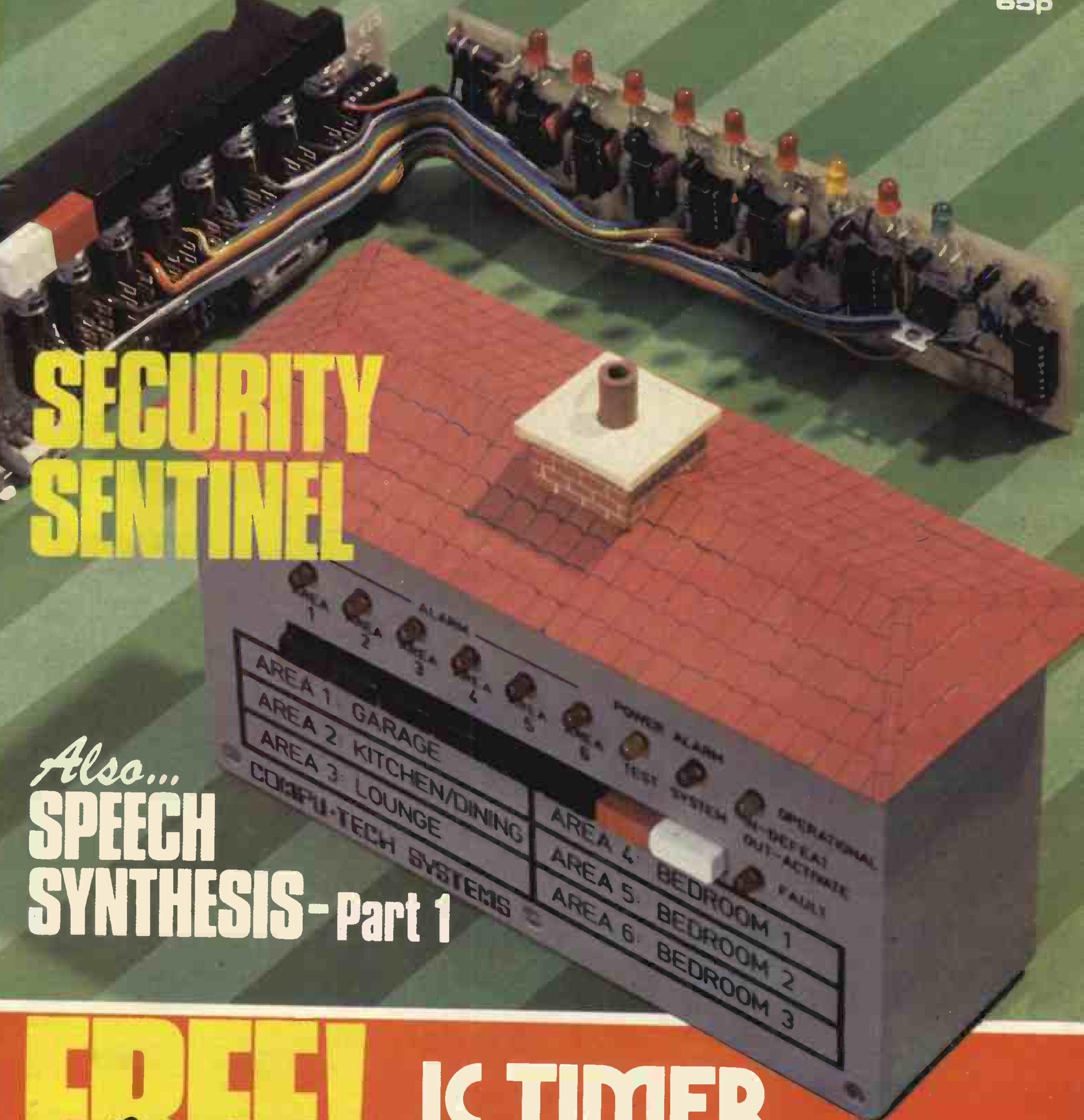
Australia $1.10 New Zealand $1.20 Malaysia $4.50

PRACTICAL
ELECTRONICS

NOVEMBER 1980

65p



SECURITY SENTINEL

Also...
SPEECH SYNTHESIS - Part 1

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OUR DECEMBER ISSUE WILL BE ON SALE FRIDAY, 14 NOVEMBER 1980
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WATFORD ELECTRONICS

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POLYESTER CAPACITORS: (Axial Lead Type)
400V: 1nF, 1n5, 2n2, 3n3, 4n7, 6n8, 10n, 15n, **9p**; 18n **10p**; 22n, 33n **11p**; 47n, 68n **14p**; 100n **17p**; 150n, 220n **24p**; 330n, 470n **41p**; 680n **48p**; 1μF **64p**; 2μ2 **82p**; 4μ **85p**.
1000V: 10n, 15n **20p**; 22n **22p**; 47n **26p**; 100n **42p**; 470n **80p**; 1μF **175p**.

POLYESTER RADIAL LEAD CAPACITORS: 250V;
10n, 15n, 22n, 27n **6p**; 33n, 47n, 68n, 100n **7p**; 150n **10p**; 220n, 330n **13p**; 470n **17p**, 680n **19p**; 1μ **22p**; 1μ5 **30p**; 2μ2 **34p**.

ULTRASONIC TRANSDUCERS
.40KHz **350p pr.**

ELECTROLYTIC CAPACITORS: (Values are in μF).
500V: 10 **50p**; 47 **78p**; **250V**: 100 **65p**; **63V**: 0·47, 1·0, 1·5, 2·2, 2·5, 3·3, 4·7, 6·8, **9p**; 10, 15, 22 **11p**; 32, 47, 50 **14p**; 63, 100, **27p**; **50V**: 100, 220 **25p**; 470 **32p**; 1000 **80p**; **40V**: 22, 33μF **8p**; 100 **12p**; 2200, 3300 **85p**; 4700 **115p**; **35V**: 10, 33 **8p**; 330, 470 **32p**; **25V**: 10, 22, 47, 100 **8p**; 160, 220, 250 **15p**; 470 **25p**; 640, 1000 **35p**; 1500 **40p**; 2200 **54p**; 3300 **77p**; 4700 **92p**; **16V**: 10, 40, 47 **7p**; 100, 125 **8p**; 220, 330 **16p**; 470 **20p**; 1000, 1500 **30p**; 2200 **36p**; **10V**: 100 **7p**.
TAG-END TYPE: 450V: 100μF **180p**; **70V**: 4700 **165p**; **64V**: 2500 **110p**; 3300 **150p**; **50V**: 2200 **99p**; 3300 **135p**; **40V**: 4700 **130p**; 4000 **92p**; 3300 **98p**; 2500, 2200 **90p**; 2000 + 2000 **120p**; **30V**: 4700 **110p**; **25V**: 15,000 **195p**; 6400 **120p**; 4700 **100p**; 330 **85p**; 2200 **60p**.

TANTALUM BEAD CAPACITORS
35V: 0.1μF, 0.22, 0.33, 0.47, 0.68, 1.0, 1μ5, 2μ2, 3μ3, 4μ7, **25V**: 10, **20V**: 6μ8. **16V**: 2μ2, 4μ7, 10 **20p each.**
16V: 22μ **32p**; 47, 100 **58p**; 220 **80p**; **10V**: 15μ, 22, 33 **28p**; 100 **40p**; **6V**: 47μ, 68μ, 100 **32p**; **3V**: 100 **25p.**

MYLAR FILM CAPACITORS
100V: 0·001, 0·002, 0·005, 0·01μF **6p**
0·015, 0·02, 0·03, 0·04, 0 05, 0·056μF **7p**
0·1μF **8p**; 50V: 0·47μF **12p.**

CERAMIC CAPACITORS: (50V)
Range: 0.5pF to 10nF **4p**
15nF, 22nF, 33nF, 47nF **5p**
100nF/30V **7p**; 220nF/6V **8p**

POLYSTYRENE CAPACITORS:
10pF to 1nF **8p**; 1·5nF to 47nF **10p.**

POTENTIOMETERS: Carbon Track, 0.25W Log & Linear Values.

