn and they are still marketing it. It's only available to OEMs at the moment. GIS has the rights to it and we are still working on creating the necessary information base to launch our version. It is a long process, providing a systems house role if you like. We are presenting the hardware with the software, not just the systems software but material people are actually in need of, the raw information.

"We are hoping to appeal to the top end of the consumer market, in which case the software must be available as part of the machine. When the Communicator is ready, it must be absolutely straightforward to extract information. You should be able to feed a demand into the computer, and it will search for the database and do the rest. It must be capable of reprocessing the data, of extracting the exact details or figures you want and giving a printout that you don't have to analyse further. It has half a megabyte of storage — it's not just a dumb terminal."

So what is it that appeals to him personally? Developing new ideas, or developing the company as a whole?

"Success. Whether it's a successful product or a successful company. Both, preferably. The pleasure of seeing something well received, and the added pleasure of seeing it make a profit for the company. I think the two go together. In a small company, which GIS is, if you're not very close to the conceptual development of a product then you are not close to the company. I'm also very close to the corporate development and strategy of the company. I make no claims to be close to the technical development of the products — there are people much better than me to look after that. But no matter how clever the technology is, if the concept is wrong, the product fails, and vice versa, of course."

"There are lots of really clever products that have failed because they weren't marketed properly. The development of a company is an expensive gamble. If you don't get the market and the product right, you will lose a lot of money.

"Having said that, there are a lot of independent commercial organisations these days where people with an idea can go to get support, without laying out a lot of money. They can get a bit of market research done, or management advice on how best to produce and market the product. That type of support didn't exist a few years ago. People ought to take full advantage of it, while being careful not to to be taken advantage of. Some provide venture capital as well, but I think one should try to separate venture capital from management services. Some sources of capital are offshoots of banks, who probably know less about the management problems of a small company than the inventor of the idea!

"But if you are looking for ongoing management support, it is very important to remember that you must have a good, personal working relationship with any partners. People with ideas don't like being interfered with. Unfortunately, there are no set rules. You can't separate being the boffin from running the business in a small company.

"I'm a great believer in working back from the market's needs. You have to try and imagine what the customer will want and work back to the product without detracting from the craft. As the developer of a product, you are leading the customers. If you ask them what they want, they won't know. It's only when they see it they can make a decision. We have to use our imaginations to show people the possibilities open to them. But if the product isn't right, they won't have it however clever it is."

ETI

NUCLEAR STRATEGY SIMULATOR

Deterrence is dead, the victim of precisely-targetted Cruise and Trident missiles. So says David Guinness and he sets out to prove it with the aid of a map and a little logic.

Most of us have got used to thinking of nuclear weapons as a simple deterrent: if they launch theirs against us, we'll launch ours back at them. That way, everyone loses so it is in both our interests not to fire first.

This concept of Mutually Assured Destruction (MAD) is out of date in the view of many people. It relied on the fact that missiles were not terribly accurate and a large number would have to be launched against an enemy to ensure complete destruction of important targets. Such an attack could be detected with relative ease long before any missiles arrived, giving the enemy plenty of time to launch their own missiles in response.

Now we have highly accurate weapons such as Cruise and Trident, many of which can fly at low altitude so that they are very difficult to detect until shortly before they hit their target. With this sort of accuracy, missiles can be directed at enemy missile silos and have a good chance of destroying them before the missiles can be launched in return.

The result is a complete reversal of deterrence theory. When it is possible to destroy enemy missiles with little risk to oneself, the best means of defence is to fire first. You may not get enough warning to fire second.

This view is inevitably controversial. Governments don't way to give away a possible advantage so they certainly won't announce that they have a first strike capability in these terms. Indeed, most refuse to concede

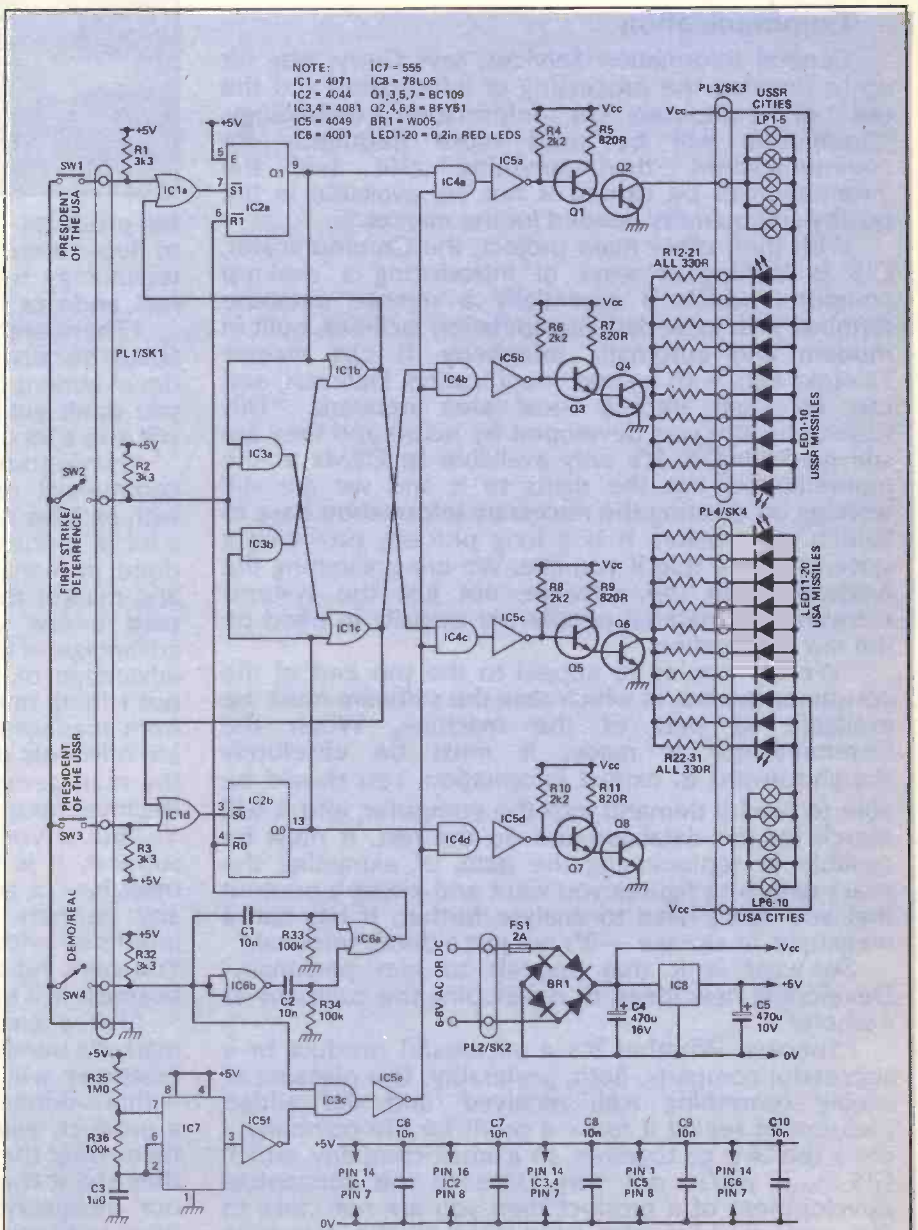


Fig. 1 Circuit diagram of the Nuclear Strategy Simulator.

HOW IT WORKS

With SW2 closed and SW4 open, the Nuclear Strategy Simulator is set to the DEMO and DETERRENCE modes. One input of IC1a and IC1d will be held high and a logic high will appear on the inputs to the two latches (IC2a and b). These inputs are active low so outputs Q_0 and Q_1 will not latch.

When SW1 is pressed the previously high input to IC1a is pulled low and a low output level is passed to pin 7 of IC2. The output from pin 9 will go high and remain latched in this state when SW1 is released.

The high level output from the latch is combined in AND gate IC4a with the signal from IC7 and its associated circuitry. IC7 is a 555 timer which generates a low-frequency (roughly 1Hz) square wave. This output is passed via IC3c and IC5e to IC4a and produces a square wave output which drives Q1/Q2 and causes LP1-5 to flash steadily on and off. These lamps represent USSR cities.

The high level on IC2 pin 9 is also passed to IC1b whose output in turn feeds IC4c. The other input of IC4c receives the square wave output from the oscillator circuitry so the output of this gate will also be a square wave. This is passed via IC5d to Q5/Q6 and causes LEDs 11-20 to flash. These LEDs represent USA missiles.

When SW4 is set to the REAL position, IC3c receives a low on one of its inputs. This stops the oscillator output being passed to the rest of the circuitry. Instead, the output of IC3c goes low and is inverted by IC5e so as to provide a high level on the inputs of the four AND gates, IC4a-d. Pressing SW1 or SW3 now causes one output of IC2 to latch as before and produces a high level on the other input of two AND gates. The resulting high output level is inverted by the buffers IC5a and c or IC5b and d to provide a low level into the transistor pairs. Pressing one of the buttons in the REAL mode therefore causes one set of missile lights and the opposite set of city lights to go out completely.

Moving SW4 from DEMO to REAL also puts a low level on the input of IC6b and a short high level pulse emerges from the differentiating network, C2/R34. This is inverted by IC6a to form a short, low-level pulse into the active-low reset inputs of IC2. Moving SW4 back to DEMO sends a high level to the other differentiating network, C1/R33, producing a short high level pulse which is again inverted by IC6a. In this way the two latches are reset every time SW4 is operated.

Opening SW2 transfers the simulator from DETERRENCE to FIRST STRIKE mode. R2 pulls up one input on each of the two AND gates, IC3a and b. If SW1 is pressed now, the resulting high on the output of latch IC2a will take the other input of IC3a high and place a high level on one input of the OR gate, IC1c, causing its output to go high as well.

The output of IC1c feeds one input of OR gate IC1d which drives the input of latch IC2b. This high level will prevent the active-low input of IC2b being triggered. In this way, pressing SW1 first prevents SW3 being used and vice versa.

The output of IC1c also feeds the AND gate IC4b, the other input of which receives the square wave output from the oscillator circuitry. This signal will be passed to inverter IC5b and the transistor pair Q2/Q3, causing LEDs 1-10 to flash. These LEDs represent USSR missiles.

LEDs 11-20 (representing USA missiles) and LP1-5 (representing USSR cities) will also flash, having been enabled in the normal way by the high output on latch IC2a. The difference between DETERRENCE and FIRST STRIKE modes is in the addition of the extra set of flashing LEDs.

Just as in the DETERRENCE mode, moving from DEMO to REAL in the FIRST STRIKE mode removes the flashing oscillator from the circuit.

that such a scenario is militarily feasible and continue to talk in terms of nuclear deterrence.

Because of this, we have no firm idea just when either of the superpowers is likely to achieve full first strike capability. Estimates for the USA range from 1992 (put forward by Robert Alridge in his book *First Strike*) to as close as 1988 (according to the book *Death Of Deterrence*). Even the most optimistic independent sources expect the change to take place before 1995. There are fewer estimates regarding progress in the USSR because less information is available but given their oft-stated intention to match US capabilities it is unlikely they will be more than a few years behind.

The Nuclear Strategy Simulator described here is a simple demonstration unit which allows the concepts of deterrence and first strike to be explored in the form of a game. One player (or a group of players) takes the part of America while the other is Russia. Both have cities to protect (represented by white lamps on a large map) and both have missiles they can fire at the enemy (represented by red LEDs on the map).

The Simulator has two very simple modes of operation. In DETERRENCE mode, the missiles are assumed to be fairly inaccurate on both sides and therefore threaten only the enemies' cities. Firing one set of missiles destroys the opponents' cities but leaves them with missiles which they can fire back. The missile lights go out once the missiles have been fired and the city lights go out when the cities have been destroyed.

In the second mode (FIRST STRIKE) the missiles on each side are assumed to be accurate enough to destroy enemy missile sites as well as cities. Firing either set of missiles now causes all the lights on the opposite side to go out and prevents the enemy mounting a return attack.

A DEMO mode allows missiles which have been fired and cities which have been destroyed to flash rather than go out. This is helpful while the rules are being explained to players.

Construction

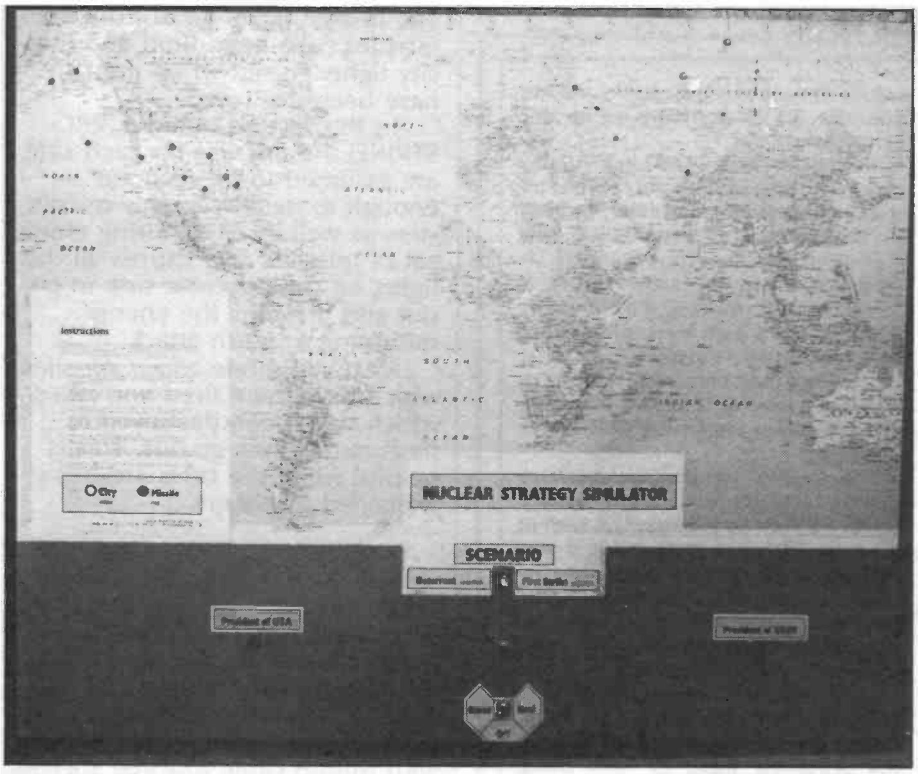
All the main circuitry is carried on one printed circuit board which mounts on the back of the map board. The lamps, LEDs and switches are mounted directly through the map board and wired with ribbon cable to three sockets on the PCB.

The only item not mounted on the back of the board is the transformer which will be required for mains operation. This is housed in a separate earthed metal box and only the low-voltage output taken to the Simulator.

The board as it stands is designed to operate from a 6-8V supply, AC or DC. If preferred, the values of the LED series resistors (R12-31) can be altered to allow the Simulator to run from a 12V AC or DC supply such as a car battery. The filament lamps would also need to be changed from 6V to 12V for this. Decide before proceeding which voltage you want the Simulator to run from and select the appropriate resistor values (330R for 6-8V operation, 510R for 12V operation).

The PCB component layout is shown in Fig. 2 Begin assembly by installing the connectors, the fuseholder and the IC sockets (if you plan to use them). The fuseholder has a screw-cap on one end and should be positioned so that this overhangs the side of the board. Insert the resistors and capacitors next and then the transistors. Last of all, solder the ICs into place or install them in their sockets.

The board can be tested by connecting it to a 6V battery or a suitable power supply (you won't need a large battery at this stage because the board draws very little current without the lamps and LEDs). Connect the supply to



SK2 and leave plugs PL1, 3 and 4 empty. Assuming nothing nasty happens at switch on, connect one of the 6V bulbs between V_{cc} and the collectors of Q2, Q4, Q6 and Q8 in turn. The bulb should light in each case.

If all seems well, take a piece of wire and briefly short it between 0V and the 'TO SW1' connection of PL1. Go back and check the collectors of the four output transistors again. You should find that the bulb lights up when connected to Q8 but flashes when connected to Q2, 4 or 6.

The next stage is to stick the map firmly to its backing board. When complete, it is a good idea to protect the edges of the map and board with tape or edging strip.

Refer to Fig. 3 and drill the holes for the LEDs and filament lamps. Drill the holes from the front of the board and take care not to rip the map.

Drill a further set of holes for the switches, one directly above the other in the lower middle part of the board and one at each side directly below America and the USSR.

The PCB is attached to the back of the board using woodscrews and spacers and the LEDs, lamps and switches are wired using ribbon cable. The LEDs and lamps representing American missiles and cities are wired to one piece of 12-way cable, the LEDs and lamps on the USSR side are wired to another 12-way cable and the four switches are wired to a 6-way ribbon cable.

The wiring of the lights and switches should be obvious from the circuit diagram and component overlay. Each LED has its own resistor on the PCB so ten of the twelve ways on each of the larger connectors are for the LEDs. The remaining connections are a common 0V lead for the five lamps and a common V_{cc} connection for both the lamps and the LEDs. The only point to watch is that the LEDs must, of course, be wired the right way round.

If you intend using the Simulator from a mains supply, a transformer unit will be needed. This should consist of a metal box with a suitable transformer firmly fixed inside it. The box should be earthed and all the usual care must be taken with the mains input lead and wiring. Use a strain relief bush and include a fuse in the mains circuit.

In Use

The Simulator can be used by any number of people from two upwards. Provided clear instructions are printed in a prominent position, it can be left unattended

PARTS LIST

RESISTORS (all ¼W)	
R1, 2, 3, 32	**3k3**
R4, 6, 8, 10	**2k2**
R5, 7, 9, 11	**802R**
R12-31	**330R (or 510R — see text)**
R33, 34, 36	**100k**
R35	**1M0**
CAPACITORS	
C1, 2, 6	**10n**
C3	**1u0 35V tantalum**
C4	**470u 16V axial electrolytic**
C5	**470u 10V axial electrolytic**
SEMICONDUCTORS	
IC1	**4071**
IC2	**4044**
IC3, 4	**4081**
IC5	**4049**
IC6	**4001**
IC7	**555**
IC8	**78L05**
Q1, 3, 5, 7	**BC109**
Q2, 4, 6, 8	**BFY51**
LED1-20	**0.2" red LEDs, preferably high intensity types**
BR1	**S005 bridge rectifier**
MISCELLANEOUS	
FS1	**2A 20mm fuse and PCB-mounting holder (fully enclosed type with screw-on end cap — see Buylines)**
LP1-10	**6V 60mA wire-ended filament lamps (or 12V 60mA — see text)**
PL1	**6-way 0.1" PCB plug**
PL2	**2.1mm DC power plug**
PL3, 4	**12-way 0.1" PCB plug**
SK1	**6-way 0.1" insulation displacement connector**
SK2	**2.1mm DC power socket, PCB-mounting**
SK3, 4	**12-way 0.1" insulation displacement connector**
SW1, 3	**non-latching, push-to-make switch**
SW2,4	**SPST toggle switch with long shank**

PCB; world map; backing board; woodscrews and spacers to mount PCB; ribbon cable, 5-way and 12-way; IC sockets (optional), 1 x 8 pin, 4 x 14 pin, 2 x 16 pin; connecting wire; tape, glue, etc.

Optional mains transformer unit: chassis-mounting mains transformer with 6-8V output rated at 2A or more (eg., RS/Electromail 207-504 giving 6V at 3.3A); metal case; fuseholder and 1A fuse; cable strain-relief bushes; 3-core mains cable and 2-core low voltage cable; nuts, bolts, etc for transformer mounting.

and people approaching it will work out for themselves what to do. This makes it ideal for use in libraries, in the foyer at conference centres or in any other position where people are passing by.

Where larger groups are expected it is helpful if someone is around to demonstrate the Simulator and explain its significance. In this case, the people present should be divided into two groups ('Russians' and 'Americans'), each of which selects a 'President' to operate the button.

Start with the Simulator set to DEMO and DETERRENCE so that all the lights are on. Explain to the players that the red lights represent missiles and the white lights represent cities. Get one of them to press their button so that one set of missiles and the opposite set of cities start flashing. This represents one superpower using its missiles to threaten the cities on the other side.

Now tell the other side to press their button and show that they can return the threat, causing their missiles and their opponents' cities to flash. Thus either side can launch an attack

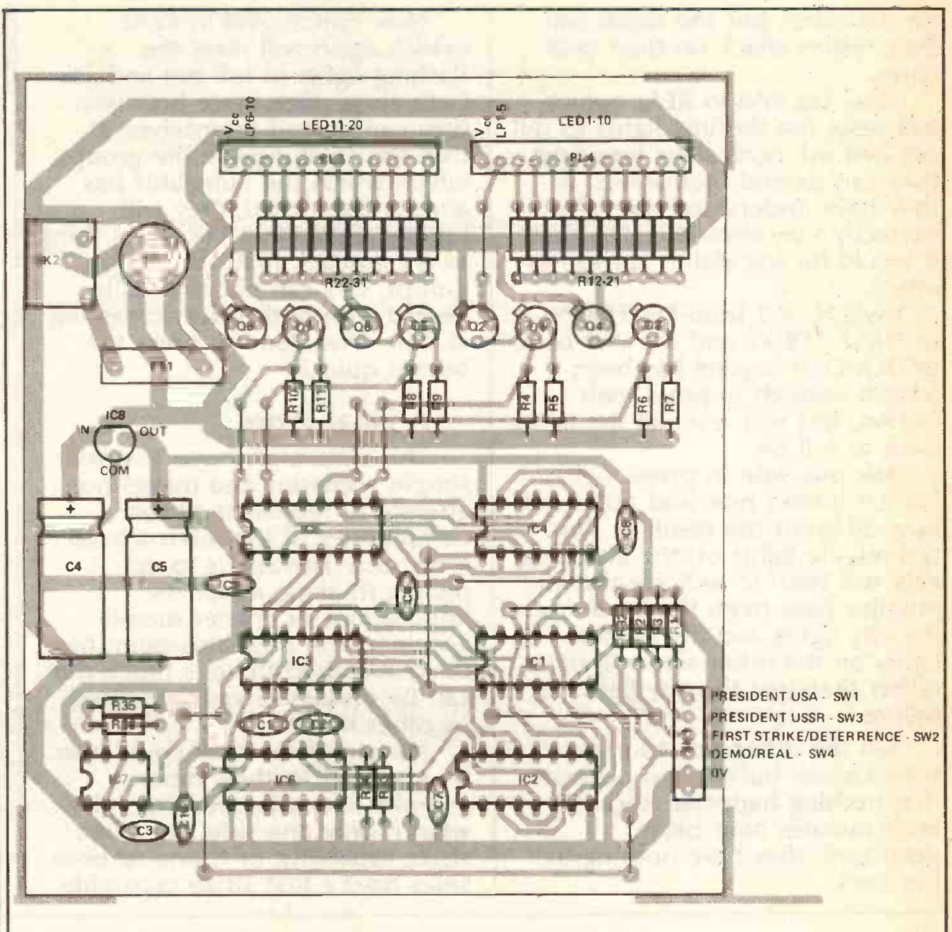


Fig. 2 Component overlay for the Simulator PCB.