500Ω, 1K & 2K (LIN ONLY) Single	29p
5KΩ-2MΩ single gang	29p
5KΩ-2MΩ single gang D/P switch	69p
5KΩ-2MΩ dual gang stereo	88p
1W Wire-wound 50Ω-20K	105p

SLIDER POTENTIOMETERS
0·25W log and linear values 60mm track

5KΩ 500KΩ Single gang	60p
10KΩ 500KΩ Dual gang	80p
Self-Stick graduated Alum. Bezels	36p

PRESET POTENTIOMETERS

0·1W 50Ω-2·2M Mini. Vert. & Horiz.	7p
0·25W 100Ω-3 3MΩ Horiz. larger	10p
0·25W 250Ω-4 7MΩ Vert.	10p
Precision Cermet 1W 100Ω-100K	90p

SILVER MICA (pF)
2, 3.3, 4.7, 6.8, 8.2, 10, 12, 18, 22, 27, 33, 39, 47, 50, 56, 68, 75, 82, 85, 100, 120, 150, 180, 200, 220 **11p each**
250, 270, 300, 330, 360, 390, 470, 600, 800 & 820pF **16p each**
1000, 1200, 1800, 2000, 4700 **26p each**

TRIMMERS miniature
2·5pF; 3-10pF; 3-30pF; 3-50pF **28p**
5-25pF; 65pF 88pF **35p**

COMPRESSION

3-40pF; 10-80pF	30p
25-200pF	33p
100-500pF	45p
400-1250pF	58p

RESISTORS–Erie make 5% carbon Miniature High Stability. Low Noise

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

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

TRANSISTORS

AC107	28	BC307B	14	BFX86	28	TIP33C	78	2N1132	28
AC125	35	BC308B	16	BFX87	28	TIP34A	74	2N1303	50
AC126	25	BC327	15	BFX88	28	TIP34C	88	2N1304	50
AC127	22	BC328	15	BFY50	21	TIP35A	160	2N1305	35
AC128	20	BC337	14	BFY51	21	TIP35C	186	2N1307	50
AC141	27	BC338	12	BFY52	21	TIP36A	170	2N1308	46
AC142	28	BC441	30	BFY56	32	TIP36C	199	2N1670	150
AC187	26	BC461	30	BFY64	40	TIP41A	55	2N1671B	215
AC176	25	BC477	35	BFY81	99		60	2N2219A	22
ACY17	60	BC516	38	BRY39	39	TIP41B	64	2N2220A	26
ACY18	60	BC517	35	BSX20	20	TIP42B	82	2N2221A	23
ACY19	60	BC547	10	BSX29	45	TIP120	90	2N2222A	20
ACY20	53	BC548	10	BSY95A	18	TIP121	99	2N2369A	17
ACY21	60	BC549C	15	BU105	170	TIP141	190	2N2646	48
ACY22	60	BC557	15	BU205	170	TIP142	125	2N2784	55
ACY28	60	BC558	15	BU208	215	TIP147	125	2N2904	26
ACY39	80	BC559	15	E421	250	TIP2955	60	2N2905A	26
AD149	75	BCY70	14	MD8001	225	TIP3055	60	2N2906	22
AD161	42	BCY71	18	MJ491	175	TIS43	30	2N2907A	22
AD162	42	BCY72	20	MJ2955	95	TIS44	46	2N2926G	10
AF114	60	BD121	78	MJE340	54	TIS45	45	2N3053	24
AF115	75	BD123	98	MJE370	70	TIS88A	50	2N3054	55
AF118	95	BD124	115	MJE371	70	TIS90	30	2N3055	48
AF139	40	BD131	42	MJE2955	99	TIS91	32	2N3442	140
AF178	75	BD132	42	MJE3055	70	UC734	65	2N3504	55
BC107	10	BD133	50	MPF102	66	ZTX107	11	2N3663	17
BC107B	12	BD135	40	MPF103	36	ZTX108	11	2N3702	10
BC108	10	BD136	40	MPF104	36	ZTX109	11	2N3703	10
BC108B	12	BD137	40	MPF105	36	ZTX212	28	2N3704	10
BC108C	12	BD138	40	MPF106	40	ZTX300	13	2N3705	12
BC109	10	BD139	40	MPSA05	22	ZTX301	15	2N3706	12
BC109B	12	BD140	40	MPSA06	24	ZTX302	20	2N3707	12
BC109C	12	BD144	198	MPSA12	29	ZTX303	25	2N3708	11
BC140	26	BD145	175	MPSA55	29	ZTX304	17	2N3709	11
BC142	26	BD205	110	MPSA56	29	ZTX314	24	2N3710	12
BC143	26	BD245	50	MPSU02	58	ZTX320	30	2N3711	12
BC147	9	BD378	70	MPSU05	50	ZTX326	45	2N3771	179
BC147B	10	BD434	32	MPSU06	50	ZTX341	28	2N3772	195
BC148	8	BD517	70	MPSU52	65	ZTX500	15	2N3773	288
BC148B	10	BD695A	85	MPSU55	55	ZTX501	15	2N3819	20
BC148C	10	BD696A	85	MPSU56	80	ZTX502	17	2N3820	45
BC149	9	BDY56	170	OC23	170	ZTX503	15	2N3822	130
BC149C	10	BF115	28	OC26	170	ZTX504	25	2N3823	70
BC153	20	BF167	24	OC28	120	ZTX531	25	2N3866	90
BC154	13	BF177	24	OC35	125	ZTX550	25	2N3903	18
BC157	10	BF178	25	OC36	130	40250	85	2N3904	18
BC158	10	BF179	38	OC41	125	40251	97	2N3905	18
BC159	11	BF180	38	OC42	48	40311	60	2N3906	17
BC160	28	BF194	12	OC43	65	40313	125	2N4037	58
BC167A	11	BF195	12	OC44	56	40315	68	2N4058	15
BC168C	10	BF196	12	OC45	40	40316	80	2N4061	17
BC169C	10	BF197	12	OC70	40	40317	65	2N4062	17
BC170	15	BF198	16	OC71	35	40319	71	2N4069	45
BC171	11	BF199	21	OC72	40	40320	70	2N4427	80
BC172	11	BF224	24	OC74	50	40361	50	2N4829	65
BC173	11	BF244A	28	OC76	45	40362	50	2N4859	65
BC177	16	BF244B	29	OC81	35	40406	65	2N4871	55
BC178	14	BF245	30	OC82	50	40407	82	2N4922	55
BC179	16	BF256	50	OC83	48	40408	95	2N5135	42
BC181	10	BF257	35	OC84	45	40411	280	2N5136	42
BC182	10	BF258	35	OC140	110	40412	65	2N5138	28
BC183	10	BF259	35	OC170	85	40467	95	2N5172	25
BC184	10	BF274	42	OC171	45	40468	60	2N5179	60
BC182L	10	BF336	35	OC200	48	40594	95	2N5180	80
BC183L	10	BF451	35	TIP29	31	40595	98	2N5191	75
BC184L	10	BF594	40	TIP29A	36	40603	90	2N5305	40
BC187	25	BF595	40	TIP29B	56	40636	126	2N5457	35
BC212	9	BF910	95	TIP29C	60	40673	95	2N5458	35
BC212L	9	BFR39	25	TIP30	40	2N697	25	2N5459	35
BC213	9	BFR40	25	TIP30A	48	2N698	40	2N5485	40
BC213L	9	BFR41	24	TIP30B	50	2N699	35	2N5642	750
BC214	10	BFR79	24	TIP30C	58	2N706A	19	2N5777	45
BC214L	10	BFR80	24	TIP31A	45	2N708	22	2N6027	44
BC237	14	BFR81	24	TIP31C	55	2N914	32	2N6109	50
BC238	15	BFR98	105	TIP32A	48	2N916	37	2SD234	70
		BFX29	28	TIP32C	60	2N918	33	3N128	112
		BFX84	26	TIP33A	65	2N1131	26	3N140	112
		BFX85	28						

ANTEX Soldering Irons

C15W	390
CX17W	398
CCN15W	420
X25W	415
Spare bits	50
Elements	190
Iron stand	150

DIL SOCKETS (TEXAS)

	Low pofile	Wire wrap
8 pin	10p	25p
14 pin	12p	35p
16 pin	13p	46p
18 pin	16p	52p
20 pin	22p	65p
22 pin	25p	70p
24 pin	30p	78p
28 pin	35p	85p
36 pin	—	105p
40 pin	40p	109p

SPECIAL OFFER

2114-450n	225
2114-300n	295
2708	400
2716-5V	620
4116-16k	299

Access

LINEAR IC's

702	75	LD130	452	NE565A	120
709C 8 pin	35	ICM7555	89	NE566	180
710	67	LF356	90	NE567	170
741	17	LM10	395	NE570	450
747C 14 pin	78	LM301A	23	NE571	420
748C 8 pin	36	LM308T	70	RC4136D	110
753 8 pin	185	LM311H	80	S5668	275
810	159	LM318	195	SAB3209	425
AY-1-0212	595	LM324A	48	SAB3210	275
AY-1-1313A	660	LM339	70	SG3402	295
AY-1-1320	315	LM348	90	SN76003N	240
AY-1-5050	190	LM349	125	SN76013N	170
AY-1-5051	160	LM379	375	SN76018	148
AY-1-6721/6	210	LM380	80	SN76023N	170
AY-3-1270	840	LM381N	145	SN76033N	195
AY-3-8500	390	LM382	125	SN76115N	215
AY-3-8910	850	LM384	110	SN76131	110
AY-3-8912	796	LM386	99	SN76227N	95
AY-5-1224A	235	LM387	150	SN76477	175
AY-5-1230	450	LM389	93	SN76660	120
AY-5-1315	595	LM733	125	SP8629	299
AY-5-1317A	630	LM3900	60	TAA621AX1	250
AY-5-8100	735	LM3909	70	TAA661A	155
CA3011	110	LM3911	125	TAD100	159
CA3014	157	LM3914	240	TBA120S	70
CA3018	68	LM3915	240	TBA540	220
CA3019	70	LM13600	135	TBA550Q	330
CA3020	186	M252AA	625	TBA641-A12/ BX1 or BX11	250
CA3023	191	M253AA	1150	TBA651	190
CA3028A	80	MC1303	88	TBA800	90
CA3035	236	MC1304P	260	TBA810S	95
CA3036	115	MC1310P	150	TBA820	70
CA3043	275	MC1458	45	TBA920Q	260
CA3045	365	MC1494	595	TBA990Q	270
CA3046	70	MC1495	350	TCA965	120
CA3048	214	MC1496L	92	TDA1004	290
CA3059	175	MC1596	225	TDA1008	310
CA3075	213	MC1710	79	TDA1022	575
CA3080E	65	MC3302	150	TDA1024	105
CA3081	190	MC3340P	120	TDA2020	320
CA3089E	215	MC3360P	120	TDA2030	300
CA3090AQ	375	MC3401	52	TL061CP	54
CA3123	150	MC3403	135	TL064CN	159
CA3130	90	MC3405	150	TL071CP	45
CA3140	48	MFC6040	97	TL072CP	90
CA3160	95	MK50398	635	TL074CN	140
ICL7106	795	MM5303	635	TL081CP	42
ICL7107	975	MM5307	1275	TL082CP	70
ICL8211	150	MM57160	620	TL083CP	95
ICL8038CC	340	MSM5526	820	TL084CP	120
ICM7205	1150	NE543	210	UAA170	150
ICM7207A	550	NE544	185	UAA180	150
ICM7215	1050	NE555	22	XR2206	350
ICM7216A	1950	NE556DB	55	XR2266	750
ICM7216B	1950	NE560	325	ZN414	95
ICM7217A	780	NE561	395	ZN423	195
ICM7224	785	NE562B	410	ZN424E	130
		NE564	435	ZN425E	415
				ZN427E	660
				ZN1034	200
				ZN1040E	685

COMPUTER IC's

2102	125	MC1489	90
2112-2N	250	MC14411	1020
2114-450N	240	MC14412	1520
2114-300N	295	MK4027·2	470
2708	445	MK4027-4	350
4116 16K	299	MM1702	299
6502	650	RO-3-2513	650
6505	850	SFF96364	1050
6520	350	SFC71301	820
6522	650	SFS80102	205
6530	1350	TMS2516	750
6532	850	TMS2716	1250
6545	1450	TMS 4035	250
6551	850	TMS 4039	250
6592	2572	TMS 4047	775
6800	700	TMS 6011	355
74S132	360	Z80 CPU2.5	750
74S138	250	Z80 A4M	920
74S158	624	Z80 P10	610
74S188	210	Z80 CTC	580
74S189	168	Z80A P10	725
74S194	750	Z80A CTC	695
74S195	795		
74S241	195		
74S262	895		
74S287	325		
74S288	210		
74S470	325		
74S472	1150		
74S475	825		
75150	140		
75154	150		
75450	80		
75451	75		
75452	90		
75454	225		
75491/2	92		
8080A	499		
8085A	1195		
8251	700		
8253	1275		
8T26AN	235		
8T28N	280		
8T95N	160		
8T97N	150		
81LS95	135		
81LS96	135		
81LS97	140		
AY-3-1015	550		
AY-5-1013	399		
AY-5-2376	980		
DM8123	195		
IM6402	420		
MC1488	90		

TTL 74 (TEXAS)

7400	11	7445	116	74153	75	74393	185		
7401	12	7446	132	74154	140	74490	160		
7402	12	7447	99	74155	75				
7403	14	7448	99	74156	80				
7404	14	7450	20	74157	75				
7405	18	7451	20	74159	185				
7406	48	7453	20	74160	99				
7407	48	7454	20	74161	99				
7408	22	7460	20	74162	99				
7409	22	7470	41	74163	99				
7410	19	7472	31	74164	120				
7411	25	7473	40	74165	120				
7412	20	7474	34	74166	155				
7413	33	7475	56	74167	240				
7414	52	7476	41	74170	230				
7416	31	7480	55	74172	420				
7417	31	7481	120	74173	120				
7420	19	7482	75	74174	105				
7421	38	7483	94	74175	82				
7422	26	7484	113	74176	90				
7423	32	7485	121	74177	90				
7425	30	7486	33	74178	149				
7426	44	7489	215	74179	155				
7427	32	7490	57	74180	90				
7428	35	7491	85	74181	290				
7430	20	7492	59	74182	88				
7432	28	7493	59	74184	145				
7433	38	7494	95	74185	145				
7437	35	7495	75	74188	299				
7438	30	7496	95	74190	135				
7440	20	7497	180	74191	135				
7441	74	74100	130	74192	135				
7442	71	74104	62	74193	135				
7443	120	74105	62	74194	105				
7444	116	74107	35	74195	198				
		74109	60	74196	130				
		74110	54	74197	90				
		74111	68	74198	195				
		74112	150	74199	198				
		74116	198	74221	140				
		74118	99	74246	195				
		74119	125	74247	195				
		74120	105	74248	195				
		74121	42	74249	195				
		74122	55	74251	120				
		74123	95	74265	63				
		74125	45	74273	270				
		74126	55	74278	220				
		74128	74	74279	99				
		74132	70	74283	150				
		74136	65	74284	385				
		74141	85	74285	385				
		74142	195	74290	125				
		74143	350	74293	125				
		74144	350	74297	236				
		74145	90	74298	185				
		74147	180	74365	90				
		74148	145	74366	90				
		74150	150	74367	90				
		74151	75	74368	90				
				74390	185				