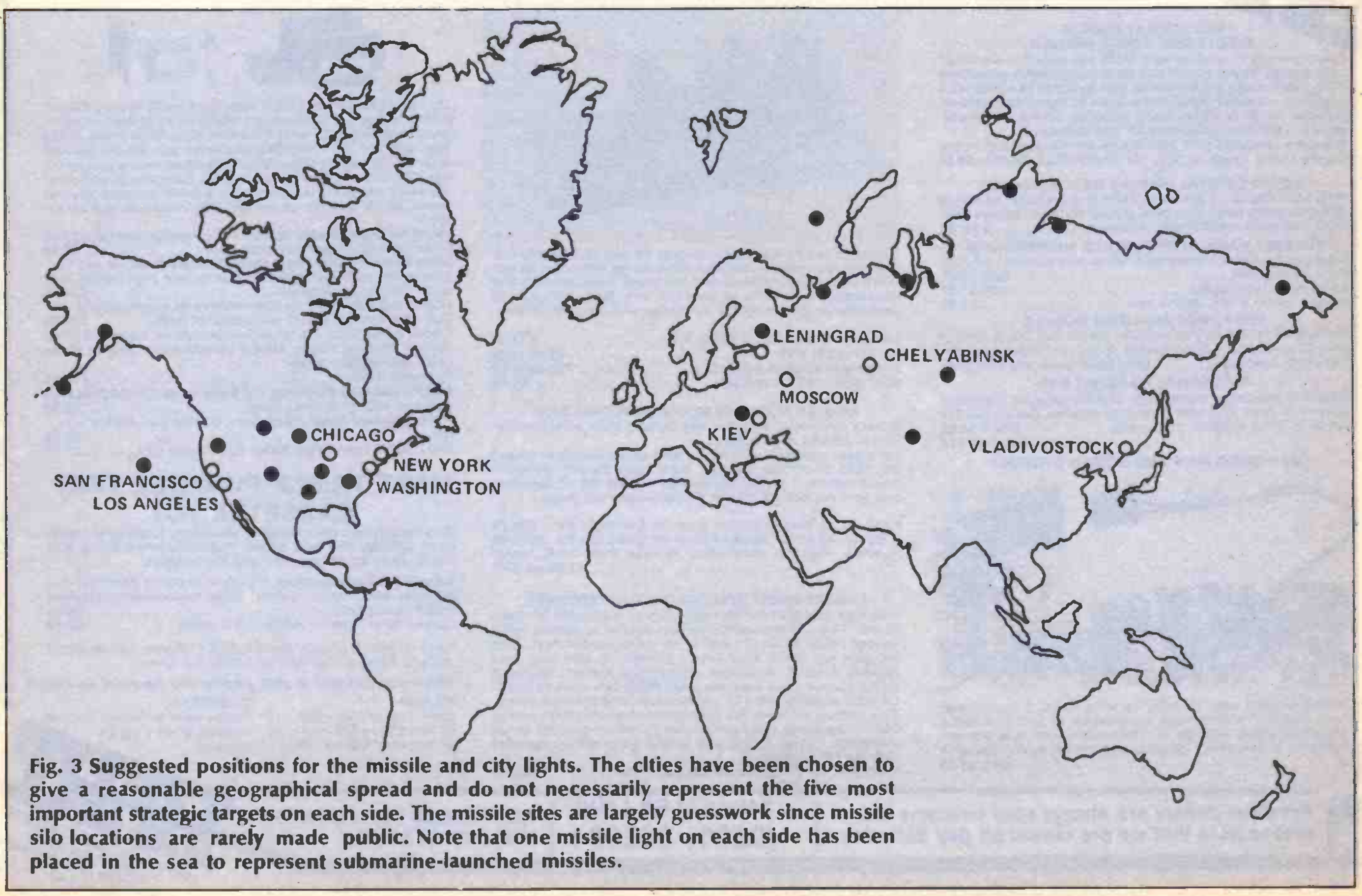


Fig. 3 Suggested positions for the missile and city lights. The cities have been chosen to give a reasonable geographical spread and do not necessarily represent the five most important strategic targets on each side. The missile sites are largely guesswork since missile silo locations are rarely made public. Note that one missile light on each side has been placed in the sea to represent submarine-launched missiles.

on the other, but the result will be a return attack on their own cities.

Now set SW4 to REAL (which will reset the flashing lights to full on) and ask both sides how best they can defend themselves. If they have understood the rules correctly they should realise that it would be suicidal to launch an attack.

Switch SW2 from DETERRENCE to FIRST STRIKE and set SW4 back to DEMO. If anyone has been foolish enough to press their button, this will reset all the lights back to full on.

Ask one side to press their launch button now and point out how different the result is. The red missile lights on the attacking side will flash to indicate that the missiles have been fired, but both the city lights and the missile lights on the other side will flash rather than just the city lights as before.

Tell the other side to press their launch button and observe that nothing happens. Because their missiles have been destroyed, they have nothing to fire back.

Now switch SW4 to REAL (which again will reset the flashing lights to full on) and ask both sides once more how best they can defend themselves. If they are anything like the groups which which the Simulator has already been tried, they will rapidly realise that the safest thing to do is attack first. With large groups, this can become quite heated with both sides screaming at their 'President' to press the button quickly.

A Final Word

This simulator shows two very simple scenarios and makes no attempt to represent all the complexities of the international arms race. The aim is to get people thinking about the implications of greater missile accuracy, and once this point has been absorbed there is much that can be discussed and presented by other means.

The simulator itself could also be modified to show more complex scenarios. For example, what if only one side has a first strike capability, or if one or both sides have a first strike capability which does not destroy all of their opponents' missiles? What if Star-Wars technology is added to the equation on one or both sides, allowing any missiles not destroyed by a first strike to be wiped out before reaching their targets? This makes a first strike even more tempting.

ETI

BUYLINES

Most of the components for this project are readily available from the usual mail-order suppliers. The 6V wire ended-lamps and the fuseholder came from RS/Electromail (order codes 587-069 and 413-147) and the six and twelve-way PCB connectors came from Maplin. The S005 rectifier was also obtained from Maplin but other 2A, 50V bridge rectifiers should do just as well. Push-button switches with long shanks for SW1 and SW3 are easy enough to obtain but you may have more difficulty with long-shank toggle switches. The ones used on the prototype came from a surplus store.

World maps can be purchased from local booksellers or stationery stores. The one used on the prototype was a 48 x 26in 'Pioneer' map from the London Map Centre, Caxton Street, London SW1.

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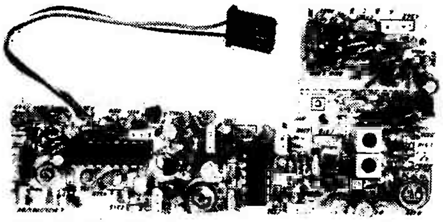

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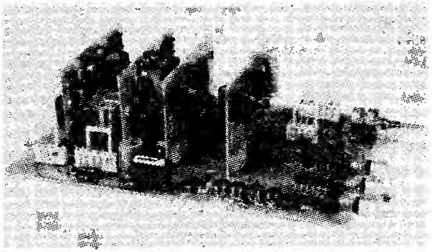

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ROBOTICS

Project		Mth	Yr	Pg
Robot arm	part 1	Sep	1981	50
	part 2	Oct	1981	43
Robot motor controller	part 1	Mar	1982	61
	part 2	Apr	1982	94
	part 3	May	1982	34
Servo arm interface	part 1	Oct	1982	69
	part 2	Dec	1982	77

SECURITY

Project		Mth	Yr	Pg
Alarm alarm		Jul	1977	29
Alarm extender		Nov	1983	39
Alarm module		Mar	1983	63
	Errata	Aug	1983	70
Alarm, ZX-based		Dec	1983	31
Anti-theft auto alarm		Jan	1974	16
Automatic car-theft alarm		Aug	1972	50
Automatic light switch		May	1984	19
Automatic porch light		Jul	1980	77
Banshee siren unit		Sep	1984	35
Burglar alarm system		Apr	1977	57
	Errata	Jun	1977	9
Burglar proof your home		Jul	1974	30
Car alarm		Mar	1975	24
	Errata	Jul	1975	68
Car alarm		Dec	1978	16
Car alarm		Oct	1983	66
	Errata	Nov	1983	96
Car security device		Apr	1980	50
CMOS burglar alarm		Apr	1975	51
CMOS house alarm		Jan	1978	16
Combination lock		Mar	1981	74
Ecolight		Jul	1984	55
Electronic combination lock		Mar	1975	46
Home security system		Aug	1981	18
Infant guard		Jan	1982	80
Infra-red intruder alarm		Jul	1972	54
Infra-red intruder alarm		Feb	1981	62
Infra-red Intruder Alarm	part 1	Jul	1984	61
	part 2	Aug	1984	59
	Errata	Jul	1986	56
Logic lock	part 1	Jun	1982	79
	part 2	Jul	1982	39
	Errata	Nov	1982	75
Porch light		Feb	1978	28
Proximity switch		Oct	1978	75
Radar intruder alarm		Aug	1975	21
Second line of defence, the — simple house alarm		Nov	1985	60
Ultrasonic burglar alarm		Aug	1980	86
Warlock alarm system		Jul	1984	35
Watchdog home security system		Aug	1981	18
ZX-based alarm		Dec	1983	31

TELEVISION AND VIDEO

Project		Mth	Yr	Pg
CCTV camera		Dec	1977	46
Colour board for the Ace microcomputer		Apr	1984	41
	Errata	May	1984	69
Digital framestore	part 1	Dec	1984	61
	part 2	Jan	1985	44
	part 3	Feb	1985	55
	part 4	Mar	1985	59
	part 5	Apr	1985	48
Low-cost framestore	part 1	Sep	1986	36
	part 2	Oct	1986	48
	part 3	Nov	1986	43
Low-cost VDU interface	part 1	Aug	1976	56
	part 2	Sep	1976	10
	part 3	Oct	1976	30
	Errata	Oct	1976	30
RGB-composite converter		Jan	1987	32
Teletext decoder	part 1	Jul	1979	20
	part 2	Aug	1979	41
TV chess game	part 1	Oct	1978	48
	part 2	Nov	1978	44
TV games unit		May	1977	12
TV sound tuner		Sep	1980	73
TV sound tuner		Dec	1981	37
UHF aerial preamplifier		Aug	1973	34
VDU interface (System 68)	part 1	Jun	1977	33
	part 2	Jul	1977	54
Vector graphic display		Jan	1984	19
Videograph — TV audio display		Apr	1979	27
Video Vandal		Nov	1984	50
	Errata	Jul	1985	27

TEMPERATURE MEASUREMENT AND CONTROL

Project		Mth	Yr	Pg
Differential temperature switch Module		Mar	1981	49
Digital thermometer		Oct	1977	20
Economical heater controller		May	1982	22
	Errata	Jul	1982	35
Freezer alarm		Dec	1977	30
Heater controller		Mar	1980	67
Heat/light controller (Free PCB project)		Oct	1982	25
Heat pen — temperature probe for DVMs		Jun	1985	48
	Errata	Mar	1986	60
Immersible heater		Jun	1983	65
Micropower thermal alarm		Oct	1981	68
Seven-input thermocouple meter		Dec	1973	23
Temperature alarm		Nov	1974	25
Temperature alarm		Mar	1977	53
Temperature alarm (free PCB project)		Apr	1986	44
Temperature controller		Nov	1984	63
Temperature controllers, three		Mar	1975	18
Temperature meter		Aug	1974	30
Temperature meter		Jul	1978	21
Temperature meter add-on for voltmeters		May	1976	49
Thermometer — max/min memory thermometer		Apr	1983	70
	Errata	Jul	1983	20
Under temperature switch module		Mar	1981	51
Wine temperature meter		Dec	1978	31

TEST EQUIPMENT

Project		Mth	Yr	Pg
1kHz function generator		Mar	1977	55
All purpose power supply, 30V, 1A		Aug	1978	75
Amplifier, bench (Short Circuit)		Feb	1977	52
Amplifier, bench		Aug	1979	67
Amplifier, bench		Dec	1980	74
Analogue/digital probe (ETI Modular Test Equipment)		Apr	1986	36
Attenuator, audio		May	1973	53
Attenuator, RF		Sep	1976	62
Audio Analyser		Oct	1986	43

Project		Mth	Yr	Pg
Audio frequency meter		Jul	1973	66
Audio millivoltmeter, 'A' weighted		Apr	1976	26
Audio noise generator		Apr	1976	22
Audio oscillator		Nov	1980	27
Audio oscillator with LCD DFM		Nov	1978	71
Audio power meter		Jun	1976	29
Audio power meter		Mar	1979	67
Audio spectrum analyser		Mar	1978	27
Audio wattmeter		Oct	1973	46
Autoranging capacitance meter	part 1	Mar	1982	48
	part 2	Apr	1982	108
	Errata	Jul	1982	35
Basic power supply, 4.5A-12V, 0.4A		Oct	1974	53
	Errata	Nov	1974	71
Bench amplifier		Aug	1979	67
Bench amplifier		Dec	1980	74
Bench amplifier (Short Circuit)		Feb	1977	52
Bench PSU, 20V/2.5A or 40V/1.25A		Jul	1976	18
Bench PSU, 3-8V/2.5A and ±8-16/0.5A		Feb	1984	41
Bench PSU, 25V/1.5A (Short Circuit)		Apr	1977	47
Cable tester		Oct	1979	23
Capacitance meter, 10pF-10uF		Aug	1980	93
Capacitance meter, autoranging	part 1	Mar	1982	48
	part 2	Apr	1982	108
	Errata	Jul	1982	35
Capacitance meter, direct-reading		Nov	1984	41
Capacitance meter (ETI Capacitometer)		Mar	1987	45
Capacitance meter, large value (ETI Millifaradometer)		Nov	1985	44
Capacitance meter module for DVMs (Free PCB project)		Mar	1986	30
Circuit probe, analogue/digital (ETI Modular Test Equipment)		Apr	1986	36
CMOS IC tester		Aug	1984	64
	Errata	Sep	1984	68
CMOS IC tester, simple		Feb	1976	19
Component bridge (RCL bridge)		Aug	1985	30
Component tester (for semiconductors)		Dec	1981	69
Continuity tester, audible (ETI Loudspeaker Squeaker)		Nov	1984	17
Continuity tester (Short Circuit)		Sep	1977	38
Counter/timer module (ETI Modular Test Equipment)		Jan	1986	54
Cross hatch generator		Sep	1978	33
Crystal calibrator		Mar	1981	39
Curve tracer		Dec	1978	73
Decade resistance box		Dec	1972	38
Digital frequency meter (Short Circuit)		Jun	1977	19
	Errata	Aug	1977	8
Digital frequency meter, 0-150MHz		Jan	1980	56
Digital multimeter		Oct	1976	42
	Errata	Nov	1976	8
Digital multimeter		Aug	1978	23
Digital oscilloscope trigger		Sep	1983	51
Digital test meter (DMM/DFM)		Sep	1980	79
Digital voltmeter		Mar	1977	35
	Errata	Jun	1977	9
Digital voltmeter module		Oct	1975	18
Direct-reading capacitance meter		Nov	1984	41
Distortion Meter	part 1	Jan	1985	55
	part 2	Feb	1985	37
	part 3	Mar	1985	43
Dual logic probe		Sep	1982	68
Dual power supply		Apr	1972	50
Dual trace adaptor		Oct	1974	18
Dual trace adaptor (Design Competition)		Feb	1983	72
Dual trace adaptors (Readers' Designs)		Jul	1981	27
Dummy load for audio testing		Jan	1982	71
FET DC voltmeter		Dec	1972	36
Frequency counter module, 1 MHz		Nov	1975	11
Frequency counter module (ETI Modular Test Equipment)		Jan	1986	54
Frequency counter, PLL	part 1	Oct	1986	28
	part 2	Nov	1986	29
Frequency meter, audio		Jul	1973	66
Frequency meter, digital, 0-150 MHz		Jan	1980	56
Frequency meter, digital (Short Circuit)		Jun	1977	19
	Errata	Aug	1977	8
Frequency meter, linear 100 Hz-100 kHz		Jul	1980	99
Frequency meter module for DVMs (free PCB Project)		Apr	1986	46
Function generator, 1kHz (Short Circuit)		Mar	1977	55
Function generator, 1Hz-100kHz		Dec	1979	20
Grid dip oscillator		Aug	1975	34
High impedance instrument probe		Apr	1982	57
IC power supply		Jan	1973	34
IF strip tester (Free PCB project)		Oct	1982	26
Impedance meter, direct reading		Jun	1975	17
Instrument probe, high-impedance		Apr	1982	57
Insulation tester, 500V		May	1982	73
Laboratory PSU, 0-30V, 1,2A		Sep	1981	87
LCD digital multimeter		Aug	1978	23
	Errata	Oct	1978	13
LEDline logic analyser		Feb	1987	50
LEDscope AF flat-screen oscilloscope		Jan	1987	57
Linear frequency meter, 100Hz-100kHz		Jul	1980	99
Linear IC tester		Nov	1974	30
Linear ohmeter, 1k-1M FSD		Jun	1980	34
Logic/analogue probe (ETI Modular Test Equipment)		Apr	1986	36
Logic analyser (ETI LEDline)		Feb	1987	50
Logic clip, 16 point, TTL/CMOS		Nov	1983	91
Logic IC tester, TTL/CMOS		Jan	1976	19
Logic probe		Sep	1972	32
Logic probe		Dec	1975	32
Logic probe, CMOS, single point		Mar	1983	73
Logic probe, dual		Sep	1982	68
Logic probe, TTL/CMOS		Dec	1979	101
Logic Pulser		Dec	1975	37
Logic tester, CMOS		Aug	1980	73
Logic-trigger for oscilloscopes		Mar	1979	39
Loudspeaker squeaker		Nov	1984	17
Low-ohm meter, 0.1-100R FSD		Apr	1981	40
Marker generator		May	1976	25
Memory 'scope display		Nov	1985	28
Meter mount (multimeter stand)		Jan	1973	43
Millifaradometer — large-value capacitance meter		Nov	1985	44
Millivoltmeter, audio, 'A' weighted		Apr	1976	26
Modular test equipment	part 1	Oct	1985	38
	part 2	Nov	1985	36
	part 3	Dec	1985	37
	part 4	Jan	1986	54
	part 5	Apr	1986	36
	Errata	Jun	1986	55
Multimeter (DMM/DFM)		Sep	1980	79
	Errata	Apr	1981	8
Multimeter, digital		Oct	1976	42
	Errata	Nov	1976	8
Multimeter, LCD digital		Aug	1978	23
	Errata	Oct	1978	13
Ohm-meter, linear, 1k-1M FSD		Jun	1980	34
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Oscillator, audio, with LCD DFM		Nov	1978	71
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Oscillator, wide range		Jun	1978	90
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	part 2	Jun	1982	30
	part 3	Jul	1982	63
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Oscilloscope calibrator		Apr	1972	12
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Oscilloscope logic trigger		Mar	1979	39
Oscilloscope memory display		Nov	1985	28
Oscilloscope probe, high-impedance		Apr	1982	57

Project		Mth	Yr	Pg
Oscilloscope, television	part 1	Jul	1983	21
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Power supply, 30V/1A		Aug	1978	75
Power supply, 20V/2.5A or 40V/1.2A		Jul	1976	18
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Power supply, dual, 0-20V/1.8A		Apr	1972	50
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Simple CMOS IC tester		Aug	1984	64
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Stereo power meter		Mar	1984	35
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Voltmeter, FET DC		Dec	1972	36
Voltmeter module, digital		Oct	1975	18
Voltmeter, true RMS		Mar	1978	13
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Wide range voltmeter		Apr	1972	36

A number of errors have come to light since the publication of the first part of this index in the April 1987 issue. The correct entries are given below in the sequence in which they appear.

Under the heading AUDIO (page I of the index):-

2040 II active loudspeaker, September 1982 page 46: a correction concerning this article was published on page 75 of the November 1982 issue;

Balanced line preamplifier: this article appears on page 38 of the May 1983 issue, not page 63 as stated;

FM tuner with digital frequency display: this article appears on page 21 of the September 1978 issue, not page 71 as stated;

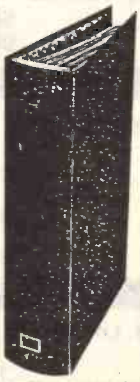
Headphone adaptor; this article appears on page 53 of the March 1976 issue, not page 52 as stated;

Moving coil preamplifier, Audiophile: the first errata for this article appears on page 17 of the February 1980 issue, not page 29 as stated;

Preamplifier, RIAA: this article appears on page 98 of the September 1980 issue, not page 73;

Under the heading CLOCKS and TIMERS (page III of the index):-

STAC timer: this article appears in the September 1978 issue, not the September 1981 issue.