74LS

LS00	13	LS123	95	LS266	75
LS01	13	LS124	180	LS273	180
LS02	15	LS125	60	LS275	320
LS03	15	LS126	60	LS279	88
LS04	20	LS132	95	LS280	250
LS05	23	LS133	30	LS283	190
LS08	23	LS136	55	LS290	130
LS09	23	LS138	70	LS293	130
LS10	20	LS139	90	LS295	215
LS11	32	LS145	120	LS298	215
LS12	32	LS147	210	LS299	420
LS13	40	LS148	175	LS300	175
LS14	75	LS151	96	LS302	175
LS15	40	LS153	85	LS323	270
LS20	21	LS155	96	LS321	450
LS21	32	LS156	96	LS324	200
LS22	40	LS157	76	LS325	320
LS26	48	LS158	85	LS326	330
LS27	45	LS160	120	LS327	315
LS28	48	LS161	98	LS346	185
LS30	24	LS162	110	LS347	150
LS32	30	LS163	118	LS348	190
LS33	39	LS164	115	LS352	185
LS37	39	LS165	155	LS353	185
LS38	39	LS166	175	LS365	90
LS40	28	LS168	210	LS366	90
LS42	80	LS169	210	LS367	90
LS47	85	LS170	288	LS368	90
LS48	120	LS173	105	LS373	180
LS49	120	LS174	147	LS374	180
LS51	25	LS175	110	LS375	150
LS54	30	LS181	295	LS377	199
LS55	70	LS183	298	LS378	185
LS63	150	LS189	120	LS379	215
LS73	40	LS190	120	LS384	50
LS74	40	LS191	120	LS385	420
LS75	48	LS192	125	LS386	85
LS76	45	LS193	125	LS390	140
LS78	45	LS194	125	LS393	140
LS83	105	LS195	125	LS395	210
LS85	105	LS196	120	LS396	199
LS86	45	LS197	120	LS398	275
LS90	50	LS200	345	LS399	230
LS91	125	LS202	345	LS445	140
LS92	75	LS221	120	LS447	195
LS93	75	LS240	225	LS490	150
LS95	115	LS241	225	LS668	105
LS96	180	LS242	232	LS669	105
LS107	45	LS243	232	LS670	270
LS109	75	LS244	225	LS673	750
LS112	80	LS245	450	LS674	850
LS113	65	LS247	135	LS689	420
LS114	49	LS248	135		
LS122	70	LS249	135		
		LS251	130		
		LS253	130		
		LS257	115		
		LS258	120		
		LS259	160		
		LS261	450		

CMOS

4000	18	4012	24	4501	28
4001	18	4013	45	4502	125
4002	24	4014	85	4503	75
4006	92	4015	85	4506	75
4007	22	4016	42	4507	60
4008	82	4017	82	4508	325
4009	40	4018	88	4510	99
4010	48	4019	48	4511	150
4011	24	4020	99	4512	98
		4021	105	4513	225
		4022	95	4514	265
		4023	25	4515	299
		4024	75	4516	120
		4025	25	4517	450
		4026	180	4518	105
		4027	48	4519	70
		4028	82	4520	115
		4029	105	4521	250
		4030	60	4522	150
		4031	225	4526	150
		4032	125	4527	160
		4033	175	4528	120
		4034	210	4529	175
		4035	125	4530	89
		4036	365	4531	165
		4037	115	4532	140
		4038	118	4534	575
		4039	360	4536	395
		4040	105	4538	160
		4041	80	4539	135
		4042	80	4541	150
		4043	95	4543	175
		4044	95	4549	296
		4045	175	4553	440
		4046	130	4554	175
		4047	98	4555	85
		4048	65	4556	75
		4049	45	4557	425
		4050	48	4558	130
		4051	80	4559	290
		4052	80	4560	235
		4053	80	4561	95
		4054	130	4562	595
		4055	135	4566	190
		4056	135	4568	299
		4057	2850	4569	250
		4059	575	4572	48
		4060	130	4580	595
		4061	1225	4581	350
		4062	995	4582	150
		4063	120	4583	125
		4066	58	4584	65
		4067	430	4585	140
		4068	26		
		4069	26		
		4070	30		
		4071	25		
		4072	25		
		4073	25		
		4075	25		
		4076	99		

CMOS (CONT.)

4077	48
4078	30
4081	28
4082	28
4085	90
4086	90
4089	150
4093	89
4094	240
4095	105
4096	105
4097	350
4098	115
4099	190
4160	125
4161	125
4162	125
4163	125
4174	130
4175	120
4194	125
4408	790
4409	790
4410	790
4411	1020
4412F	1520
4412V	1520
4415F	850
4415V	850
4419	320
4422	570
4432	1050
4435	1050
4440	999
4450	350
4451	350
4452	000
4490F	750
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Book 2 OR and AND functions; logic gates; NOT, exclusive-OR, NAND, NOR and exclusive-NOR functions; multiple input gates; truth tables; De Morgans Laws; canonical forms; logic conventions; karnaugh mapping; three state and wired logic.

Book 3 Half adders and full adders; subtractors; serial and parallel adders; processors and arithmetic logic units (ALUs); multiplication and division systems.

Book 4 Flip flops; shift registers; asynchronous and synchronous counters; ring, Johnson and exclusive—OR feedback counters; random access memories (RAMs) and read only memories (ROMs).

Book 5 Structure of calculators; keyboard encoding; decoding display data; register systems; control unit; program ROM; address decoding; instruction sets; instruction decoding; control programme structure.

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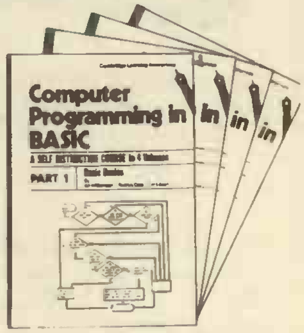

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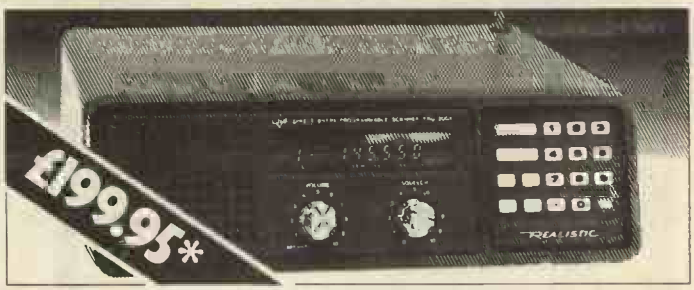

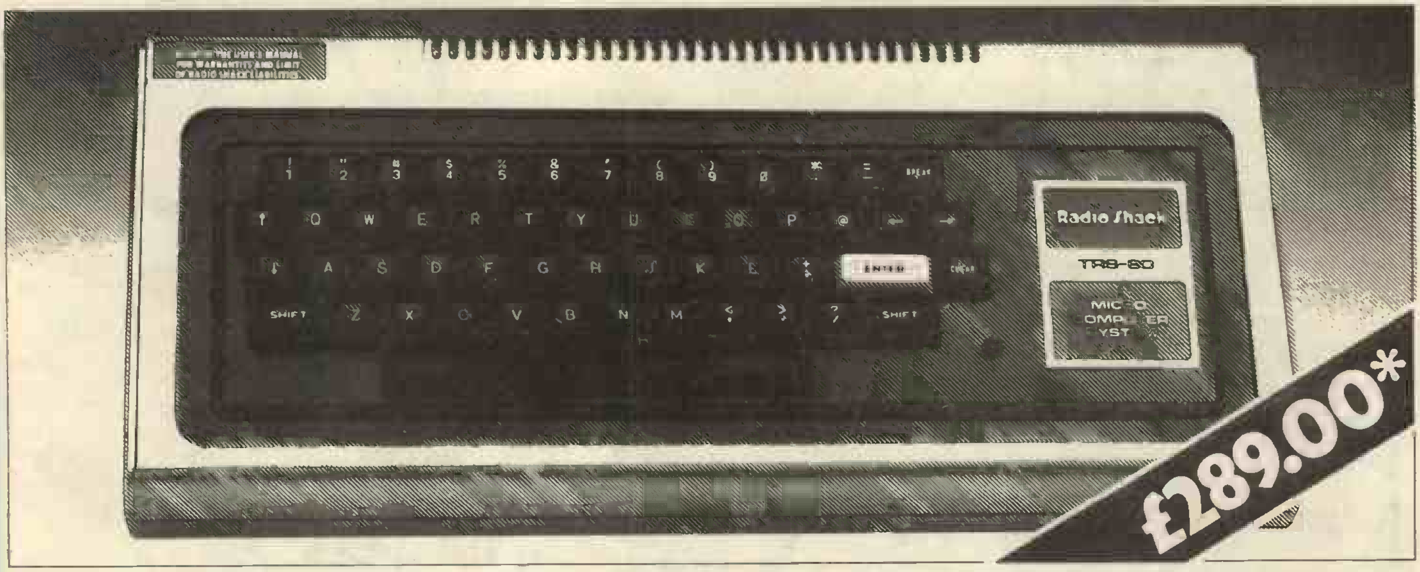

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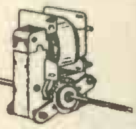

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2N 3053	.31	2N 5038	3.01
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2N 3439	.61	2N 5294	.42
2N 3440	.43	2N 5296	.35
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For just £79.95 (*including* VAT and p&p) you get everything you need to build a personal computer at home...PCB, with IC sockets for all ICs; case; leads for direct connection to a cassette recorder and television (black and white or colour); *everything!*

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The ZX80 is programmed in BASIC, and you can use it to do quite literally anything from playing chess to managing a business.

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Your ZX80 kit contains...
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- FREE course in BASIC programming and user manual.

Optional extras
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- Additional memory expansion boards allowing up to 16K bytes RAM. (Extra RAM chips also available–see coupon).

*Use a 600 mA at 9 V DC nominal unregulated mains adaptor. Available from Sinclair if desired (see coupon).

The unique and valuable components of the Sinclair ZX80.

The Sinclair ZX80 is not just another personal computer. Quite apart from its exceptionally low price, the ZX80 has two uniquely advanced components: the Sinclair BASIC interpreter; and the Sinclair teach-yourself BASIC manual.

The unique Sinclair BASIC interpreter offers remarkable programming advantages:
- **Unique 'one-touch' key word entry: the ZX80 eliminates a great deal of tiresome typing. Key words (RUN, PRINT, LIST, etc.) have their own single-key entry.**
- Unique syntax check. Only lines with correct syntax are accepted into programs. A cursor identifies errors immediately. This prevents entry of long and complicated programs with faults only discovered when you try to run them.
- Excellent string-handling capability–takes up to 26 string variables of any length. All strings can undergo all relational tests (e.g. comparison). The ZX80 also has string input–to request a line of text when necessary. Strings do *not* need to be dimensioned.
- Up to 26 single dimension arrays.
- FOR/NEXT loops nested up to 26.
- Variable names of any length.
- BASIC language also handles full Boolean arithmetic, conditional expressions, etc.
- Exceptionally powerful edit facilities, allows modification of existing program lines.
- Randomise function, useful for games and secret codes, as well as more serious applications.
- Timer under program control.
- PEEK and POKE enable entry of machine code instructions. USR causes jump to a user's machine language sub-routine.
- High-resolution graphics with 22 standard graphic symbols.
- All characters printable in reverse under program control.
- Lines of unlimited length.

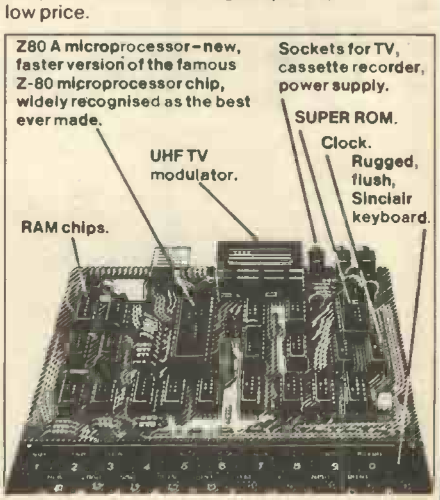
Fewer chips, compact design, volume production–more power per pound!

The ZX80 owes its remarkable low price to its remarkable design: the whole system is packed on to fewer, newer, more powerful and advanced LSI chips. A single SUPER ROM, for instance, contains the BASIC interpreter, the character set, operating system, and monitor. And the ZX80's 1K byte RAM is roughly equivalent to 4K bytes in a conventional computer–typically storing 100 lines of BASIC. (Key words occupy only a single byte.)

The display shows 32 characters by 24 lines.

And Benchmark tests show that the ZX80 is faster than all other personal computers.

No other personal computer offers this unique combination of high capability and low price.



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ZX80 software – now available!

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New dedicated software – developed independently of Science of Cambridge – reflects the enormous interest in the ZX80. More software available soon – from leading consultancies and software houses.

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If the specifications of the Sinclair ZX80 mean little to you – don't worry. They're all explained in the specially-written 128-page book *free* with every kit! The book makes learning easy, exciting and enjoyable, and represents a complete course in BASIC programming – from first principles to complex programs. (Available separately – purchase price refunded if you buy a ZX80 later.) A hardware manual is also included with every kit.

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	Ready-assembled Sinclair ZX80 Personal Computer(s). Price includes ZX80 BASIC manual and mains adaptor.	£99.95	
	Mains Adaptor(s) (600 mA at 9 V DC nominal unregulated).	8.95	
	Memory Expansion Board(s) (each one takes up to 3K bytes).	12.00	
	RAM Memory chips – standard 1K bytes capacity	16.00	
	Sinclair ZX80 Manual(s) (manual free with every ZX80 kit or ready-made computer).	5.00	

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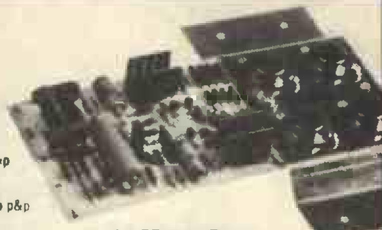
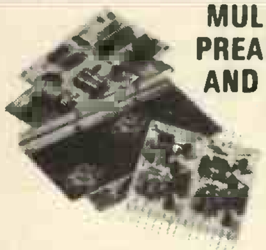
ACCESSORIES available only when purchasing packs.