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TRANSISTORS

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BC107A	15
BC107B	15
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100uF	25V	12	.22uF	35V	10	470pF	500V	6
470uF	25V	28	.47uF	35V	10	1000pF	100V	6
1000uF	25V	36	1uF	35V	10	2200pF	100V	6
10uF	25V	08	2.2uF	35V	15	4700pF	100V	6
220uF	25V	15	4.7uF	35V	20			

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TIL 113 Darlington o/p	120
3021 Triac driver	150

ZENER DIODES

BZY88C 500m W	
4V7	10
10V	10
12V	10
BZX55C 500m W	
24V	10
BZX85C 1.3 Watt	
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16pin	13
24pin	20
40pin	30

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Metal Film 5% ⅓ Watt
100R 680R 1K 1K2 2K2 4K7
5K6 6K8 10K 12K 15K 22K 27K
33K 39K 47K 56K 68K 82K
100K 120K 150K 180K 220K
270K 330K 390K 470K 560K
680K 820K 1M **2p**

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Green	18
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Red	35

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555	30	NE5534	80	TL081	50
556	65	ZN414	90		
LM301	28	ZN416	160		

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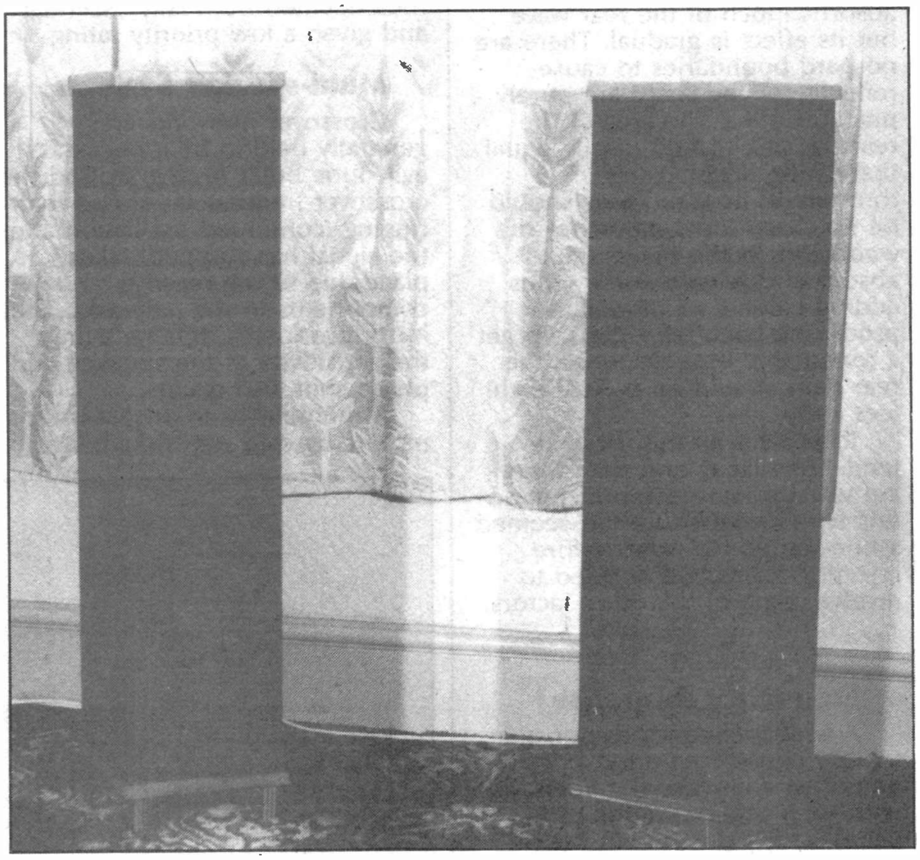
THE ETI KAPELLMEISTERS

Vivian Capel has been hard at work in the garden shed and now emerges to show off his high quality but novel loudspeaker design.

The perfect loudspeaker which exactly reproduces the sound field obtaining at the original performance does not, of course, exist. So many of the requirements are incompatible when applied to practical loudspeaker design. If we want one feature we must sacrifice another.

The designer usually tries to effect a compromise, giving us some of both as far as that is possible. One designer may favour one characteristic and so slant his design in that direction, while another may consider the other to be of greater importance.

The Kapellmeister speaker was designed to fulfil a particular pattern of priorities. Some unorthodox methods were used to achieve them and constructing the prototypes though not difficult, was time-consuming. However, the results obtained more than justified the time and effort expended.



Requirements

The overriding consideration was that of size. In many homes, so much has to be accommodated in a modest living space there just isn't room for two large speaker boxes. However, most of the furniture stands around the walls so it is cabinet width that is the most critical dimension. Depth is of less importance and (within reason) height is no problem at all.

I found that eight inches was the maximum width I could allow for each speaker. This didn't seem very hopeful for a hi-fi unit!

For small size, the infinite baffle seemed the obvious choice, yet I wasn't too happy with the prospect. Pressure acting on the back of the cone is non-linear because it increases as the cone moves back. As the cone can only move in accord with *all* forces acting on it, its movement is thus not in exact proportion to the applied electrical signal.

The effect is more pronounced at lower frequencies. Indeed, the measured distortion of infinite baffle enclosures is high in the bass region. Internal reflections lead to standing waves and hangover, while high internal pressures produce panel resonances in the cabinet which require rigid construction, careful selection of materials and various forms of damping.

Bass resonance can be tamed only by critical adjustment of cabinet volume in conjunction with the driver parameters. Many designers adjust the cabinet Q to give moderate bass resonance to enhance the bass response.

However, in my priorities, low distortion and lack of coloration came higher than a pronounced bass response. Infinite baffles, especially small ones, need a lot of amplifier power which I did not have, so the infinite baffle enclosure was out.

Reflex enclosures suffer from similar drawbacks although there are some very good ones. These also were rejected.

The rear-loaded folded horn is

an attractive speaker with many advantages — low power requirement being one of them. However, the lowest bass frequency it will produce is proportional to the width of the horn flare. My eight inches wouldn't even get into the upper bass register, so this prospect too had to be abandoned.

I have always had a hankering after the transmission line principle. It provides a long folded path behind the driver which eventually emerges into the free air. Thus there are no high internal pressures, no non-linear cone excursions, no reflections and no panel resonances.

Wadding stuffed into the path absorbs much of the rear wave but its effect is gradual. There are no hard boundaries to cause reflections. The snags are purely practical ones. The area of the rear passage should ideally equal that of the driver cones throughout its run. There should be no sharp turns otherwise the woodwork at the bends could absorb and release energy thus adding coloration, as well as producing back reflections. To get a reasonable bass response, this rear path should be at least eight feet long.

To achieve all this, designs tend to be large, and then there are usually some comromises. So this type of enclosure too seemed a non-starter. However, before rejecting it finally, I decided to resolve some of the other factors.

Frequency Response

A wide frequency response is usually considered a top priority and most commercial models vie with each other in getting the widest range possible in their specifications.

Often this is just a case of one-up-manship. A wide range is indeed desirable and within certain limits essential for hi-fi but there can be overkill, especially if it is at the expense of other features.

The upper limit of human hearing extends to about 16kHz in the young but falls increasingly over the age of 30. BBC FM music radio broadcasts have 15kHz as their upper limit. A response above 15kHz was therefore deemed superfluous, especially if only achieved at the expense of other factors.

As for the bass, the lowest note produced by any orchestral instrument is 29Hz from the contra-bassoon, while piano goes down to 27.5Hz. In practice it is rare that even these instruments get down that far. When they do, spectrum analysis reveals that the fundamental is very weak anyway and most of the character is imparted to the tone by the harmonics.

The lowest harmonic which is the second in the above cases, is 55Hz and 58Hz respectively. So while it may be desirable to reproduce down to the lowest frequencies, it is by no means essential. In fact sub-bass response can reveal rumble, record warp and even subway trains passing near the studio! A bass response below 45Hz was thus deemed not really essential and given a low priority rating.

Multi-speaker Systems

Crossover networks are generally held to be a necessary evil. Tone burst testing around the crossover frequencies shows that ringing (continued oscillation after the signal has stopped) takes place due to the reactive components in the networks. They introduce losses thus reducing the sensitivity of the speaker, and phase shift also occurs.

A multiplicity of drivers means more crossover networks hence more spurious signals and phasing problems, with lower sensitivity. Not only this but trying to make the drivers work together can create difficulties. Sensitivities must be carefully matched to ensure an even response, and even when this is done there can be response vagarities around the crossover points due to overlap.

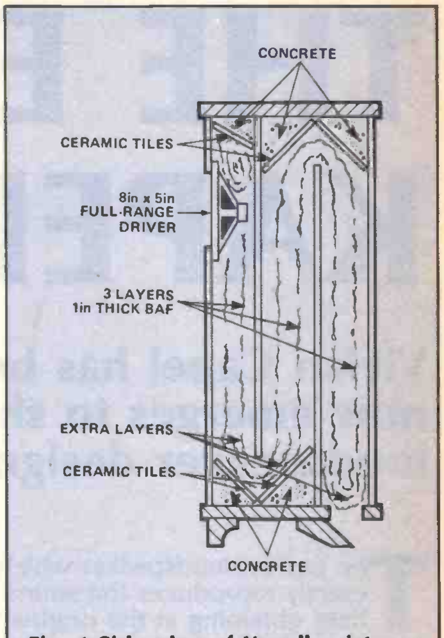


Fig. 1 Side plan of Kapellmeister speaker.

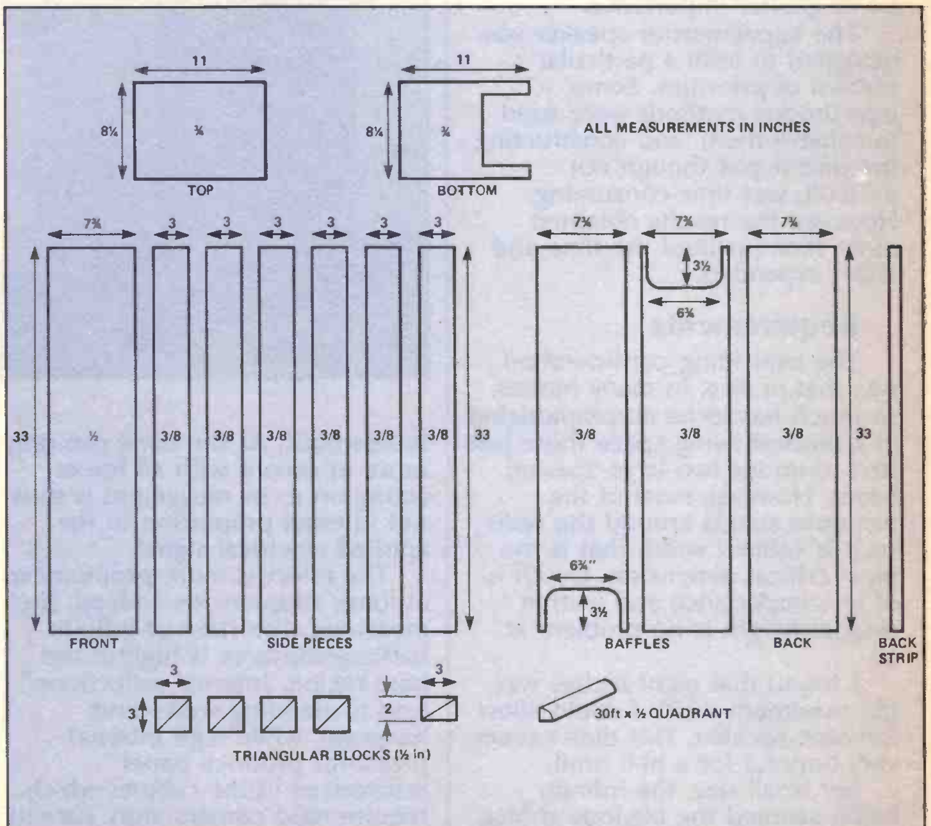


Fig. 2 View of all wooden parts for one speaker. Note that each side is in three parts, thus requiring six identical pieces for the two sides. All pieces should be of plywood.

A particular problem is phasing. As the cones of tweeters, mid-range units and bass drivers are of different depths, they are at different distances from the listener when mounted normally.

The resulting phase differences vary with frequency and the total wavefront pattern from all units is quite different from that of the original sounds. These phase anomalies are compounded by those arising from the crossover networks.

Phasing is particularly important in the reproduction of the stereo signal because stereo information is largely conveyed by subtle phase differences between the channels, as well as by amplitude variations. Some commercial speakers have stepped front baffles so that all the cones are in line (and in phase). This is an improvement on the conventional arrangement but only one listener right on axis will gain any benefit. Those off axis still have to suffer phase differences. Others have the tweeter reverse-connected to minimise phase shifts in their crossover networks, but all these are really palliatives.

All this casts grave doubts on the desirability of multi-speaker units. The problems can so easily be resolved by using a single full-range speaker if some limitation of the frequency range is accepted. The question is, how much?

Investigation into available drive units revealed a full-range elliptical 8-inch by 5-inch with centre HF cone that had a frequency response of 45Hz to 16,000Hz — just the frequency range I had decided on!

Power rating seemed rather low at eight watts RMS, but without the inherent loss of the infinite baffle enclosure and those of the crossover networks a high efficiency could be anticipated, giving ample sound output.

Freedom from the clutter of extra drivers could well make a transmission line possible too.

A single driver also approaches the ideal point source, something achieved with considerable complication and expense in the prestigious Quad ELS-63 electrostatic. Coupled with the narrow eight inch cabinet width, this should produce outstanding stereo imaging.

Is there any disadvantage with using a single driver apart from restricting the frequency response? Doppler effect is one sometimes mentioned. High frequencies are modulated by the forward and backward cone movement made when reproducing bass at the same time. However, with an acoustically efficient system, cone movement due to bass is limited so the effect is small.

Even so, a point sometimes overlooked, is that the microphone diaphragm itself originally experienced doppler effect by responding to some high and low frequencies at the same time, although its bass movements are much smaller than those of a speaker cone. The motion of a single-speaker cone is therefore closer to that of the microphone diaphragm than those of the cones of a multiple-speaker system.

Design Considerations

The transmission line type of enclosure is top of the league for pure uncoloured reproduction — providing good design principles are observed. These are not easy to achieve in practice, and usually mean considerable bulk.

The Kapellmeister speakers use some novel and highly successful methods of overcoming the problems, while occupying only 8x11in of floorspace.

One of the requirements is for the area of the transmission line to equal that of the driver cone throughout its length. Any variations result in sound pressure differences, back pressure and other complex effects which upset the smooth passage of sound along the line.

This ideal is frequently compromised in practical designs because of another rule that there should be no sharp bends. These can cause reflections, absorbtion and release of energy from wooden baffles angled to deflect the sound around the corners. All of this results in coloration.

Conventional designs usually house all the drivers in a cubicle which extends to the back of the cabinet. From this the path, considerably reduced in area, descends to follow its course through horizontal and vertical sections. At the back of the cubicle there is usually a deflection back to the drivers.

For reasons already mentioned, we use only one driver and this simplifies matters because we can dispense with the cubicle. The driver is thereby mounted at one end of the line which does not vary in area throughout its length, so totally fulfilling one of the main requirements.

The path followed is shown in Fig. 1. It is in three sections; the sound travels downwards, then up through the centre section, and finally down again through the rear one to exit at the bottom.

This arrangement appears to violate the other main rule regarding bends and deflectors. However, that rule does not apply if deflectors could reflect the sound perfectly along the required path without back reflection and without adding coloration.

Wood does not fulfil that requirement but other materials can do. One excellent one is ceramic tile with concrete backing. (Note how sound bounces around in a tiled swimming bath). So, the deflectors are glazed ceramic tiles set on concrete corner blocks. These might seem to be a nuisance when considering construction, but they are easily formed in situ, and are the real secret of the quality obtainable from these speakers.

The tiles are set at an angle of 45° to reflect the sound accurately around the bends. It will be noticed that there is also a tile at the top just above the driver. The purpose of this is to reflect sound generated by the top part of the cone downward.

The wave-front radiated by the back of a loudspeaker cone travels outward along an axis that is perpendicular to the surface of the cone. If the cone is at an angle of 22° the tile should be set at an angle of 56°. If the speaker has a different angle from this, the difference for the angle of the tile should be halved, so a 20° cone should have a tile angle of 55°. Most loudspeakers of this size have cone angles in this region, but the angle varies slightly with cone curvature anyway, so the above figure can be used in most cases and is not *too* critical.

As the sound pressure on either side of the baffles is almost the same they are not excited into vibration to produce coloration, and this is true also of the back. The top and bottom pieces are of stout timber lined on their insides with the concrete and tiles, so they too are prevented from vibrating.

Only the front panel has a sound pressure differential between its faces but this is much lower than with a totally enclosed cabinet. Also its narrow width makes for high rigidity which inhibits vibration. The material of

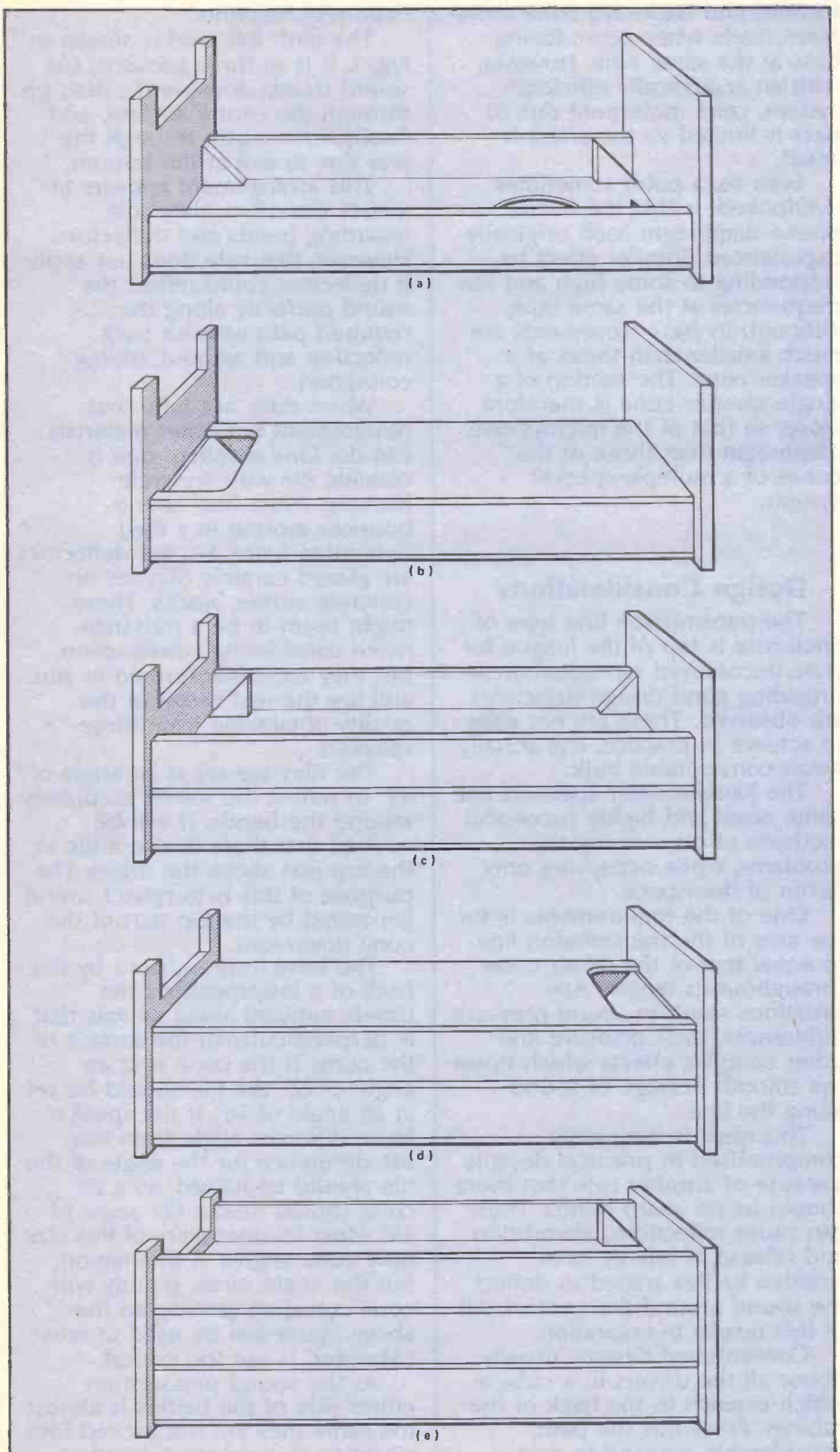


Fig. 3 (a) First stage in construction. The front is glued to top and bottom cheeks using ¼in supports to lift front into correct position. First pair of side pieces fitted and triangular blocks (small ones at the top) in position. Apply concrete, fit tiles and lay wadding. (b) Fix first baffle, glueing and pinning down to ensure close fit. (c) Fit second pair of side pieces and four triangular blocks (all blocks from now on are regular size). Apply tiles, concrete, and wadding. Tuck two extra lengths of wadding through aperture into first channel. (d) Fit second baffle glueing and pinning. Aperture goes at the top. (e) Glue in third pair of sides and last pair of blocks. Fit tile and concrete, lay wadding and fit back. Double an extra length of wadding around the ends of the full lengths. Sand down, fill crevices, finish top and bottom cheeks, fit fabric and fix legs.

the enclosure thereby adds very little to the sound.

Closed Pipe

The transmission line is in effect a pipe that is closed at one end but open at the other. As such it inhibits a fundamental resonance plus odd harmonics. There are no even harmonics. The fundamental resonance occurs where the total length equals a quarter wavelength of the frequency. Here, the length is just over eight feet, so the resonance is at 35Hz, which is below the lower limit of the driver at 45Hz. However, being broadened by the dampening material in the pipe, it can influence the range of the speaker, usefully extending it by a few Hertz.

The antinodes (points of maximum air motion) at the third harmonic occur at the third and two-thirds positions, that is at the bends. Extra wadding at these points serve to suppress this harmonic. Extending the extra wadding up the first channel and also at the exit dampens out two of the three antinodes of the fifth harmonic. Above the fifth, the harmonics are smaller and the normal wadding fitted throughout the length of the pipe tames them.

The speaker unit is an 8in x 5in ellipitical unit which, allowing for the frame and surround, has 7in x 4in cone. Thus the approximate area is 21in². Area of the channels is a 7in x 3in rectangular, which is the same as the cone.

Parameters of the driver are not too critical, so if the specified one is not available any similar unit will do. The size is important and this includes the front to back measurement which should be about 2½ inches. It should be a full-range speaker with a response from 45Hz to 15kHz or better. Generally you will find that an extension at one end is at the expense of the other.