AS FEATURED IN PRACTICAL ELECTRONICS OCTOBER ISSUE

DIY STEREO BARGAIN PACKS FEATURING FAMOUS BUILT MULLARD PREAMP MODULES



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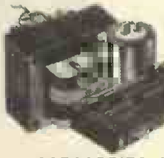

DIY ACCESSORIES Mains transformer smoothing capacitor rectifier 4 x slider controls, for base, treble and volume. **£3.00** plus £1.60 p&p

ACCESSORIES: Available only at time of purchase of Bargain Packs

12 + 12 WATT AMPLIFIER KIT
NOTE: for use with 4 to 8 ohms speakers.

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Size 9¼" x 8¾" x 4" approx.
NOTE: for use with 4 to 8 ohms speakers.

£13.95 plus £2.55 p&p

BSR chassis record player deck with manual set down and return, complete with stereo ceramic cartridge. **£8.50** plus £2.75 p&p when purchased with amplifier available separately **£10.50** plus £2.75 p&p.

TWO WAY SPEAKER KIT. 2 Phillips 8" approx speakers **£4.75** per stereo pair plus £1.50 p&p when purchased with amplifier available separately **£6.75** plus £1.50 p&p.

ALSO AVAILABLE Stereo magnetic pre-amp conversion kit all components including P.C.B. to convert your ceramic input on the 12 + 12 amp to magnetic. **£2.00** when purchased with kit featured above. **£4.00** separately inc. p&p.

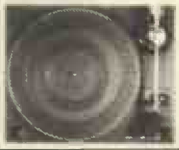
OFFER! SAVE MONEY by purchasing 12 + 12 amp kit, BSR record deck and speaker kit together for only **£25.50** p&p £4.50.

BSR Manual single play record deck with auto return and cueing lever. Fitted with stereo ceramic cartridge 2 speeds with 45 rpm spindle adaptor ideally suited for home or disco use.

£12.25 OUR PRICE plus £2.75 p&p

Size approx 13" x 11"

PHILLIPS RECORD PLAYER DECK GC037
Size approx 15¾" x 12¼"



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2 Wavebands MW and LW

- Easy to build
- 5 push button tuning
- Modern styling design
- All new unused components
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- Incorporates suppression circuits
- Now with tape input socket

All the electronic components to build the radio, you supply only the wire and solder as featured in the Practical Electronics March issue. Features: Pre-set tuning with five push button options, black illuminated tuning scale, with matching rotary control knobs, one, combining on/off volume and tone-control, the other for manual tuning, each set on wood simulated fascia.
The P.E. Traveller has a 6 watts output, neg ground and incorporates an integrated circuit output stage, a Mullard IF module LP1181 ceramic filter type, pre-aligned and assembled and a Bird pre-aligned push button tuning unit. The radio fits easily in or under dashboards.
Complete with instructions.

CONSTRUCTORS PACK 7A
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Pack 7A may only be purchased at the same time as Pack 7.
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30 + 30 WATT STEREO AMPLIFIER BUILT AND TESTED

Viscount IV unit in teak simulate cabinet silver finished rotary controls and pushbuttons with matching fascia, red mains indicator and stereo jack socket. Functions switch for mic magnetic and crystal pickups, tape and auxiliary. Rear panel features fuse holder. DIN speaker and input socket 30 + 30 watts. RMS 60 + 60 watts peak for use with 4 to 8 ohm speakers. Size 14¾" x 10" approx.

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NOTE: Persons under 16 years not served without parent's authorisation.

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ARISTON PICK UP
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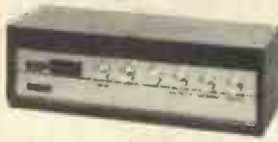

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PE VOLUME 16 No. 11 NOVEMBER 1980

NOSTALGIA!

THE industrial revolution left its mark and today early machinery is a fascinating reminder of how things developed. A traction engine at full song, or one of the well preserved steam engines powering out of a station are awe inspiring sights. We can all explain something of their operation to the kids and show them the stack of coal, the fire and the steam. Even an old typewriter can be quite fascinating, but what will we leave behind from the m.p.u. revolution for others to marvel at!

The fascination of a UK101 or a PET in seventy-five years' time does not seem to carry the same feelings—and how many of us could explain the basic operation? Presumably a few nostalgic types will keep them alive and perhaps specialist firms will make outdated chips to order. BASIC will probably be a lost language to most and maybe some will marvel at that old fashioned p.c.b. and the push button keys for communicating with the beast.

Possibly the preservation of a 6502 under a microscope will be of interest, but we doubt it. As technology moves on at its ever increasing pace "the man in the street" has less and less knowledge of the theory and circuit operation of the equipment. As the operation of new technology products becomes easier, that already basic knowledge will diminish even further until we will blindly use the products without even trying to understand them.

This situation is of course already coming about; we wonder how many musicians understand the operation of the modern "computer organ" or of the new generation of programmable rhythm generations now becoming popular. Of course it is still necessary to understand music in order to do one's own original programming, but just how much longer will even that be necessary.

KEEPING UP

We hope that PE can continue to keep readers abreast of the general principles of high technology devices. It has always been our policy to explain circuit operation, although these days we cannot go into detailed circuit operation of l.s.i. devices. The *PE Master Rhythm* project starting next month will explain the principles of operation, in addition to providing full constructional information, on a rhythm unit we believe to be better than its commercial counterparts.

This issue looks at the next significant step in the development of artificial intelligence—the synthesised voice. We will show how to construct an interface for a speech synthesiser module so that our UK101 can tell us where to get off. The computer is one of the main uses for synthesised speech, but not by any means the only one; we intend to publish a digital readout project with an add-on speech board for those that want it. The project, with luck, will come out early next year.

Finally we are pleased to bring you another component supplier's catalogue—free with next month's issue. Regular readers will have collected a number of free catalogues over the past few years and we anticipate this situation continuing. Next month all UK copies will carry the new larger format, 68 page Electrovalue catalogue. Electrovalue were the first British mail order component supplier to computerise their business and are now highly experienced in stock control, order processing, etc., by computer. They have had a working system for many years—some things are not as new as they seem.

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Technical Queries
We are unable to offer any advice on the use or purchase of commercial equipment or the incorporation or modification of designs published in Practical Electronics.

All letters requiring a reply should be accompanied by a stamped, self addressed envelope and each letter should relate to **one published project only.**

Components are usually available from advertisers; where we anticipate supply difficulties a source will be suggested.

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

Binders
Binders for PE are available from the same address as back numbers at £4·30 each to UK or overseas addresses, including postage and packing, and VAT where appropriate. Orders should state the year and volume required.

Subscriptions
Copies of PE are available by post, inland or overseas, for £11·80 per 12 issues, from: Practical Electronics, Subscription Department, Oakfield House, Perrymount Road, Haywards Heath, West Sussex RH16 3DH. Cheques and postal orders should be made payable to IPC Magazines Limited.

Market Place

Items mentioned are usually available from electronic equipment and component retailers advertising in this magazine. However, where a full address is given, enquiries and orders should then be made direct to the firm concerned. All quoted prices are those at the time of going to press.

by David Shortland and Jasper Scott

TOUGH CASE

With provision to accommodate almost everything except the kitchen sink, the Antler D532 deluxe tool case should be everything the budding service engineer needs.

With a frame made from hardened aluminium and moulded ABS shells, the case combines light weight with strength. Inside, there is a multi-pocket lid wallet to hold manuals, and tension tool straps which can be

swiftly adjusted to hold any shape or size of tool. The base area is left open to hold larger tools and instruments. As the case is likely to be quite heavy when in use, the swing handle is bolted on. Overall size of the case is 460 × 340 × 145mm.

Priced at £42·50 plus VAT, the Antler D532 is available from:

Toolrange Ltd., Upton Road, Reading RG3 2JA.

THE PLATMETER

A dual range, dual accuracy indicator designed for use with platinum resistance thermometers with characteristics to BS 1904 or DIN 43760 is announced by the Platline Division of Rosemount Engineering Co Ltd.

The 'Platmeter', which has an l.c.d. readout, is part of the Platline range of associated devices using platinum resistance technology. Designed to fill a gap between hand-held devices and bench-mounted instruments, the indicator is light in weight, readily held while in operation, and can also be placed on any flat surface for easy reading.

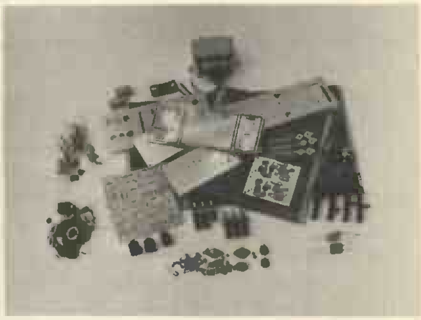
Its dual range facility enables temperature in the range of 120°C to 700°C to be resolved at the flick of a switch without the need to change the indicator or probe. This eliminates the tolerance errors in indicator and probe that are applicable to a single-range instrument.

The Platmeter is supplied compete with nickel cadmium batteries and charger. A warning that the battery voltage is low is indicated automatically at least 30 minutes before recharging is essential. An electrical interlock disconnects the battery when the probe is disconnected from the unit, preventing battery discharge.

Further information on the Platmeter is available from: **Rosemount Engineering Co. Ltd., Durban Road, Bognor Regis, Sussex PO22 9QX (0243 863121).**

TWELVE PLUS TWELVE

Pictured below is the 12 + 12 watt stereo amplifier kit from RT-VC. Succeeding their 10 + 10 watt model, the kit is based around the Mullard LP1183 pre-amp module. The amplifier features slider level controls, push button switches, and inputs for tape, tuner, mic and ceramic cartridge.



The kit comes complete with metalwork and an easily assembled wood finish cabinet—all that is needed are screws, solder and wire. The instructions and diagrams are quite easy to follow provided that they are thoroughly studied. As well as resulting in a satisfying finished product, the kit should provide the less experienced constructor with a good introduction to building more ambitious projects.

Priced at £13·95 plus £2·55 postage and packing, the kit is available from:

RT-VC, 21b High Street, Acton, London W3 6NG.

SOLAR EFFICIENCY

A new differential temperature switch (DTS) for use in solar heating systems is now available from Microvitec Limited. The DTS1 is controlled by silicon chips and is programmed to operate the circulating pump to achieve maximum energy transfer efficiency.

Microvitec analysed the latest research in this field which showed that the pump could consume more energy than a solar system extracted, if it operated at the wrong temperature differential. This is particularly important at low winter temperatures. A differential of 4·5°C between the panels and the pre-heating cylinders proved optimal. With these figures Microvitec designed the DTS1 using semiconductor sensors which are capable of monitoring differential temperatures accurately.

The DTS1 has two probes, one to monitor temperature at the exit point of the panels, the other at the exit from the cylinder to the pump. Thus they are placed at the highest and lowest temperature points in the system. The pump starts to operate when the temperature in the panels is 4·5°C above that in the cylinder. The sensors continue to read the temperature and the pump is switched off when the differential drops to 1·5°C. The DTS1 temperature hysteresis is therefore 3°C nominal.

The use of silicon chips has several advantages over thermistors which are traditionally used in these systems. The linear probes are highly stable and do not age. This means that performance does not vary and so considerably improves long term stability. The inclusion of integrated circuits, both in the probes and the control panel, ensures long maintenance free operation. In addition, the DTS1 has been fitted with a test socket to allow the system to be checked without being dismantled.

The whole unit is encased in a fire-proof metal box making it easy and safe to handle. A further economic advantage is the low power consumption—the DTS1 needs only 2VA (excluding the pump) to run. It is also interference free because of built-in suppression.

The DTS1 has been designed to British Standards 415 and 3861. The pump control switch can be changed to an override position from the normal automatic mode to check pump performance. Neon indicators show when the system is powered and also when the pump is working.

Microvitec's DTS1 is in full production and has already been installed by one manufacturer of domestic solar heating equipment with very satisfactory results.

Further details are available from: **John Martinez-Perez, Microvitec Ltd., PO Box 188, Bradford BD8 9HH (0274 499672).**

CASIO PRESET SYNTHI

Casio, acknowledged as the world leaders in the calculator and watch market have just launched a new range of keyboards—musical, that is. With the painstaking market research that is characteristic of the Japanese, I've no doubt that they will prove popular, as they combine novelty with a compact size which is ideal for the modern home.

The Casiotone 201 has a 49 note keyboard with 29 digitally synthesised voices selectable by pressing any one of the 29 white keys. It is possible to preselect a total of four voices at any one time and alternate between these whilst playing, so providing tonal variety. It is partially polyphonic inasmuch that chords of up to eight notes can be played together.

The internal amplifier delivers 2 watts and there are tone and vibrato facilities to expand its entertainment capability. Connections are provided for rhythm unit, reverb or external amplifier. The latter dramatically expands the possibilities of the 201 when used as a combo solo instrument, as was demonstrated by the Dooleys who helped Casio with the launch promotion.

The M-10 is a smaller instrument of 2½ octaves and four preset voices.

The 201 is priced at £285 and the M-10 £79. For further information contact: **Casio Electronics, 28 Scrutton Street, London EC2A 4TY.**

THANDAR DMM

The latest addition to the Thandar range of low-cast test equipment is the TM352 l.c.d. multimeter. This is a battery operated 3½ digit instrument with a 0·5in display with over-range indication.

The TM352 has an input impedance of 10MΩ and covers 16 ranges: d.c. volts 100μV to 1000V (5 ranges), a.c. volts 100mV to 1000V (2 ranges), d.c. current 100nA–10A (5 ranges) and resistance 1Ω to 10MΩ (4 ranges).

There is an audible continuity check feature which will sound if the resistance is less than 130Ω ± 50Ω and an hfe measurement facility. Range and function selection is via side mounted push-button switches. The unit, which will operate for in excess of 150 hours from a single PP3 battery, has all its ranges protected by a 0·5A fuse except for the 10A range which is unprotected.

The TM352 is supplied complete with battery and test leads and accessories include a universal test set, 40kV high voltage d.c. probe and carrying case.

The TM352 is priced at £49·95 excluding VAT and p&p.

A. Marshall's (London) Ltd., Kingsgate House, Kingsgate Place, London NW6 4TA. (01-624 0805)

TANDY POCKET POWER

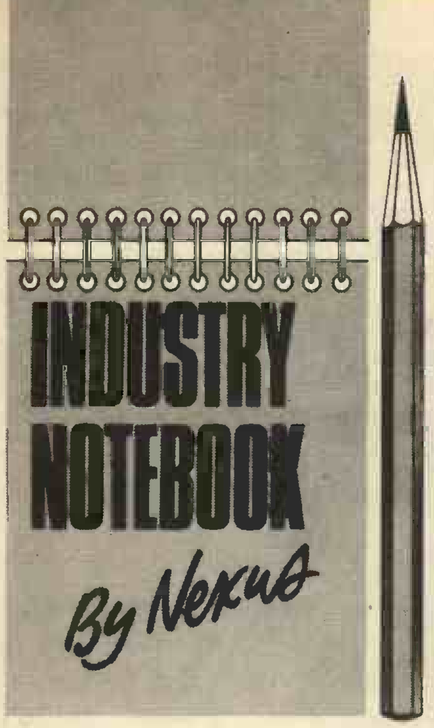
The new Tandy TRS–80 Pocket Computer is the latest addition to the TRS–80 range. This pocket-sized unit measures only 175×70×15mm and retails at £119 including VAT.