High power is not essential because of the good acoustic and electrical efficiency, but eight watts RMS minimum is recommended. General good quality construction with a magnet of not less than 9,000 gauss should be looked for.

Construction

Although quite a lot of woodworking is needed, none of it is difficult and it consists mostly of cutting straight edges. These *must* be straight though, so if your saw cuts tend to wander, get the timber yard to cut them for you. The measurements are uniform with many pieces being the same, which helps.

Use standard 8in x 4in ceramic tiles, cut down to 7in x 4in. That is just one straight cut per tile. The exception is the top tile over the speaker which because of its different angle must be 7in x 3½in.

Triangular blocks are used to support the tiles as shown in Fig. 1. These are made by first cutting four 3in squares, then sawing diagonally to give eight triangles. The two blocks for the over-speaker are made by halving a 3in x 2in rectangle. A standard 3:1 mix of sand and cement is used to fill the space behind the tiles. In some cases the cement is applied first between the blocks and the cement applied at the back afterwards.

In all cases screw two or three stout screws at random angles into the wood where the cement is to be laid leaving about an inch out of the wood, so that they will be buried in the cement. These will then secure the concrete block in place when it is dry. Thoroughly wet the back of the tile before applying it to the cement. In some cases the front of the tile may need to be held in place while the cement sets, with panel pins knocked into the wooden sides. It does little harm to leave them in place afterward.

All jointing is done by a strong wood glue. Evostik wood glue was used for the prototypes which is very strong and convenient to apply. If not available, a substitute can be used but make sure it is a wood glue and not a general purpose adhesive.

Construction must proceed in numerous stages (Fig. 3) to allow the glue and concrete to set before continuing with the next, so some patience must be exercised. Make both speakers at the same time so that each stage can be completed on both and some time saved.

Stages

Having cut all the pieces, we start with the front panel. Lay it face downward supported on some scrap ¼in ply or hardboard. Glue the top and bottom edges and fit the top and bottom boards. The front edges of these should *not* rest on the ply supports but directly on the work surface. They will then protrude a quarter of an inch beyond the panel. They should also be positioned to give an equal overlap at either side. The idea is for the top and bottom cheeks to overhang the front, sides and back. Weights should be applied to the free sides of the cheeks to hold them against the panel while drying.

Measure the distance between the rear edges of the top and bottom cheeks to ensure that it is exactly 33in and therefore the top and bottom are parallel. Wait for the glue to set and harden.

Next, fit the first pair of side pieces, glueing the ends and the edge contacting the back of the front panel. Ensure the pieces are flush with the edge of the front panel. Measure across the upper edges to make sure they are 7¾in and so are true. Now glue the triangular blocks in place at the bottom and top as shown in Fig. 3. The top ones are the special sized onces. Glue the edges as well as the face that contacts the sides, but be careful in pressing them into place that you do not move the sides. Leave it to set.

Now fit the speaker, screwing it in place over the aperture, and solder a pair of wires which are run down the panel to a hole drilled in the bottom. Leave a few inches free, and make sure both speakers are connected the same way to colour-coded wire. It is prudent to cover the front of the speaker with a piece of card secured by drawing pins to protect the cone during subsequent operations.

Fit supporting screws to the base and top, then fill the space between the bottom blocks with cement (not too wet) and bed the tile. Fit the top narrow tile on the blocks and fill in behind it with cement. Allow time to harden. If desired, a quick-drying additive can be used to speed matters up.

Saw suitable lengths of quadrant and glue into the corners between the front panel and the sides. If they are warped they should be held in place with panel pins. Glue two further strips of quadrant at the top inside edge of the sides and pin to secure.

Cut three lengths of BAF wadding to size and lay them in the cabinet so that two start at the bottom of the speaker and the third lies over it to the top of the case. Fill the space above the speaker with a rolled up piece of wadding. Make the lengths a few inches longer than the channel so they bend up at the bottom over the tile. The three layers will fill the channel without compression.

Now fit the first baffle with the cut-out at the bottom, glueing to the top edge of both sides and the upper quadrant surface. Also glue to the top and bottom cheeks. Secure with panel pins to ensure a close fit. Next, fit the second pair of side pieces and two pairs of blocks top and bottom. Fit quadrant to the corners, as with the first channel, and to the top edges of the sides. Wait for all the glue to dry.

Fit the tiles and cement as with the first pair, but this time the top one will be bedded and the bottom one rear-filled. Wait for the concrete to set.

Cut two pieces of wadding about 18in long and push half the length of each up the lower channel through the cut-out, and lay the other half length back along the top channel. Now lay three full length strips over these along the complete upper channel. This gives the extra density at the first bend needed to dampen the third harmonic antinode.

Next comes the second baffle which is glued and pinned as the first but with the cut-out at the top. Fit the third and final pair of sides, also the last pair of blocks plus the quadrant in the corners and top edges. Allow the glue to harden.

Now for the last tile. Don't forget the screws in the top to secure the concrete block inside. Mount the tile on the blocks using panel pins to keep it in place; this will be easier if the enclosure is stood vertically upside down. Return to the horizontal, and fill in rear with cement. Wait until set.

Lay three strips of wadding in the channel making sure the bend is filled. Put some extra here if necessary to fill completely. Cut another strip about 24in long and tuck half the length under the other three at the outlet, and bring it over the top so that it covers the rough ends.

Lastly glue and pin the back in place. Now for the finishing. Sand down any ridges in the sides, but do not be too fussy, for they will be completely covered with fabric. Check carefully for any cracks or crevices in the jointing and fill with wood glue. Sand, then stain or varnish the top cheek and the edges of the bottom one. There is no need to do the underneath. Paint the body with matt black.

This is not strictly necessary, but if it isn't done, bare wood can show through the fabric. Take care not to get any paint on the loudspeaker cone as this would affect its flexibility.

Cut the fabric to the exact size to cover the body between the cheek overhangs, but leave a 4in flap 8in wide, at the start. Secure the vertical starting edge at one edge of the back of the enclosure with tacks so that the flap overhangs the bottom. Then pull it around, keeping it taut overlapping the start and securing it with a wooden strip (previously painted) down the middle of the back. Trim the flap to fit between the prongs of the bottom and fix it across the exit port with gimp pins.

Fit some 2in high legs. The rear ones should be inclined backward to give greater stability as in Fig. 1. Pack filler around the hole in the bottom through which the speaker wire passes to make it airtight, and fit a connecting block underneath.

Performance

Well, was it all worth it? That's what I wondered when the prototypes were complete. It took very few listening sessions to provide the answer. Ambience and sense of presence was perhaps the first noticeable effect. Woodwind was clear, easily identifiable and rounded in tone. Brass was brilliant yet mellow, stacatto passages really were stacatto, not slurred as they sometimes sound.

A recording of harpsichord was remarkable, revealing tones and subtleties never heard before. A solo violin sounded natural with no moments of discomfort in the higher passages. One passage in an orchestral work which I always thought was performed by the cellos playing pizzicato, could be clearly identified as played on the lower registers of a harp. I am now really hearing many of my recordings for the first time.

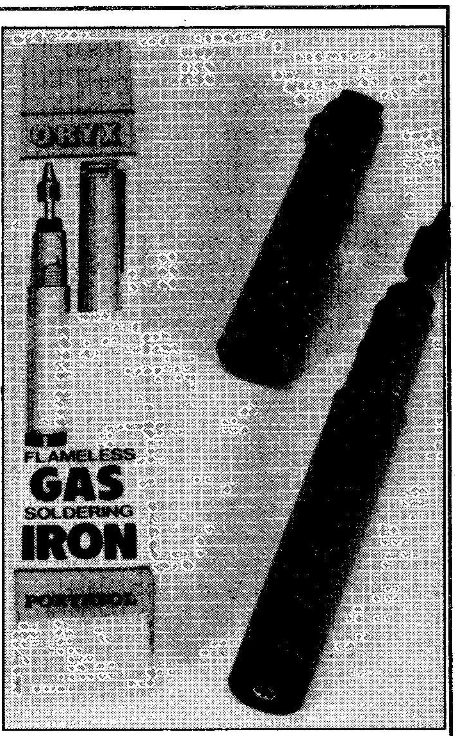
Stereo broadcast drama is quite dramatic, with postive locational identification even in crowd scenes. Sensitivity of the speakers enabled a 4+4 watt amplifier used for initial tests to provide ample undistorted volume. This opens up the possibility of using low-powered class A amps for even higher fidelity. Just one drawback though, I now find I cannot listen to other speakers with enjoyment (especially infinite baffle systems) so be warned!

ETI

BUYLINES

The speaker used is the ALTAI 8553DU, a full range 8in x 5in elliptical with centre HF cone. Frequency response: 45-16,000Hz, 8W RMS power. Any similar unit can be used, but it must be no more than 2½in deep.

Maplin can supply the Altai model (part number WY13P) or Wilmslow Audio (Tel: (0625) 529599) can supply an equivalent (part number EMI99140EB).



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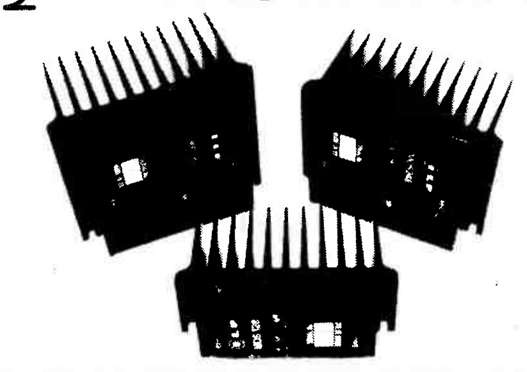

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HY124	60	4	£17.95
HY128	60	8	£17.95
HY244	120	4	£23.45
HY248	120	8	£23.45
HY364	180	4	£34.95
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PSU432	1 MOS128	£22.35
PSU512	2 HY128, 1 HY244	£23.70
PSU522	2 HY124	£23.70
PSU532	2 MOS128	£24.65
PSU542	1 HY248	£24.65
PSU552	1 MOS248	£26.65
PSU712	2 HY244	£28.35
PSU722	2 HY248	£29.30
PSU732	1 HY364	£29.30
PSU742	1 HY368	£31.25
PSU752	2 MOS248, MOS364	£31.25

All the above are for 240v operation

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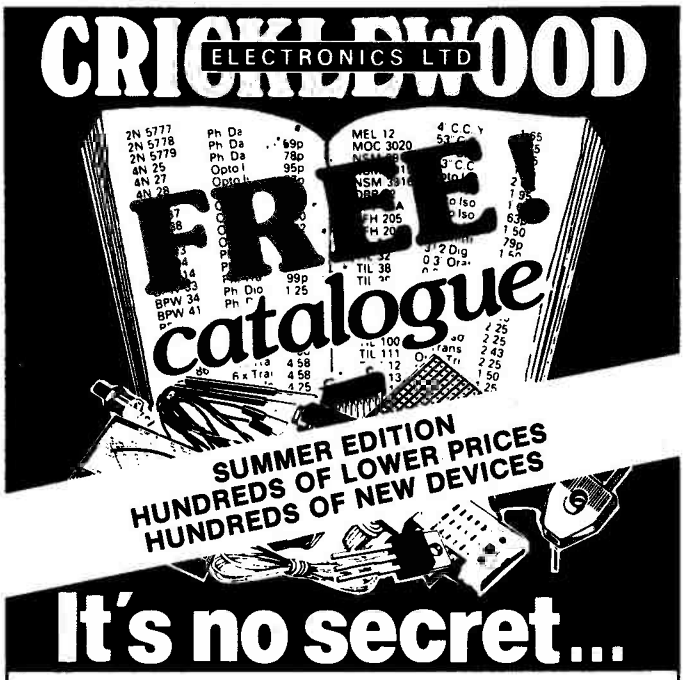

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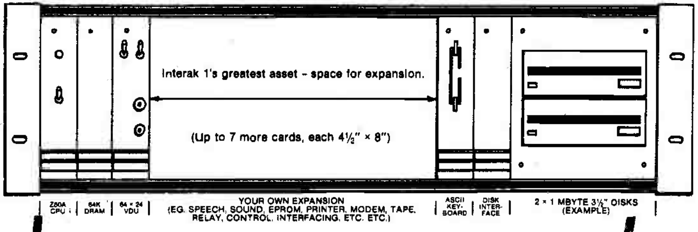

The initial development system has 64K of RAM, a 4 MHz Z80A CPU, parallel ASCII keyboard interface, VDU interface (TV set or monitor), and a floppy disk drive interface for up to 4 drives. Any size (including 8" double density) can be used, but our 1 Megabyte 3.5" drives are proving very popular because they can fit into the system rack, (and they only cost £94.00 each + VAT). CP/M Plus is available, giving access to thousands of "public domain" programs.

The system can be described as "future proof" because it uses plug in 4.5" × 8" cards in an industrial quality 19" 3U rack. We have been established since 1970, and this system was first made in 1977 so (unlike almost all other computers) it has stood the test of time.

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MIDI MASTER KEYBOARD

John Yau continues his musical masterpiece with a description of building the power supply and wiring the whole system together.

There is just one more PCB to make to complete the electronics of the MIDI Master Keyboard. This is the power supply board.

This month we shall also look at the construction of the keyboard cabinet and show how to wire up all the boards already constructed (the three keyswitch boards, the front panel and the CPU board) to make up the complete keyboard hardware.

The power supply is of a very ordinary design using three 78 series regulator ICs to provide the +5V supply required by all the other boards and ±5V for the analogue to digital converter section of the CPU board.

Construction

Building the power supply PCB is straightforward. Ensure correct orientation of the bridge rectifier BR1 and all the electrolytic

HOW IT WORKS

The power supply is constructed on a single PCB and supplies all the necessary power rails for the other boards. The main +5V power rail derived from IC37 is used by the front panel PCB, keyswitch PCBs and most of the main CPU board. A separate, lower power, +5V supply rail derived from IC36, along with the −5V rail from IC38 is used to power the joystick section of the CPU board.

The three regulator circuits are extremely standard and require little in the way of explanation.

Independent supply lines for the analogue joystick circuitry ensure maximum stability and noise immunity from the digital circuitry elsewhere.

External components in the power supply circuitry are the mains transformer, fuse and the 7805 +5V voltage regulator (IC37). IC37 is bolted to the aluminium cabinet lid, which acts as an effective heatsink. Current consumption from the main +5V power rail is around 600mA, whilst the other rails draw substantially less power.

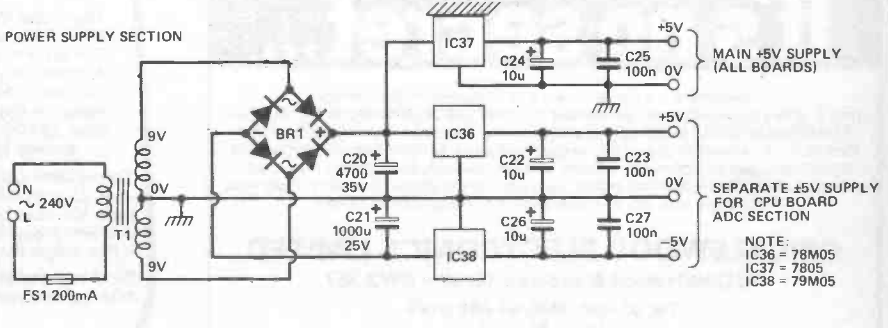


Fig. 1 The circuit diagram of the power supply board.

capacitors (especially the big ones!) as shown in Fig. 2. Mount C20 and C21 using the hole spacings on the PCB which are most suitable for the capacitors' sizes.

Solder regulators IC36 and IC38 directly onto the PCB and add a clip-on heatsink to IC36. IC37, the main 5V regulator, is to be mounted remotely to a large heatsink. In the prototype the aluminium lid of the keyboard cabinet was used for this.

Finish off the power supply PCB by adding veropins for the wire terminal points.

Cabinet Construction

Figure 3 shows the details of the cabinet used by the author in the prototype. The base is made of 1cm plywood whilst the end blocks and struts are of hardwood.

Start construction by joining the front trim to the plywood base, using a combination of wood screws and glue. Next prepare the keyboard chassis strut by cutting a recess large enough for the wiring harness to thread through on its way to the CPU board.

Position the strut on the plywood base so that the plastic notes lie just flush along the wooden front trim. Mark and join it to the base using glue and wood screws from the underside. Glue additional strutting along the join for extra strength.

After the glue has dried, fix the keyboard to the cabinet by attaching the long brass hinge along the length of the keyboard to the mounting strut. The keyboard chassis should then be able to pivot freely about the hinge.

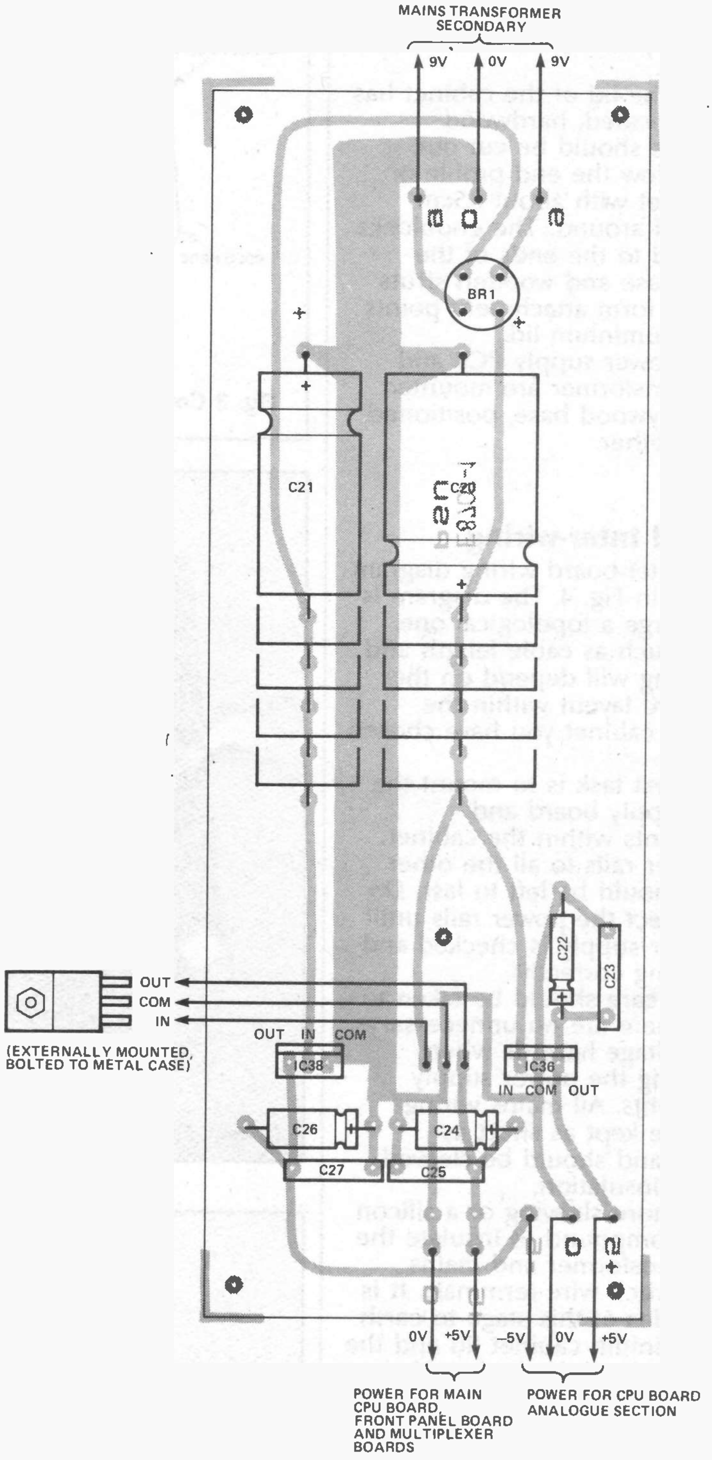


Fig. 2 The component overlay for the power supply board.

The lid for the prototype cabinet was made out of sheet alumiunium, folded and machined to provide all the necessary holes and recesses. Both the front panel and CPU boards are mounted on the underside of the lid. The whole lid is hinged along the

PARTS LIST

CAPACITORS	
C20	**4700µ 35V axial electrolytic**
C21	**1000µ 25V axial electrolytic**
C22,24,26	**10µ 16V axial electrolytic**
C23,25,27	**100n polyester**
SEMICONDUCTORS	
IC36	**78M05**
IC37	**7805**
IC38	**79M05**
BR1	**W01 bridge rectifier**
MISCELLANEOUS	
FS1	**200mA fuse and fuseholder**
T1	**9-0-9V mains transformer**

PCB; mains rocker switch; clip-on heatsink for IC36; wire and cable.

BUYLINES

None of the components used for the power supply board should provide any problems. The PCB will be available from the ETI PCB Service in due course. Details at the back of this issue.

edge of the plywood base using small brass hinges.

This method of mounting allows easy access to the circuit boards.

After the lid of the cabinet has been fabricated, hardwood endblocks should be cut out. These follow the end profile of the cabinet with about 0.5cm margin all around. The endblocks are joined to the ends of the cabinet base and wooden struts added to form attachment points for the aluminium lid.

The power supply PCB and mains transformer are mounted on the plywood base, positioned close together.

Board Inter-wiring

The inter-board wiring diagram is shown in Fig. 4. The diagram is by and large a topological one. Matters such as cable length and positioning will depend on the final board layout within the keyboard cabinet you have chosen or made.

The first task is to mount the power supply board and components within the cabinet. The power rails to all the other boards should be left to last. *Do not connect* the power rails until the power supply is checked and functioning correctly.

Great care should be taken to ensure there are no unnecessary mains voltage hazards when assembling the power supply components. All mains wiring should be kept as short as possible and should be sleeved for extra insulation.

Use more sleeving or a silicon rubber compound to insulate the mains transformer and mains power switch wire terminals. It is a good idea at this stage to earth the aluminium cabinet lid and the steel chassis of the keyboard.

Wire up the MIDI OUT DIN sockets to the CPU board and the footswitch sockets to the front panel PCB as shown in Fig. 4, before bolting them onto the aluminium lid. The board clearance of the Front Panel PCB should be such that the push button bank protrudes with the key caps flush with the lid.

Before finally bolting the front panel board into place, make sure the LEDs are all properly slotted into position.

Bolt the two joysticks onto the front panel and make up the wiring harness as shown in Fig. 5. Earth the two potentiometer cases as shown and use screened cable

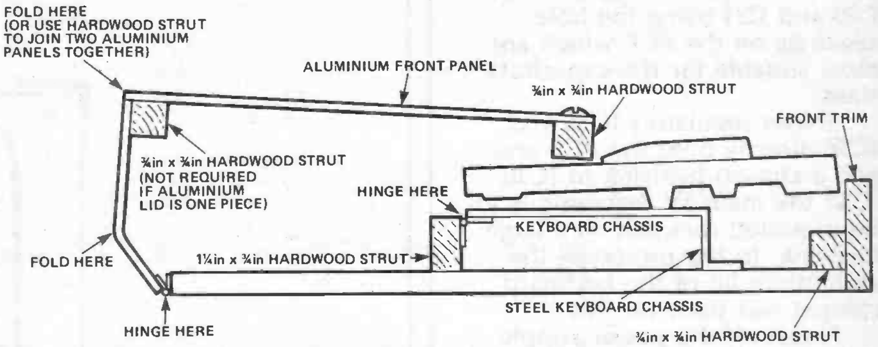
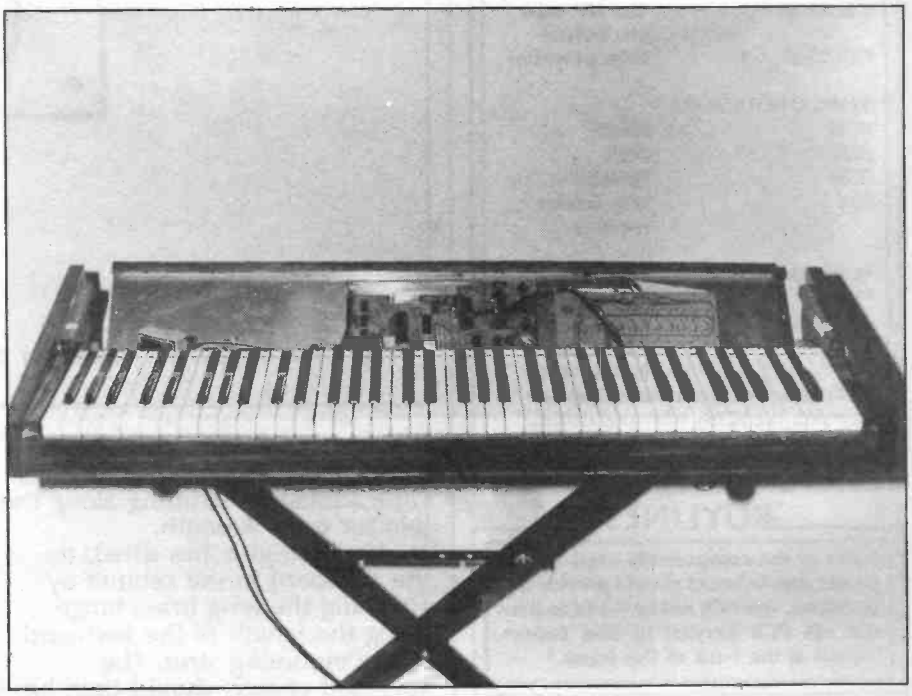


Fig. 3 Constructing the keyboard cabinet.



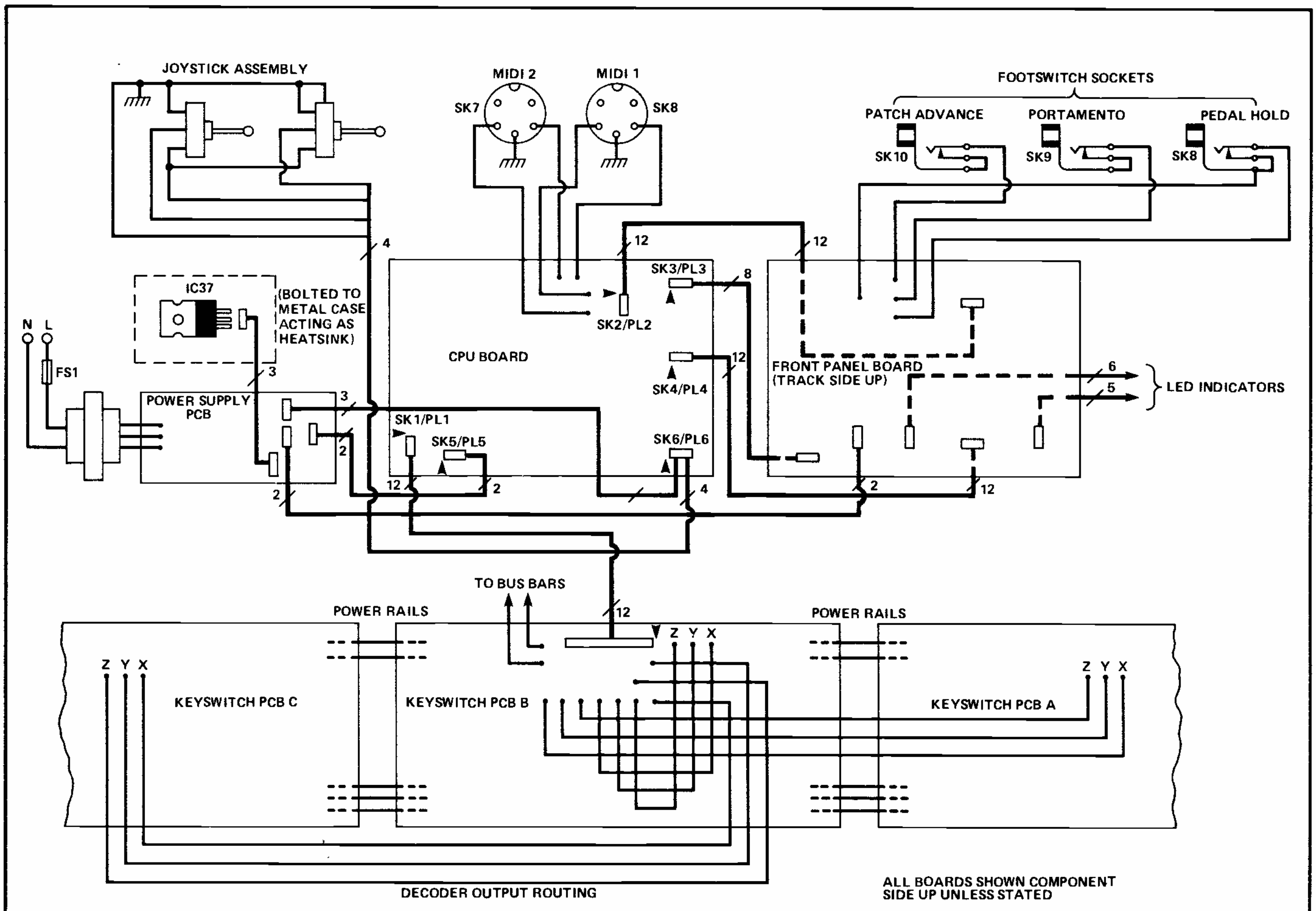


Fig. 4 The inter-board wiring for the whole MIDI Master Keyboard.

for the connections to the potentiometer wiper terminals.

Adjust the modulation joystick potentiometer so as to make the wiper voltage register 0V when the joystick lever is at its lowest point of travel. The potentiometer setting for the pitch bend joystick needs to be set so that the wiper is near the centre of the track when the joystick lever is in its neutral position. The precise position is attained later when adjusting in conjunction with the CPU board powered and operating.

All that remains is to plug all the wiring harness multi-way plugs into their respective destinations — the connectors which jump between the front panel board and CPU board and the one which links the keyswitch PCBs to the CPU board. Prepare the wiring for the power supply rails, but do not finally connect the PSU board until it has been verified that the power supply rails are functioning correctly.

Give the whole assembly a double check for correct inter-board wiring, paying particular attention to the power rail connections. Incorrectly connected power rails are catastrophic as far as the integrated circuits are concerned!

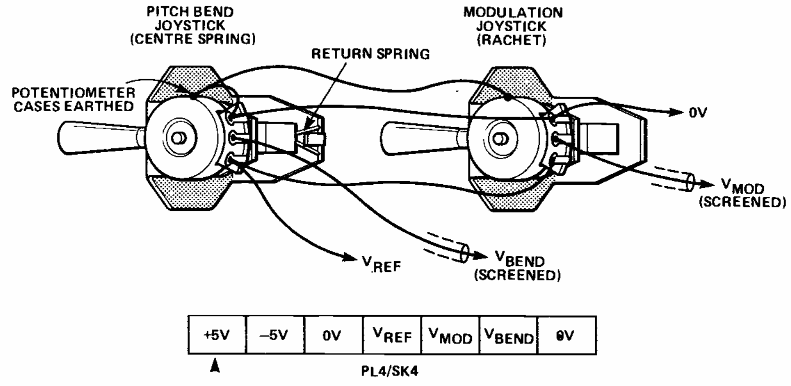


Fig. 5 Wiring the joystick assembly.

Getting the power supply working should be fairly straight forward as very little can go wrong provided all the components are correctly orientated on the PCB. Power on the mains and check the output voltages. If they are incorrect, switch off immediately and check everything over again. If the power supply regulators are operating properly, switch off and disconnect the mains supply before wiring the power rails to all the other boards.

Next month we shall look at the software to drive the MIDI Master Keyboard and the final setting up and testing. **ETI**

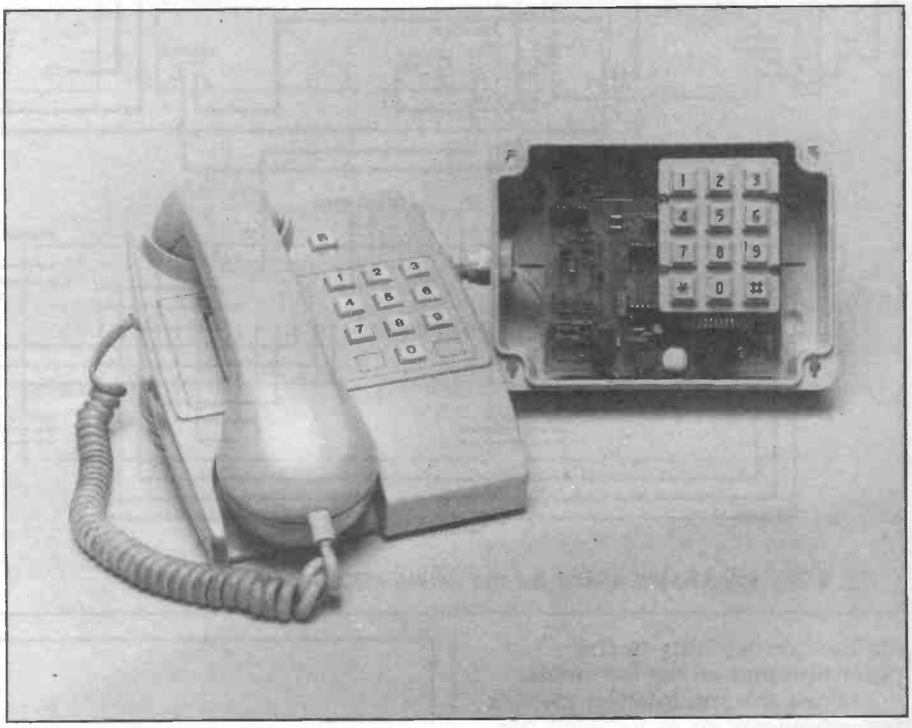
TELEPHONE ALARM

Anyone breaking into Barry Taylor's house had better watch out. This unit will phone him up and tell him just what's going on.

WARNING

The Telephone Alarm was originally designed by the author for commercial manufacture and sale. However, this circuit does not have approval from the British Approvals Board for Telecommunications (BABT) and as such should not be connected to a BT line.

Nevertheless, the Telephone Alarm can legally be used with any private exchange equipment and can form the basis of a submission to BABT for approval.



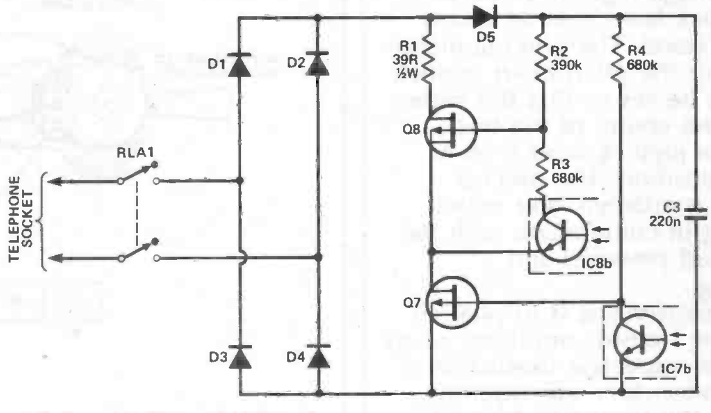


Fig. 1(a) The circuit of the Telephone Alarm line interface.

Even the most sophisticated alarm has a major drawback — it is dependent on the response of passers-by to an alarm bell or siren. Many commercial premises are in self-contained industrial estates with few or no (authorised) visitors walking around after dark. Rural homes and farms can be well isolated and far from any potential help when a break-in occurs.

Moreover, given the frequency of false alarms from all systems and in all premises it is not surprising that few passers-by who *do* hear an alarm bell starting up in their street do more than curse.

There is clearly a need for an alternative form of alarm. Several companies offer central station monitoring systems to enable alarms to be relayed over the telephone network to a computerised control centre. However, this and the option of systems offering a direct line to the police are well beyond the scope of most pockets.

It's For You-hoo

A cheaper alternative is a unit which would dial up a pre-programmed number and give an audible warning over the telephone that it had been triggered. That is exactly what this project offers.

The Telephone Alarm will automatically dial a pre-programmed number of up to 16 digits on activation of a set of external contacts. It will then transmit an alarm tone for about three minutes before hanging up. The unit is then automatically reset to dial again should another alarm occur.

Naturally, you may be so far away as to not be able to take useful direct action yourself. However, you can call the police (or a neighbour) and rest assured that the alarm has been well and truly raised.

The Telephone Alarm is not only suitable for telling you if your home or business is being burgled. Other uses, less criminal but just as vital to your piece of mind are also possible:

- fire alarm (combined with smoke and heat detectors)

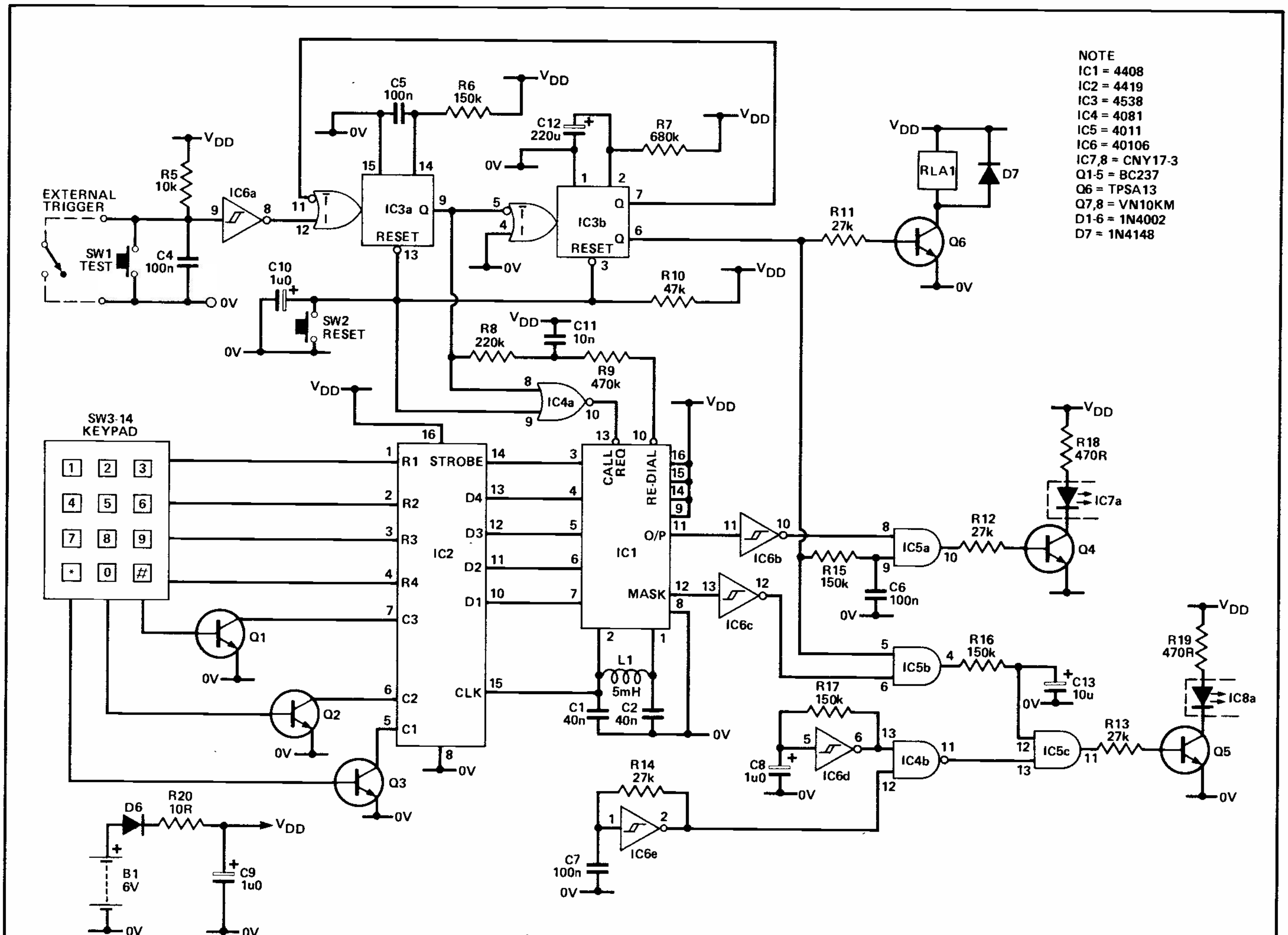


Fig. 1(b) The circuit diagram of the main body of the Telephone Alarm.

HOW IT WORKS

The full circuit of the Telephone Alarm is shown in Fig. 1. The line interface uses VMOS FETs (Q7,8) to make and break the telephone line loop to dial the number and to produce the alarm tone.

The diode bridge (D1-4) ensures that the correct polarity is observed across the FETs. When RLA1 operates the unit is connected to the telephone line and 50V from the line appears across the bridge. This turns on both FETs and completes the loop circuit.

Q7 is turned off and on via opto-isolator IC7 to dial the number. Q8 is pulsed on and off via IC8 to produce the audio tone.

At the heart of the main body of the circuit is IC1. This is a MC14408 phone pulse converter. This IC was chosen because it can be made to re-dial simply by taking pin 10 low.

Pins 14 and 15 are permanently tied high to configure the IC for the UK standard of 33% mark-to-space ratio for the dialling pulses and an interdigit time of 800ms. The on-board oscillator is set for 16kHz by L1, C1 and C3 to enable a pulse rate of ten per second.

When a valid key is pressed, the keypad encoder (IC2) outputs a strobe signal on pin 14 followed by the BCD value of the key number on pins 10 to 13. IC1 then pulses out this number on pin 11 (with ten pulses output for key zero) and stores the value in memory. IC5 prevents the number being simultaneously dialled when the unit is being programmed.

When the trigger input is closed it causes pin 8 of schmitt inverter IC6 to go high triggering the monostable IC3a. Pin 13 of IC1 (call request) is then momentarily taken low followed by a low on IC1 pin 10 (re-dial).

The monostable IC3b turns on relay RLA1 for three minutes to connect the unit to the phone line and enables the dial and tone pulses through to the opto-isolators via IC5a and IC5b. IC3b also prevents further triggering of the unit by disabling IC3a pin 11.

The two schmitt trigger oscillators formed around IC6d and IC6e make up the alarm tone generation circuitry. This is inhibited by IC5b and IC5c from reaching the opto-isolator IC8 by the mask output from IC1 while dialling is in progress. The alarm tone is then transmitted to the line via IC8 and Q8.

- freezer alarm (to warn of the imminent loss of the Sunday roast)
- flood alarm (for burst pipes and faulty tank ballcocks)

All the applications of the Telephone Alarm require some extra circuitry. In the case of the burglar alarm, simple detectors (window switches, pressure mats and so on) can be directly connected to the unit.

Many other commercial detector devices can be connected to the unit if they have a switched output and of course your own triggering devices can be designed and used with the Telephone Alarm. However, note that no voltage should be presented to the trigger input.

The Phone

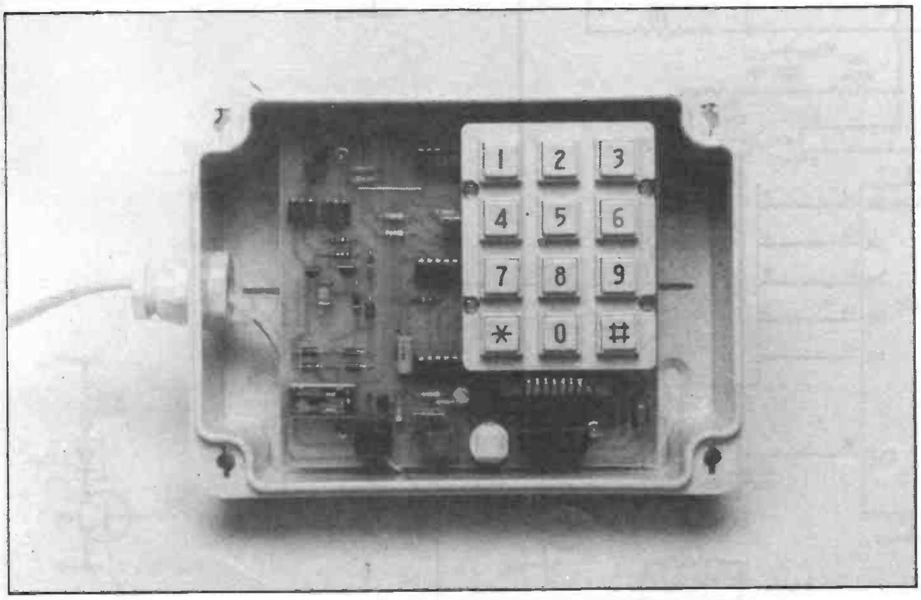
Two wires are provided from the telephone exchange to each house or subscriber. These are used for carrying the audio tones, the ringing tone and dialling signals to the exchange.

The exchange is informed that the subscriber wishes to dial by completing the circuit between the two wires. The loop circuit is then broken in a series of short pulses to signal the number being dialled.

When the exchange has then connected the call to the intended destination, the line appears as a 600ohm balanced line for the audio signals.

The Telephone Alarm circuit is in two sections — the line interface and the main body of the circuit. These are electrically isolated from one another by opto-isolators. The main body of the circuit is powered by a battery supply although a simple mains power supply could be added to the circuit. The line interface derives its power from the telephone line.

When triggered, the main body of the Telephone Alarm circuitry produces the correct sequence of making and breaking the telephone line loop to dial the number and then produces an audio tone to signal down the line that the unit has been triggered.



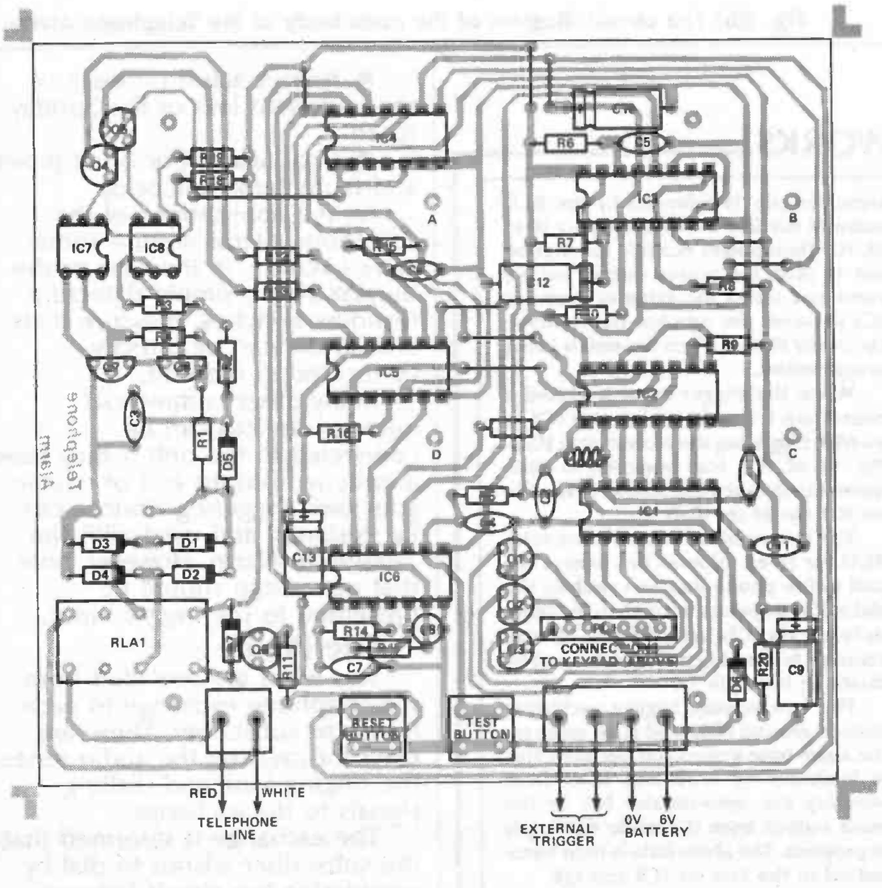


Fig. 2 The component overlay for the Telephone Alarm.

PARTS LIST

RESISTORS (all ¼W, 5% unless specified)	
R1	39R ½W
R2	390k
R3,4,7	680k
R5	10k
R6,15-17	150k
R8	220k
R9	470k
R10	47k
R11-14	27k
R18,19	470R
R20	10R
CAPACITORS	
C1,2	40n polyester
C3	220n 100V polyester
C4-7	100n polyester
C8-10	1µ0 63V axial electrolytic
C11	10n ceramic
C12	220µ 63V axial electrolytic
C13	10µ 63V axial electrolytic
SEMICONDUCTORS	
IC1	4408 or MC14408
IC2	4419 or MC14419
IC3	4538
IC4	4081
IC5	4011
IC6	40106
IC7,8	CNY17-3 opto-isolator
Q1-5	BC237 or BC337
Q6	TPSA13 or MPSA13
Q7,8	VN10KM or VN10LM
D1-6	1N4002
D7	1N4148
MISCELLANEOUS	
B1	6V (4 x 1.5V) battery
L1	5mH coil
PL1	7 way 0.1in PCB connector (male)
RLA1	DPDT, 5V coil DIL relay
SK1	7 way 0.1in ribbon cable connector (female)
SW1,2	SPST push button switch
SW3-14	12 switch keypad 4x3 matrix type
PCB; 2-way and 4-way terminal blocks; telephone lead type 431A; case.	

BUYLINES

The keypad matrix of 4x3 keys used in the prototype is available from MS Components as part number 7331. MS can also supply the relay as part number 8041. MS Components is at Zephyr House, Waring Street, West Norwood, SE27 9LH. Tel: 01-670 4466.

The opto-isolators (IC7,8) used were CNY17-3 types but any six pin opto-isolator which can withstand a Vce of 50V or more should be adequate.

IC1 and IC2 are available from Watford Electronics (Tel: (0923) 377774).

The case used for the prototype was from Legrand although any suitably sized metal or plastic case will do. None of the other components should be difficult to find.

The PCB will be available from the ETI PCB service in due course.

Construction

Figure 2 shows the component overlay for the Telephone Alarm PCB. All the ICs used are CMOS types and should be treated with the normal respect reserved for these static-sensitive devices. The usual care should also be taken to ensure the diodes and electrolytic capacitors are inserted the correct way around.

It is recommended that terminal blocks are used to connect the trigger input, the battery and the phone line itself (see Fig. 3).

The keypad should be connected last of all the components. The keypad used for the prototype (see the parts list) is mounted above the PCB on spacers secured to the PCB through the holes, A,B,C and D. The ribbon cable from the keypad is terminated with a seven way connector which is plugged onto the connector on the main PCB.

The keypad can also be mounted in the lid of the case for easy alteration of the programmed number.

You can make up your own keypad as shown in Fig. 4 on a piece of stripboard. The switches used can be any single pole, push to make buttons such as keyboard switches.

Only the switches for the numbers 0 to 9 are actually required for the Telephone Alarm. Many commercial keypads also have the * and # keys found on most push button telephone keypads. The Reset and Test buttons could occupy these positions on a keypad of your own making.

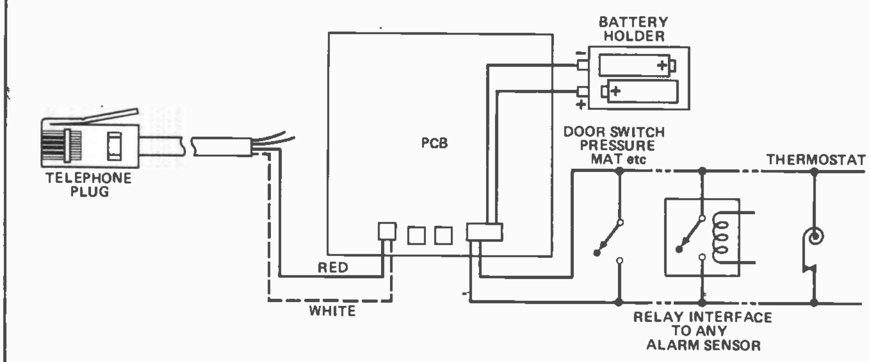


Fig. 3 Wiring up the Telephone Alarm.

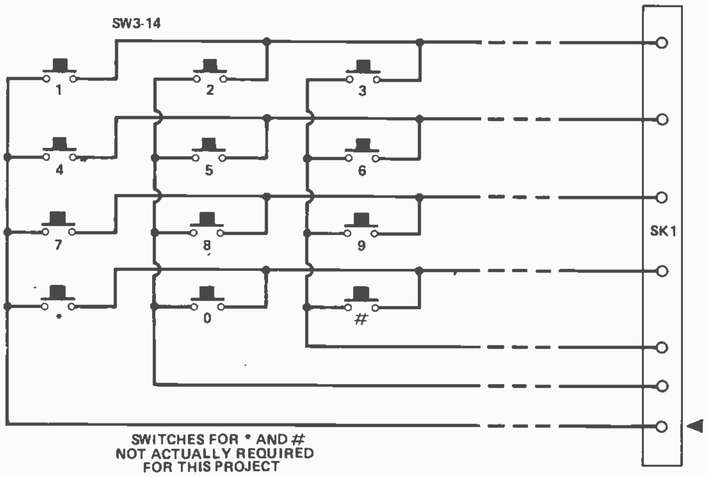
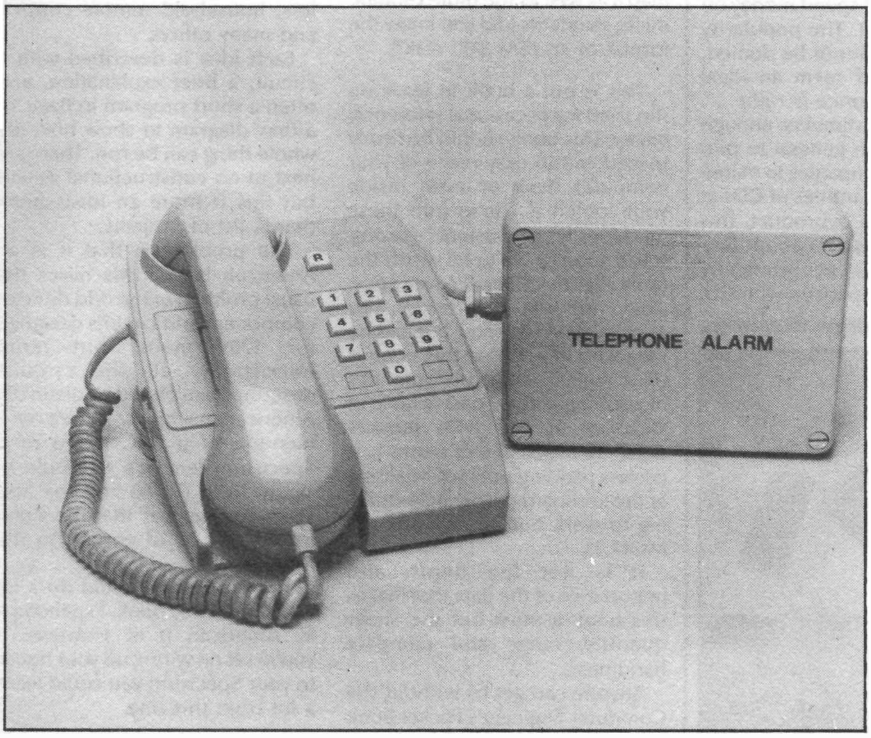


Fig. 4 Wiring your own keypad if the commercial model is not used.



Operation

The Telephone Alarm is very simple to use. The number to be dialled when the unit is triggered is programmed using the keypad and the Reset button. After the Reset button is pressed the number to be dialled (up to 16 digits) is then keyed on the keypad.

If either the Test button is now pressed or the trigger input circuit is closed the unit will dial the programmed number and sound a tone down the telephone line for approximately three minutes before hanging up and resetting the whole system.

ETI

PLAYBACK

After loudspeakers, I reckon that room acoustics have the greatest effect on the sound of good quality systems. Graphic equalisers can correct some room acoustic problems but I suspect most people use them to provide their own particular idea of what the sound colour should be.

It can be difficult to detect and null out room resonances but when you do remove a serious resonance there is less 'listener fatigue' even though the difference may not be easy to pin down at first.

All this leads me to speculate on some possible future developments. Some CD recorders nowadays have digital outputs, for connection to an external DAC (digital to analogue converter) to reduce the already minuscule noise and distortion on the original.

As microprocessing speed increases, this opens the door to the possibility of having a programmable digital room equaliser, running a high order digital filtering algorithm in up to 32 bits.

Such a microprocessor equaliser could automatically run white noise tests on the system and compute an accurate correction function. By sending many and varied test signals to each channel in turn, it could even provide a digital correction for some system non-linearities, effectively determining what distorted signal has to be fed to the loudspeakers to produce a sound equivalent to the original signal source. The amplifier may occasionally be called on to perform crazy contortions but that is no problem.

If the microprocessor equaliser was actually a computer with a colour monitor, the user could superimpose his own chosen tone correction on to the equaliser characteristic by sketching it on the screen using a mouse or lightpen. A menu of different corrections could be stored and accessed at the touch of a key.

Sound And Vision

You may wonder why I specified a colour monitor. Well, those clever chaps at Phillips are extending the CD medium to include a development of their old Laservision system. This was always technically excellent but it was not what the market had in mind at the time. Their new development will enable five minutes of sound and video plus twenty minutes of sound alone to be encoded on a CDV (CD Video) the same size as a conventional CD. In addition there will be 8in extended play and 12in long play discs, and combination players will be available to play all sizes. Surely a colour computer monitor could also display the CDV pictures and form an integral part of a future audio/video system.

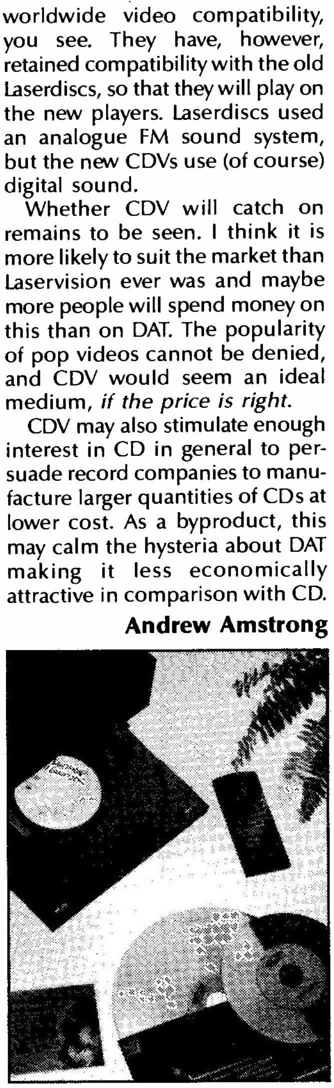
On the 5in CDVs (which look like ordinary CDs except for the gold dye in the plastic) the video information is coded on the outer area where the scanning speed is greatest. A linear speed of between 9.2 and 10.2 m/s is used for PAL video, with NTSC requiring slightly higher rates. To keep the scanning rate correct as the scanned diamater varies, the rotational speed varies from 1512 to 2250RPM.

Audio compact discs have worldwide compatability but not so the video ones. There is no worldwide video compatibility, you see. They have, however, retained compatibility with the old Laserdiscs, so that they will play on the new players. Laserdiscs used an analogue FM sound system, but the new CDVs use (of course) digital sound.

Whether CDV will catch on remains to be seen. I think it is more likely to suit the market than Laservision ever was and maybe more people will spend money on this than on DAT. The popularity of pop videos cannot be denied, and CDV would seem an ideal medium, *if the price is right.*

CDV may also stimulate enough interest in CD in general to persuade record companies to manufacture larger quantities of CDs at lower cost. As a byproduct, this may calm the hysteria about DAT making it less economically attractive in comparison with CD.

Andrew Amstrong



BOOK LOOK

Newnes Computer Engineer's Pocket Book by Michael Tooley (Heinemann) £8.95

At last Newnes (now part of William Heinmann publishers) has produced a version of the run-forever Electronic Engineer's Pocket Book exclusively for the computer enthusiast or professional.

This is the first edition of this computer version but it looks like there will be many more. This one will (as they say) run and run.

The pocket book is basically a reference work. No enrapturing bedtime reading here. What there is, is just about everything you could want to know about computer hardware. Within these pages is condensed data on most of the common processors and support chips, interface standards, operating systems, typical video waveforms, and so on (and on and on).

The pocket book is in the usual Newnes format of a long thin hardback about 8in by 3½in and around 200 pages long. Into these pages is crammed masses of information. The contents page has over 80 headings!

The information ranges over a wide area. The most basic electronics is covered (items such as TTL pin-outs and Karnaugh maps) as well as the more esoteric micro standards (did you know the format of an IBM 3740 disk?).

This is not a book to leave on the shelf for occasional reference, either. This book should be firmly placed within easy reach of your computer desk or even inside your toolkit if you're into these machines for professional reasons. It will soon prove to be worth the (only slightly inflated) cover price.

It's not just the 'things you always wanted to know but had no idea who to ask' that this book is filled with. There is vast quatities of seemingly trivial data (a table of 'devisors of 256 with remainders'. . .). Much of this seems just useless padding until you're sitting at the keyboard desperately straining to work out just what is 256 MOD 21.

It is not the depth and importance of the data that makes this book a must but the sheer quantity, range and compact handiness.

Anyone can get by without the Computer Engineer's Pocket Book but why take the hard way out?

Computer Peripherals That You Can Build by Gordon W Wolfe (John Wiley & Son) £15.30

Not a cheap one this, mainly because it comes all the way from the USA. This one's a big book, too — around 280 pages.

The biggest problem facing anyone with a home computer (after they have finished playing the games and 'learning about computers') is what the hell to do with it. It's depressing but true that most micros don't spend time doing anything useful at all.

The raison d'etre often quoted is control, automation, and the like. Now it is probable that few if any of the proponents of these claims actually do anything about them themselves. Nevertheless, they leave lots of folk out there wanting to connect up their machines to anything and everything available.

Having got that off my chest, I must say that even if the idea is a little dubious, this book approaches the whole matter in a logical and instructive way. Not a lot of knowledge is assumed at the start but the book covers an amazing amount of ground.

It starts by describing exactly what a computer is and 200 pages later it's showing how to make a flatbed plotter. In between there's paper tape readers, servo controllers, household remote control, and many others.

Each idea is described with a circuit, a brief explanation, and often a short program in Basic or a flow diagram to show how the whole thing can be run. There are next to no constructional details but this is more an ideas book than a list of projects.

The problem is that it is an American book. This raises the usual problem of the odd difficult component and circuits designed for 120V mains but more importantly all the circuits described are aimed at distinctly American machines. There's not a mention of a BBC micro or a Spectrum here. It's all Apple II, Tandy 1000, TRS-80 and the like. The good news is that the Commodore 64 is, of course, to the fore.

That aside, you could do a lot worse than this book. Expensive it is. American it is. However, if you're set on wiring up your house to your Spectrum you could learn a lot from this one.

Malcolm Brown

KEYNOTES

So far, 1987 has proved to be a dull year with regard to innovations in music technology. In fact, it is difficult to pinpoint any real innovations and, although the year is only half gone, we shall probably be forced to wait until the next NAMM and Frankfurt trade shows (in January and February respectively) to see anything original emerge.

The question is will the story be the same in 1988 too? Some people are already speculating that the electromusical instrument market may be flattening out from its previously high rate of growth or, in plainer terms, plunging into a recession not unlike the one that began hitting the semiconductor industry several years ago. The symptoms are exactly the same — prices stay fixed and new developments get shelved due to the high cost of R&D.

The cause might be put down to an increasing saturation of a finite market with cheap keyboards designed to make MIDI, not music. The result may ultimately be for such machines to paint themselves into the dark and sullen corner of obsolescence with the disgraceful lack of standardisation of the MIDI protocol as their suicidal paintbrush.

Signs of middle-aged flatulence are already in evidence and it is intriguing to compare the so-called new developments of 1987 with the music trends of our time. Old machines are being repackaged in new boxes at the same rate with which club remixes are remixed and cover versions are recovered. Furthermore, manufacturers are currently stealing ideas off each other to a degree that puts the 'sample before you get sampled' ethic of Hip-Hop to shame.

Take Sequential Circuits' Vector Synthesis technique, in which four sounds derived from digital wavetables are mixed under the control of a joystick with X-axis position controlling balance between two sounds and Y-axis position controlling balance between the other two. To be fair, this is a very useful and ergonomic feature, beautiful in its simplicity, but by the same token scarcely deserving of a name as convoluted as Vector Synthesis. With respect to originality, the technique was possible on many modular analogue synths, not unknown on DJ's mixing desks and not very dissimilar to the soundfield control joysticks found on quadrophonic equipment.

Sequential knew their rediscovery would be nicked in due course and trade-marked Vector Synthesis (no doubt patented it also) in order to make the villain's life more difficult.

Undeterred, stray dog Roland went rummaging in the dustbins and came out with a bone — Linear Arithmetic Synthesis, whereby only two sounds are mixed by means of a joystick. Boffins with lightbulbs over their heads will immediately realise at this point that joystick technology could even be extended to the control of a single sound. Maybe I shouldn't be giving Roland ideas!

FM Rules OK!

The greatest disappointment of the year is undoubtedly Yamaha's long awaited sequel to the DX7. The original DX7 made such an impact on the music world that we might reasonably have expected a follow-up to be the last nails in the coffins of their competitors but that would be overlooking the obvious. The philosophy behind the DX7 II is that if a machine is selling well then there is no point in changing it — just add a few embellishments and increase the price!

Korg has fixed up a corporate deal with Yamaha which apparently allows them to reap the benefits of Yamaha R&D. The first visible result of this deal is Korg's new DS8, a DX7 clone with an original feature: on power-up, the LCD greets you with 'Welcome to Synthworld!'

Casio's Phase Distortion is essentially identical to Yamaha's FM (which is actually phase modulation and not FM at all), except the waveforms which do the modulating or get themselves modulated are not necessarily sine waves (as on the DX7). This was a dodge for getting around patent legislation and, predictably enough, Yamaha has in its turn torn a page out of Casio's book with the introduction of the TX81Z expander — a keyboardless synth designed to be controlled by MIDI, usually housed in a 19in rack-mount case. This machine replaces their marginally popular and somewhat limited FB01 (production of which has ceased) and simultaneously provides Yamaha with the opportunity of incorporating a choice of eight operator waveforms. All one can say is that honour among thieves is a thing of the past.

Bruno Hewitt

OPEN CHANNEL

Today, I took delivery of my new Mercury telephone. I ordered it less than a week ago from Mercury Communications Ltd, having made a few rough calculations based on the use of my telephone.

I will be able to use this telephone to connect me to the Mercury 2200 telephone network which now has some 59 access areas. The latest expansion incorporates my address.

Eventually, of course, the whole country will be covered but meanwhile it's worth checking with Mercury (the customer assistance number is 0800 424 194 and no charge is made by BT for your call, incidentally) to see if you live in one of the current access areas.

The savings in telephone charges by using Mercury 2200 can make the enquiry well worthwhile. For example, a standard rate trunk call via BT can cost around 12p per minute, whereas the same call via Mercury 2200 is less than 9p per minute.

Alternatives

Mercury's alternative telephone network to British Telecom's is, unlike BT's, only a trunk network. In other words, you can't use the Mercury network to dial a local call. (In fact, this not *strictly* true — it *is* possible to use the Mercury 2200 network to make local calls by routing them out of the local area onto the trunk network then back into the local area but then it costs more than a BT local call anyway, so it's not worth the bother). So, to make a local call you must still be connected via a local line to the BT network.

However, any calls made which are longer distance and must be connected via a trunk network, can now be made via BT *or* Mercury. I have a choice of telephone networks for the very first time! At least, I *will* have a choice of network, when BT finally gives me a new socket.

Apart from a choice of network on trunk calls, I have a choice of prices. Needless to say Mercury's prices generally undercut BT's somewhat. As most of my calls are long distance, I calculate I will make savings of at least £70 per year by making all my trunk calls using my Mercury telephone.

I applied to BT to have their engineers call and fit me a new socket some seven weeks' ago. At the time, I was told that a date *eleven weeks after that* was the earliest possible appointment to do the simple job — and telecommunications in Britain are supposed to be liberated?

Do you think BT will pay up if I send them a bill for £14.80 (which is 11/52 x £70), to make up for the lost savings in telephone charges which their slow service has caused me?

Looking At A Problem

Users of, potential users of or even just parties interested in, optical fibre communications would do well to get a copy of a new booklet published by BICC Electronic Cables Ltd called 'UFO's Explained'.

The UFO's in question are 'unidentified fibre optics'. The booklet is a well thought out, well written, and well put together tome (no, I had nothing to do with it!) which starts at the beginning and ends at the end of the topic (shouldn't they all?). Somewhere in the middle is also a pretty fair description of optical fibre technology, in a non-technical yet thorough manner.

BICC has obviously seen that one problem in getting Joe Public to use optical fibres is the sheer reluctance to get to grips with the technology. Most people believe it to be too expensive and too technical for general cabling purposes. 'UFO's Explained' goes a long way to sorting this problem out.

A free copy of the booklet can be had from BICC Electronic Cables, Optical Fibre Technology Unit, Helsby Works, Helsby, Warrington, WA6 6BR. Tel: (09282) 2700.

TDF's DBS

French broadcasting body, Telediffusion de France, intends to launch the country's first direct broadcasting satellite (DBS) later this year. Problems have arisen in the satellite's launch, not because the satellite was not ready but because the launch rocket (Ariane) has been grounded following its failure some time ago.

However, now Ariane's technical problems appear to have been overcome and launch dates are currently being tentatively mooted.

Meanwhile, it has been reported that Germany's DBS satellite launch, although agreed to have been via Ariane, will instead go ahead on a Chinese or Russian rocket if further problems with Ariane occur.

Keith Brindley

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E8202-5	MM Stage Disc Preamp (Tilsbrook)	G
E8206-5	Logic Lock	F
E8208-1	Playmate Practice Amp 3bds SA1	K
E8212-1	ELCB	F
E8301-2	Analogue to digital conv (ZX81/ Spectrum)	E
E8305-3	Dual Audio Power Supply, Linsley Hood	G
E8305-5	Balanced Input Preamplifier	F
E8307-2	Flash Trigger-sound or FR	F
E8308-1	Graphic Equaliser ⅓ Oct/Chnl	M
E8308-2	Servo Fail-safe	C
E8309-1	NICAD Charger/Regenerator	F
E8310-3	Typewriter Interface - EX42	F
E8311-1	Mini Drum Synth	F
E8311-8	Moving Coil Pre-Preamp	F
E8312-3	Light Chaser EPROM Controlled (2 Boards)	K
E8402-1	Speech Board	M
E8402-2	Modular Pre-amp Disc Input Mono	F
E8402-3	Modular Pre-amp Stereo Output	F
E8402-4	Modular Pre-amp Relay, PSU	F
E8402-5	Modular Pre-amp Tone Main Mono	F
E8402-6	Modular Pre-amp Tone Filter, Stereo	F
E8402-7	Modular Pre-amp Balanced Output	F
E8402-8	Modular Pre-amp Headphone Amp	F
E8404-2	Mains Remote control Receiver	F
E8405-1	Auto Light Switch	F
E8405-2	ZX81 EPROM Programmer	N
E8405-3	Mains Remote Control Transmitter	H
E8405-4	Centronics Interface	F
E8405-6	Drum Synth	F
E8406-1	Oric EPROM Board	O
E8406-2	Spectrum Joystick	E
E8406-3	Audio Design RIAA Stage	G
E8406-4	AD Buffer/Filter/Tone	H
E8406-5	AD Headphone Amp	F
E8406-6	AD Preamp PSU	K
E8406-7	AD Power Amp	H
E8406-8	AD Power Amp PSU	J
E8406-9	AD Stereo Power Meter	F
E8406-10	AD Input Clamp	C
E8407-1	Warlock Alarm	M
E8408-2	EPROM Emulator	N
E8408-3	Infrared Alarm Transmitter	E
E8408-4	Infrared Alarm Receiver	F
E8409-1	EX42 Keyboard Interface	F
E8409-2	Banshee Siren Unit	F
E8410-1	Echo Unit	F

E8410-2	Digital Cassette Deck	N
E8410-3	Disco Party Strobe	H
E8411-5	Video Vandal (3boards)	N
E8411-6	Temperature Controller	D
E8411-7	Mains Failure Alarm	D
E8411-8	Knite Light	D
E8411-9	Stage Lighting Interface	F
E8411-10	Perpetual Pendulum	E
E8412-1	Spectrum Centronics Interface	F
E8412-4	Active - 8 Protection Unit	F
E8412-5	Active - 8 Crossover	F
E8412-6	Active - 8 LF EQ	F
E8412-7	Active - 8 Equaliser	F
E8501-3	Digital Delay (2 boards)	T
E8502-1	Digital Delay Expander	N
E8502-2	Data Logger	J
E8503-1	Combo Preamplifier	F
E8503-2	THD Meter mV & oscillator bds (2 boards)	K
E8503-3	THD Meter Mains PSU	F
E8504-1	Framestore Memory	M
E8504-3	Framestore Control	N
E8504-4	Buzby Meter	E
E8504-5	CCD Delay	F
E8505-5	Stereo Simulator	F
E8506-1	Audio Mixer Main	J
E8506-2	Audio Mixer PSU	F
E8506-3	Audio Mixer RIAA	D
E8506-4	Audio Mixer Tone Control	D
E8506-5	EPROM Prog MKII	O
E8508-1	RCL Bridge	N
E8508-2	EX42/BBC Interface	E
E8508-3	EPROM Emulator	L
E8509-1	Spectrum	F
E8509-2	Direct Injection Box	E
E8510-9	Sunrise Light Brightener	K
E8511-1	MTE Waveform Generator	H
E8511-2	Millifaradometer	H
E8511-3	Cymbal Synth	J
E8511-5	Chorus Effect	H
E8511-7	Enlarger Exposure Meter	F
E8511-8	Switching Regulator	E
E8511-9	Second Line of Defence	M
E8512-1	Specdrum connector	F
E8512-2	MTE Pulse Generator	H
E8511-3	Specdrum	L
E8601-2	Walkmate	L
E8601-3	MTE Counter-timer	M
E8602-1	Digibaro	O
E8603-2	Programmable Logic Evaluation Board	H
E8603-3	Sound Sampler Analogue Board	R
E8604-1	JLLH PA PSU	H
E8604-2	Matchbox Amplifier	C
E8604-3	Matchbox Amp Bridging Version	C
E8604-4	MTE Analogue/Digital Probe	M
E8605-1	Microlight Intercom	E
E8605-2	Baud Rate Converter	M
E8605-3	Baud Rate Converter PSU Board	G
E8605-4	Portable PA	H
E8606-1	Midi-CV Converter Board	H
E8606-2	Midi-CV Converter PSU	D
E8606-3	Troglograph	F
E8606-4	80m Receiver	H
E8606-5	Sound Sampler	R
E8607-1	Directlon	E
E8607-2	Upgradeable Amp, MC stage (Stereo)	G
E8607-3	BBC Motor Controller	F
E8608-1	Digital Panel Meter	G
E8608-2	Upgradeable Amp, MM stage (mono)	H
E8609-1	Mains Conditioner	E
E8609-2	Experimental preamp	F
E8609-3	Upgradeable amp, Tone board (mono)	H
E8609-4	Upgradeable amp, Output board (mono)	F
E8610-1	Audio Analyser Filter Board	L
E8610-2	Audio Analyser Display Driver	K
E8610-3	Audio Analyser Display	H
E8610-4	Audio Analyser Power Supply	F
E8611-1	Audio Switcher (2 bds)	H
E8611-2	PLL Frequency meter (4 bds)	Q
E8611-3	Upgradeable Amp PSU	J
E8611-4	Call meter, main bd	O
E8611-5	Call meter, interface bd	N
E8612-1	Bongo Box	J
E8612-2	Biofeedback monitor (Free PCB)	E
E8701-1	RGB Converter	F
E8701-2	Mains Controller	D
E8701-3	Flanger	H
E8701-4	Audio Selector main board	M
E8701-5	Audio Selector PSU	H
E8701-6	Tacho-Dwell	F
E8702-1	Ratemeter main board	K
E8702-2	Ratemeter ranging board	F
E8702-3	Photo Process Controller (3bds)	O
E8702-4	LEDline display board (2 off)	K
E8702-5	LEDline PSU and controller (2 bds)	G
E8703-1	Capacitometer	F
E8703-2	Geiger Counter	L
E8703-3	Credit Card Casino	E
E8704-1	BBC micro MIDI interface	L
E8704-2	ETIFaker patch box	H
E8704-3	24Hr. Sundial	E
E8705-3	MIDI Keyboard keyswitch boards (3 boards)	W
E8705-4	Batlite	C
E8705-5	Budget Power Meter	E
E8706-1	Hi-fi Power Meter	N
E8706-2	MIDI Keyboard CPU	U
E8706-3	MIDI Keyboard Front Panel	O
E8706-4	Flame Simulator	G
E8707-1	MIDI Keyboard PSU	H
E8707-2	Telephone Alarm	J
E8707-3	Nuclear Strategy Simulator	J

OOPS!

Biofeedback Monitor (December 1986)
The capacitor C4 is shown the wrong way around in the component overlay diagram (Fig. 4).

The Intelligent Call Meter (December 1986)
The hex dump listing of the ROM for this project (Table 3) was badly printed. The byte at location BF should read 7F.

The Better Flanger (January 1987)
In the circuit diagram (Fig. 2) D1 is not labelled. This is connected to Q1. In the component overlay (Fig. 5) several components are missing. A link should connect the two pads to the left of C1. Q1 is situated next to D1 and connection point P4 is situated between R16 and R33. In addition, the positions of R16 and C11 should be swapped.

Photo Process Controller (February 1987)
In the circuit diagram (Fig. 2) the cathodes of diodes D3,5 are shown connected to 0V. They should connect to the junction of R16,17,18. In the overlay diagrams (Figs. 3 and 5) the flying leads are numbered incorrectly. Leads 7, 8, 9 and 10 at the top of Fig. 3 should be numbered 16-19. In Fig. 5 leads 6 and 8 from the top of R13 should be numbered 16 and 17. Numbers 9 and 10 from Q1 and Q2 should be 18 and 19. In addition the leads 11 and 'A' should be swapped.

Capacitometer (March 1987)
The circuit diagram (Fig. 1) should show pin 1 of IC1 connected to 0V. The zener diode (ZD1) should be connected between the junction of R10/R11 and 0V. The PCB foil is correct.

BBC Micro MIDI Interface (April 1987)
IC7 and IC8 (the 6N139 opto-isolator ICs) are missing from the parts list. In the Buylines section it is incorrectly said that these are available from Electromail as part 302-126. The isolator is available from Maplin as part number RA59P. Resistors R8,9 are missing from the overlay diagram (Fig. 4). These are located in the two pairs of pads below IC6. There should also be no 0V connection to the MIDI IN sockets, only to the OUT sockets (pin 2) so as to prevent earth loops.

Power Meter (May 1987)
The foil for the budget power meter was given 50% full size on the foil pages. The correct size foil appeared in the June issue.

MIDI Master Keyboard (June 1987)
The foils for the CPU board were given 64% full size on the foil pages. Photocopies of the correct size foils can be obtained by sending a SAE to the Editorial address.

TECH TIPS

3-in-1 Reset

A.J. Holme
York

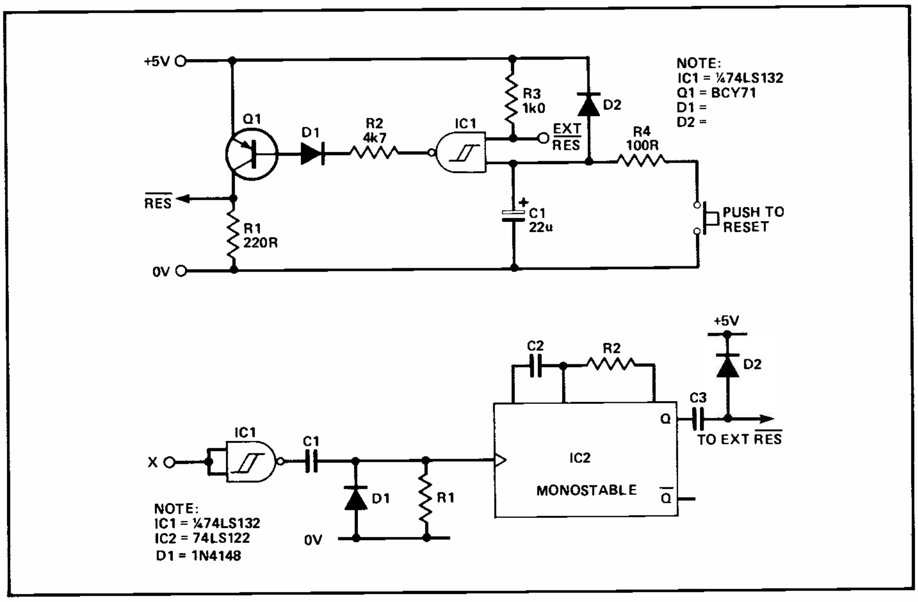
This circuit was designed for a 6502 controller board. It provides power-on reset, a TTL compatible input for externally generated resets, and a push button for manual reset.

A PNP output stage is used to prevent RES briefly going high at power-up, before the supply stabilizes at +5V. It is not strictly necessary and may be replaced by a NAND inverter if preferred.

The state of the EXT RES input is echoed at the RES output while the one-shot generator is in its stable state. There are two possible uses for this:

- Driving EXT RES with a clock causes the processor to continuously repeat its power-on reset sequence. Provided suitable triggering can be arranged, this enables the processor buses to be viewed on an oscilloscope as steady, logic-analyser style traces.
- With the addition of the lower circuit shown a restart from crash facility may be added. Point X is connected to a signal which regularly changes during normal processor activity. The network on the output of the NAND inverter produces positive pulses which clock the monostable at every falling edge of X. This ensures that the mono is permanently in its triggered state. Should the processor crash (for example from mains-borne interference) these pulses will cease, causing the mono to reset. The resulting negative edge at Q is capacitively coupled to the EXT RES input and this generates a processor reset which recovers execution.

Some simple software support for this circuitry will be required to enable the processor to distinguish between warm and cold starts.



Simple Audio Limiter

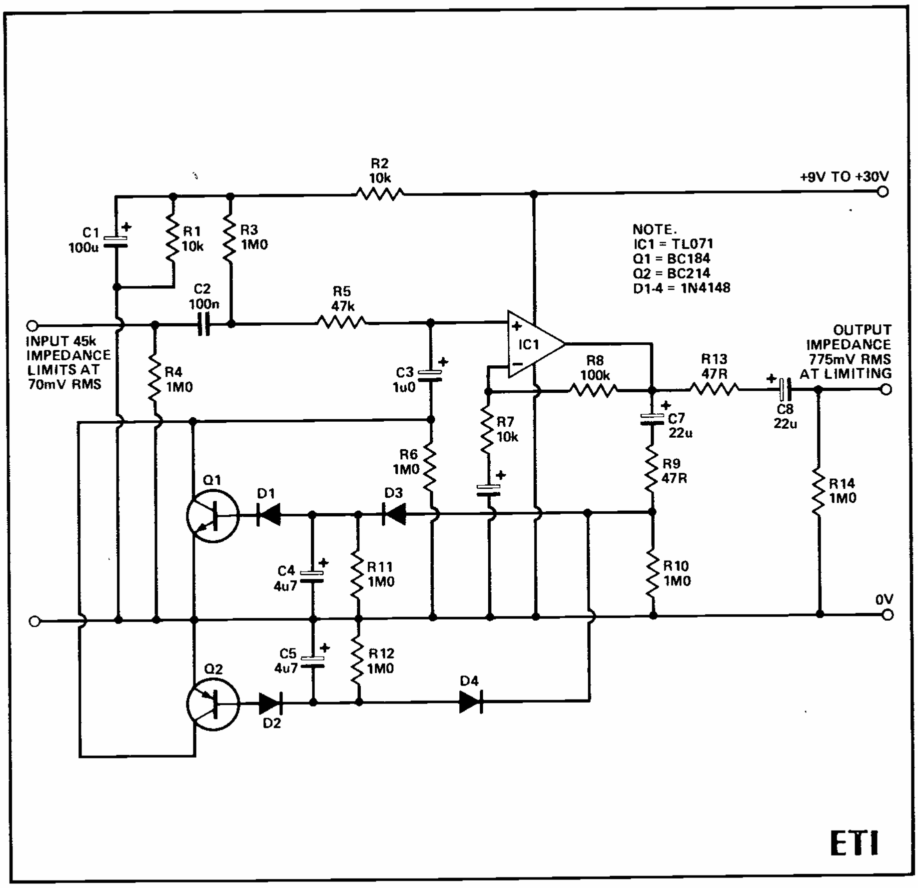
R.J. Eggleton
St Ives

Audio limiters are useful in many applications such as recording, transmitting or public address systems where over-modulation would cause unwanted distortion.

This circuit has the virtues of simplicity, fairly low distortion and no need for adjustment.

Input voltages below the limit level are amplified by the op-amp eleven times to the output ((R7+R8)/R7). When the output level rises to the limit level of 775mV RMS the diodes conduct to the two limiting transistors and limit the level. Since the transistor limiters are inside the feedback loop of the op-amp, distortion is reduced significantly.

As the input is immediately limited before entering the op-amp, the circuit can withstand considerable overload. However distortion will rise above 40dB of limiting (approx 7 volts RMS input).



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TEKTRONIX 545B scope £75. Great Yarmouth. Tel: (0493) 667689.

WANTED: secondhand strobe light. Contact: B. Clark, 73 Greenlaw Crescent, Glenrothes, Fife.

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WANTED. Technical service manual, circuit diagram, details of expansion ROMs for Acorn Atom. Tel: (0422) 70270.

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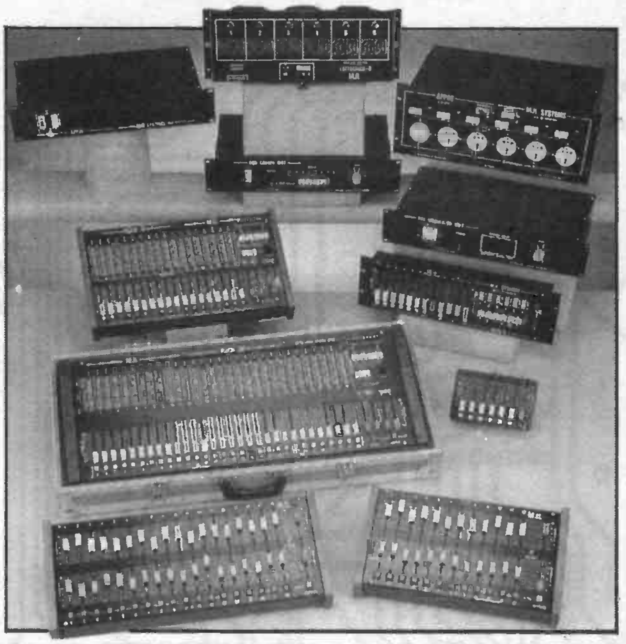

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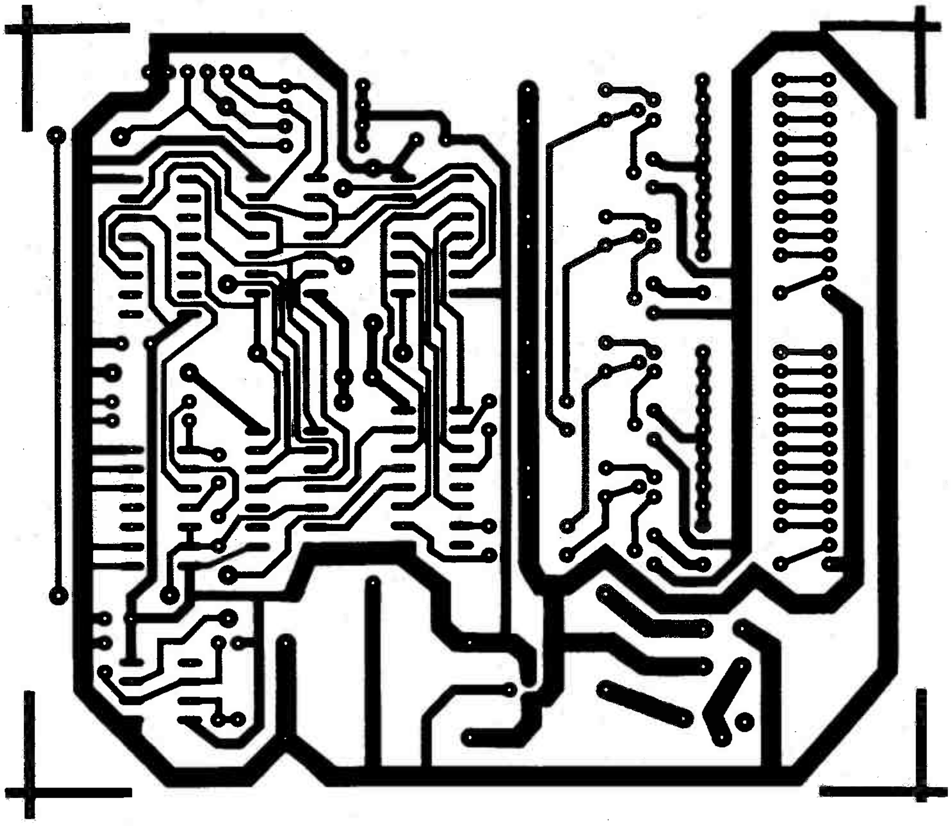
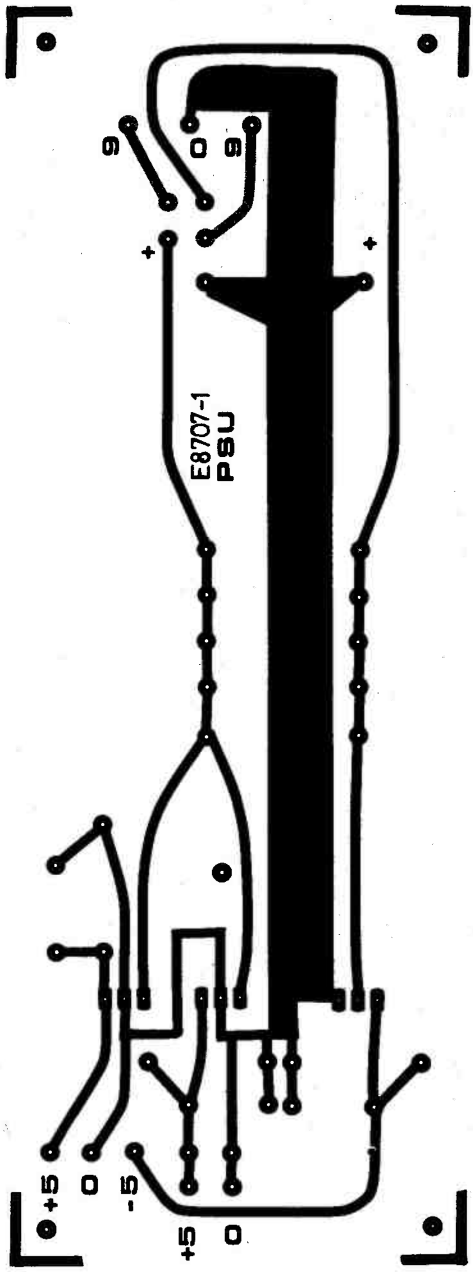
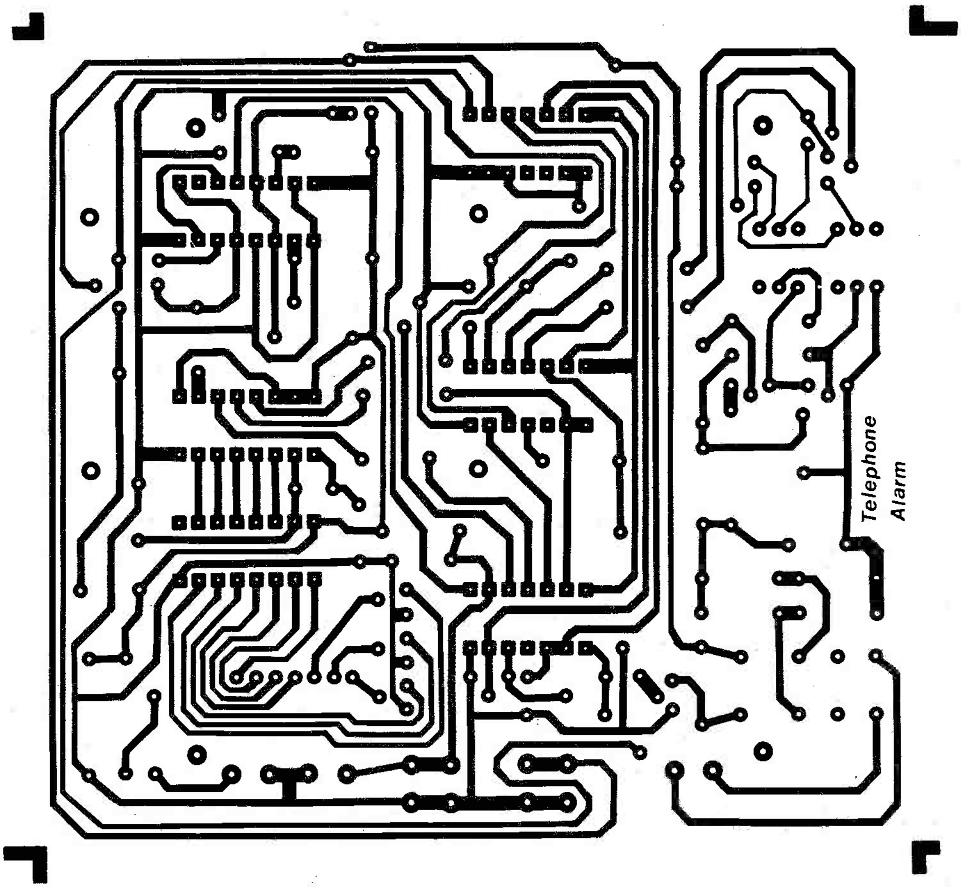


The foil for the Nuclear Strategy Simulator.



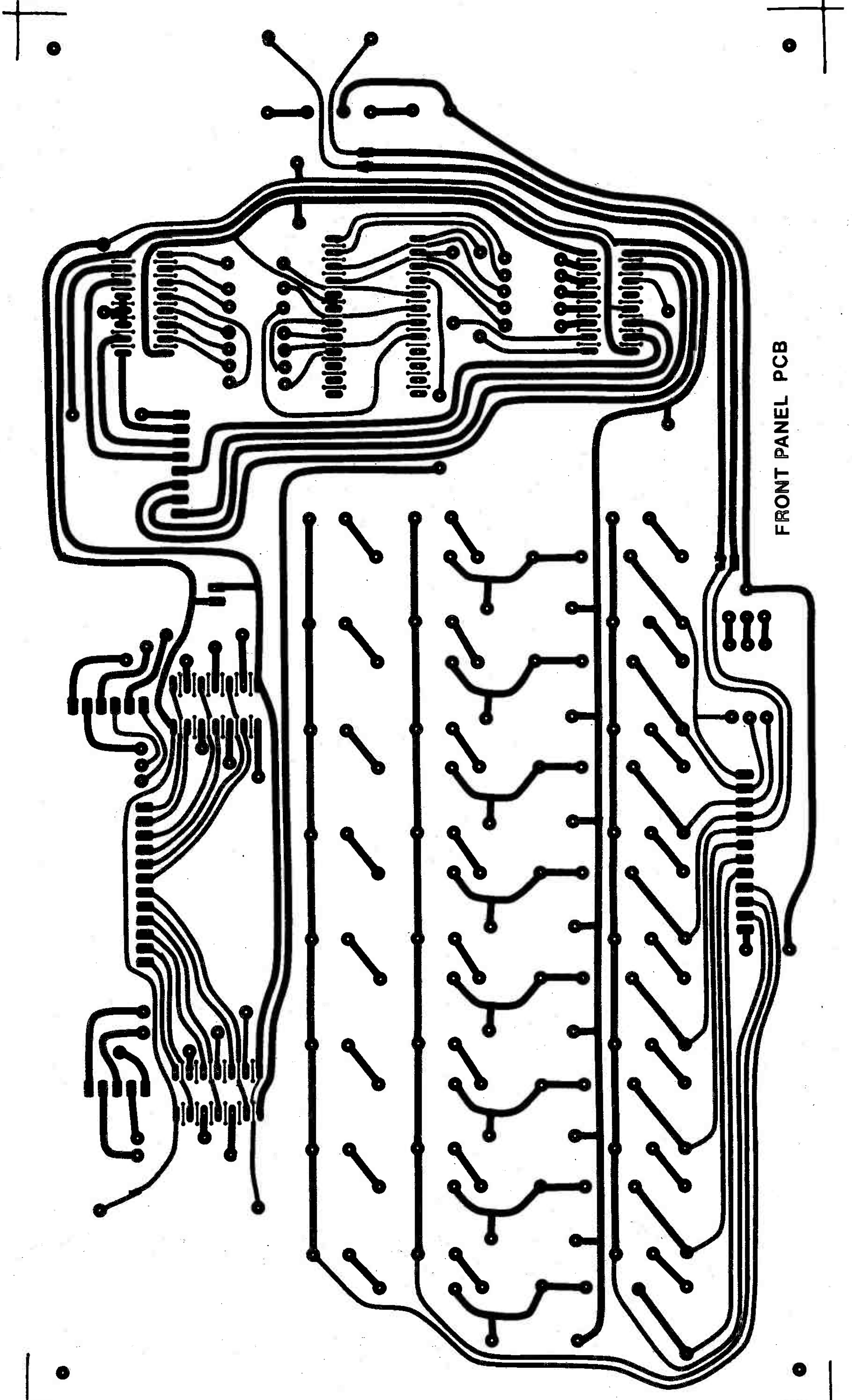
The MIDI Master Keyboard PSU foil.



The Telephone Alarm PCB foil.

PCB FOIL PATTERNS

Please note: The MIDI Master Keyboard CPU foils given last month were shown 64% full size. Photocopies of the full size foils can be supplied on receipt of an SAE. Please send in to ETI MIDI Keyboard Foils, 1 Golden Square, London W1R 3AB.



The MIDI Master Keyboard front panel board foil held over from last month.

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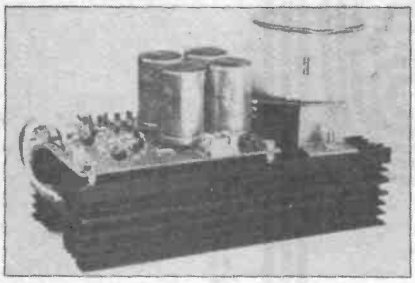

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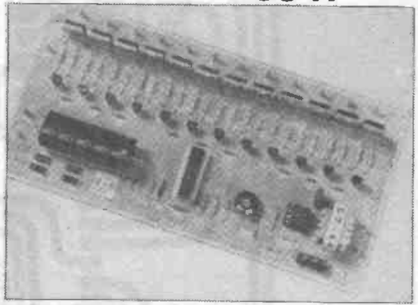

GIANT VU METER KIT NR. K2620

Several circuits providing different light effects, from the simple lightorgan to real 'lightcomputers', have already appeared on the market.
This kit is something new... a giant VU.meter with 240V bulbs. The 12 bulbs are mounted as a lightcolumn which varies according to the sound level.
The input is galvanically separated and the sensitivity is adjustable, so there is no danger when connected to a pre-amplifier or to a power amplifier.

- 12 triac outputs: 400W each (non-cooled).
- Input impedance: ca. 20 Kohm.
- Input sensitivity: adjustable from ca. 100mV to 3V at full scale.
- Power supply: 9 VAC/0,5A.

Price £36.85 + p&p

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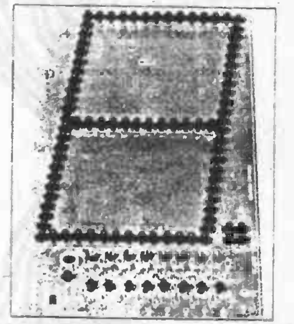


20CM DISPLAY 'COMMON ANODE' KIT NR. K2567

This kit contains a 7-segment display consisting of 12 leds per segment and 4 leds for the decimal point. With the aid of a supplementary power supply, it is possible to connect this kit to any existing circuit equipped with common anode displays of any brand and any dimension.
If the digit and segment drivers of the circuit can supply sufficient current, it will be possible to connect in parallel two or more displays, or even, leave the small display of the circuit in place and connect the 20cm display in parallel. This latter will not effect the brightness of the 20cm display due to the specila concept of the driver circuit.

- Common anode.
- Power supply: 22 to 26VDC non-stabilized.
- Minimum anode input voltage (on): 2V.
- Maximum anode input voltage (off): 1.2V.
- Segments input impedance: 10K.
- Segment current: static (R6=00):+40mA multiplex (R6=220hm): +75mA.
- Total current consumption in static mode: maximum 400mA.
- Maximum power (U=22V): 8.8Watt.

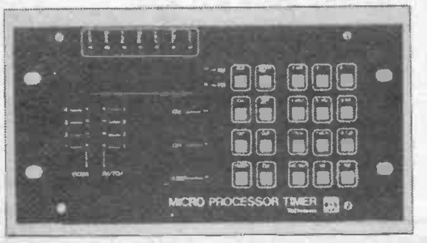
Price £30.26 + p&p

20CM DISPLAY 'COMMON CATHODE' KIT NR. K2568

This kit is in terms of appearance and application identical to K2567 'COMMON ANODE'.
As far as specifications are concerned; read cathode for anode.

Price £31.93 + p&p

MICROPROCESSOR UNIVERSAL TIMER KIT NR. K1682

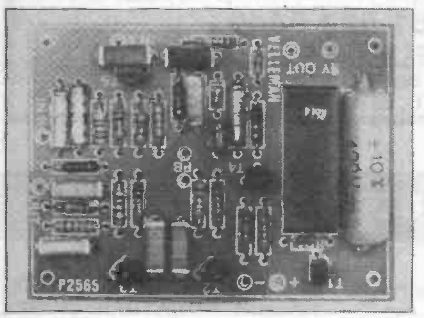


This unique timer is in principle a 24-hour clock provided with 4 relay-switched outputs and a programmation period of 1 week. 20 switching programs can be memorized and via the membrane keyboard be programmed. Outputs or timing periods can be selected at random.
All program steps are indicated be leds.
A printed alu frontplate is included in the kit, making building-in of this timer a simple affair.
This microprocessor timer was primarily designed for industrial and labo purposes, but the amateur can use it in dozens of applications as well.

- 20 daily- or weekly programmable timerfunctions.
- Memory display of programmed timer functions per output or per day.
- 4 independent relay outputs (1 relay included).
- Display of: day of week - AM/PM - output - clock.
- ON/OFF - sleep.
- The timer is based on the TMS 1122 microprocessor.
- Transformer 12VAC/1A (not included).

Price £75.85 + p&p

TAPE/SLIDE SYNCHRONIZER KIT NR. K2565

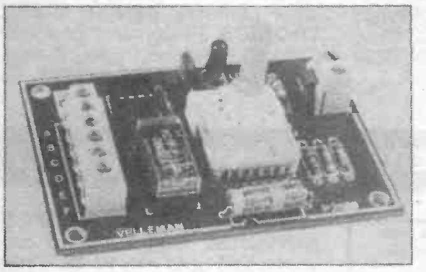


Actually, a lot of tape/slide synchronizers are available on the market. The price of these devices varies from expensive to very expensive.
Those owning a tape- or cassette recorder can with this simple and inexpensive device, record synchronizing pulses and use these pulses to control automatic slide projectors.
The circuit is small in size and can easily be housed.

- Power supply: 9 to 13VDC.
- Current consumption: 40mA.
- Output frequency (tone):+1.5KHz.
- Output amplitude:+250mV.
- Input sensitivity A: minimum 1.5V peak to peak.
- Input sensitivity B: minimum 100mV.
- Oscillator: AMV type.
- Input impedance (B): 1 KOhm.
- Output impedance: 15 KOhm.

Price £12.75 + p&p

SCREEN WIPER ROBOT KIT NR. 2599



Three different time intervals may be selected by using a multipole rotary switch. With small component changes, the intervals may be varied.
Some applications: windscreen wiper delay - diaprojector control - hazard warning via the brakinglights of the car.
In the manual you will find a complete description how to build this kit in a car, with wiring instructions to connect it to the existing wiper installation.

- Power supply: 12-15V DC.
- Intervals: 5-10-15-seconds.
- Relay output: 240V/2x3A.
- Relay output with two change-over contacts.
- Current consumption:
- Output 'OFF': 25mA.
- Output 'ON': 100mA.
- Dimensions:82×56×41mm.

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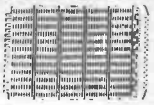
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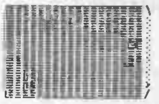
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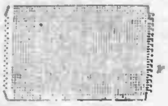
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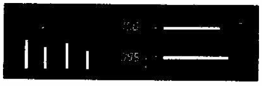

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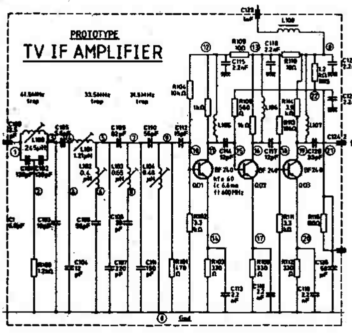

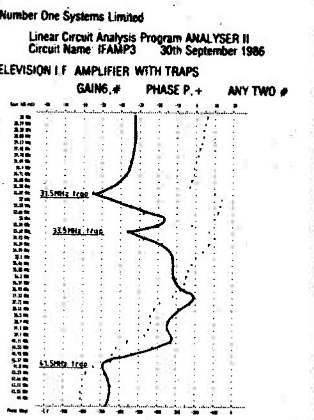

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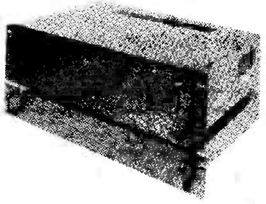

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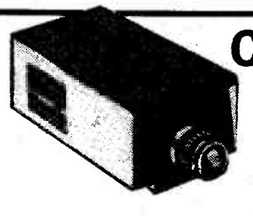

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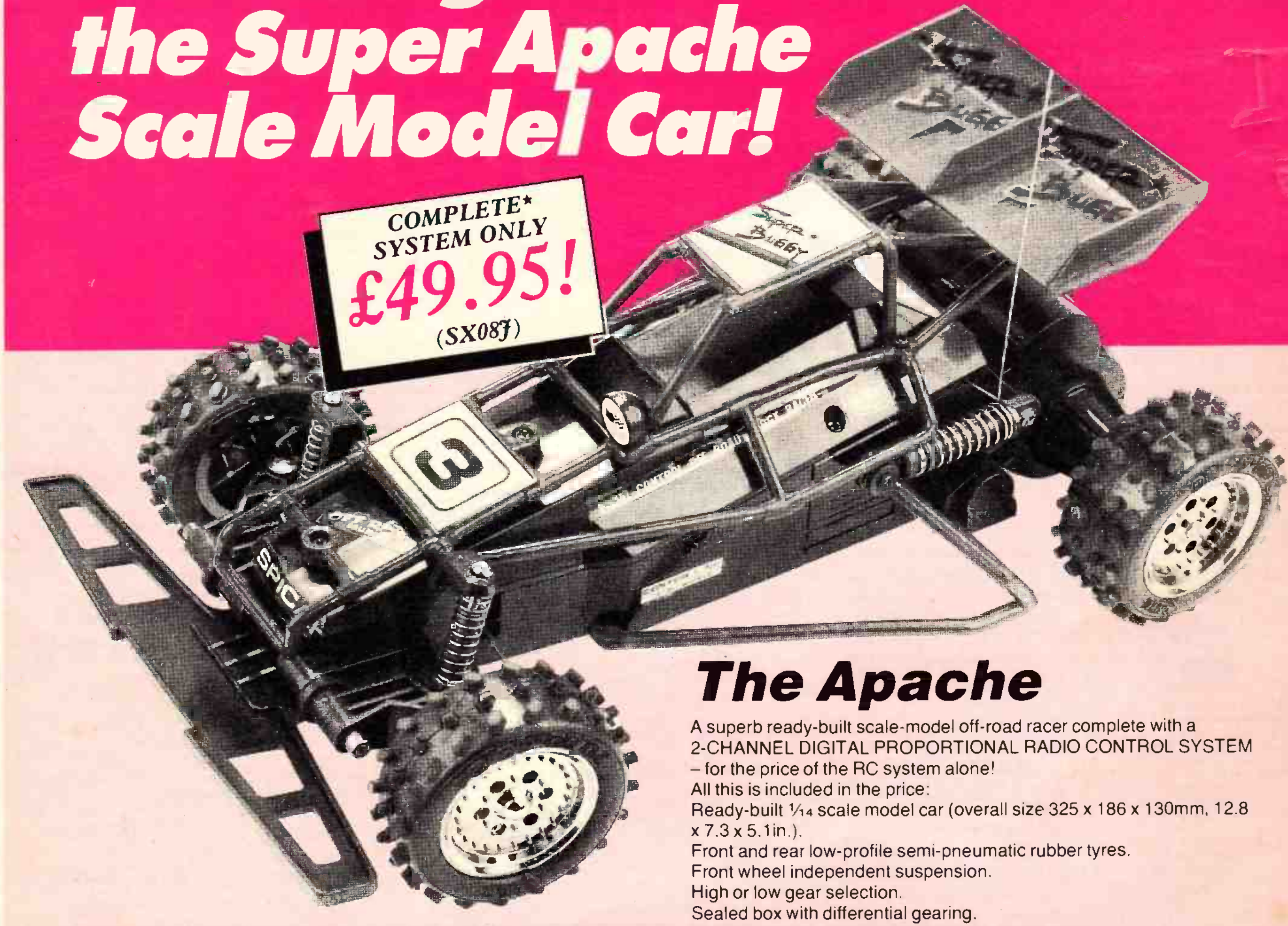

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