The unit is battery powered and programmes can be loaded, and retained for up to 300 hours (the life of the battery), even when the power is switched off.

There are already eight packages of software available to cover varying needs. These include civil engineering, aviation, maths drill, business statistics, real estate, personal finance and a games package. These will be priced from £8·95 to £13·95 (including VAT).

The Tandy Pocket Computer has a 4-bit CPU consisting of two microprocessors. It can carry 1·9K of user memory (RAM) and a total of 11K of ROM—7K for the BASIC interpreter and approximately 4K for the monitor. Using the cassette interface (£17·95), multiple programmes can be loaded from cassette tape without the previous programme being erased. Each programme in RAM can be executed selectively by a simple key input.

The machine has a display screen and a 57-key alpha-numeric keyboard. A user manual is included.



The Economy

The economic squeeze continues accompanied by well orchestrated cries of disaster from pressure groups under real or imagined threats. As I have often pointed out in this column, if all UK industry achieved the overall performance of the electronics industry there would be few problems.

But even electronics is now feeling the pinch. One sector which always gets a hammering in times of economic stringency is test and measuring instruments. Potential buyers tend to hold back and make do with what they already have. Instrument salesmen, faced with declining sales, have always been prone to make private deals with special discounts for favoured customers and not only for bulk orders.

Now I note that one leading company has publicly slashed catalogue prices by some 10 percent due, it is claimed, to increased manufacturing efficiency and production levels. The claim is no doubt entirely honest but it is market forces that have resulted in the reduction. In effect, the savings are being passed on to the buyer, or at least shared by both parties. If sales volume rises, then the manufacturer can still win. In fact everybody wins. It is the problematic 'if' in the equation that is the root of worry for the manufacturer who has traded some of his profit margin in the expectation of greater volume.

This homely example of elementary economics is the central theme of the Government economic strategy aimed at increasing the efficiency and therefore the competitive position of British industry. Critics of Government policy say that the strategy is too simplistic for what is called a complex modern industrial society. But at least it is something that people can understand. Of course nothing is starkly black and white, and never will be, but as a general principle it is true that firms have the option of pricing themselves in or out of a market and that people can price themselves in or out of jobs.

It is impossible to forecast the eventual outcome of the squeeze if only because of the many factors which cannot be under Government influence. The general world recession in trade, for example, or the loss of a particular market like Iran and political instability elsewhere which may temporarily upset trade.

What can be said is that present policy is a marked change from former policies which have been tried and found wanting. It is a harsh doctrine, often seemingly unfair, and not without controversy in the Conservative party itself.

Monopolies

One of the most extraordinary facets of present economic policy is the almost quiescent reception given to proposals considered outrageous by many people only a couple of years ago, a heartening indication of public acceptance of the need for change. It seems hard to believe that the state monopoly in telecommunications has been in existence for 111 years. Now it is to go and there will be a free market for telecommunications services more like the American system where competition is fierce and efficiency unparalleled anywhere in the world.

Response was muted from the BPO and the Post Office unions. The Government played safe by only relaxing the existing monopoly and not smashing it. The same with the postal services. The changes were well discussed in advance and, from the viewpoint of those directly affected in entrenched positions, were probably less drastic than once feared.

The big surprise however, was in electricity supply which, subject to future legislation, will no longer be a state monopoly. Any organisation will be able to generate and distribute electricity on a commercial basis. This is a big jump from present legislation which allows private generation providing it is not a main part of the business. Some 15 percent of total electrical power consumption in the UK is already generated privately by industrial users.

Even if the legislation is introduced, and no date has yet been fixed, it is unlikely that it will have much practical effect in terms of direct competition with the electricity boards. Nonetheless, it will have a psychological effect in gingering up the performance of the state industry.

The erosion of the great state monopoies is an opportunity for private industry to step in. Whether and how the opportunity will be seized is still a matter for speculation although there is already considerable activity in telecommunications where the opportunities are greatest.

Inmos

So Inmos has received its second £25 million from public funds. The decision was a long time coming and probably reflects on Government distaste for state funding. But Inmos had to give way on the siting of the UK production plant which is now to be in South Wales. This, again, is against the general principle of Government non-intervention in industrial management. It suggest that behind a facade of rigid conviction there is in fact at least a measure of flexibility in bending policy to meet political situations as they arise.

But six valuable months have been lost during which the other semiconductor manufacturers have not been idle. Revised schedules in Inmos are for UK production of memories by mid-1982 and microprocessors in 1983. Sample Inmos memories are now available to the trade with first production from the US plant at Colorado Springs early next year. The UK plant, when it starts production, will have the advantage of moving straight into a mature product already de-bugged. A published revenue plan shows a fantastic growth curve starting at £0·3m this year rising to £145·9 million by 1984. Perhaps wisely, there was no public forecast of profits.

Buoyancy

Despite all the gloom stories the electronic industry remains buoyant. True that Plessey, at the time of writing, looks likely to lose a plum hoped-for contract worth £400m in Iraq to the French company Thomson CSF. But Plessey is prospering in general and so are others in electronics, both large and small.

TV, radio and the popular press are so obsessed with disaster that they fail to report success. An example is the Marconi Avionics contract from the US Air Force for new-technology head-up displays for fitting in F-16 fighters and A-10 close support aircraft. The development programme is for $13 million and production options make the contract worth a potential $100 million. Another is Standard Telephones and Cables £20m contract for a new submarine cable between Greece and Cyprus. And there are plenty of other examples of enterprise virtually ignored.

Despite the excellent results of the past few months, industry leaders are hedging their bets by claiming only 'cautious optimism'. Even Racal Group chairman Ernie Harrison, normally bullish in sentiment, qualifies his optimism by referring to the inflation rate and the strength of the pound sterling. Yet Racal's order books are at record level as, indeed, are GEC-Marconi Electronics and Plessey.

One wonders why Britain's balance of payments last July, the best ever, were greeted by the media with utter scepticism rather than joy. Or why the mid-year reduction in inflation had a similar reception. Of course it would be stupid to ignore the many industrial and economic problems which will be with us for a long time yet. But, equally, we should not ignore the many bright aspects of our industrial performance.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GAMES TIMER

S. IBBS

MANY board games suffer from one disadvantage; boredom for all players except one at any particular time. The project described here provides increased involvement for all players, and makes use of a well known fact that in games there is nothing more satisfying than another person's downfall. Each player has a randomly chosen time limit in which to make his move. If he fails to do so before a pulsing alarm sounds, he loses his turn. The author found that it raised Scrabble to a very exciting level. Two "booby" time delays of a few seconds can be included, and of course all players *except the one making the move* hope that the "booby" has been chosen. A flashing l.e.d. is included to show that the timer is functioning, and the alarm was made to pulse to give the player, perhaps 5 pulses, to put his word down.

HOW IT WORKS

Two gates of IC1 (a & b) are connected as a fast astable multivibrator, see Fig. 1, whose frequency is within the audio range. The other two gates are connected as a slow oscillator, which drives the l.e.d. The output from the fast oscillator is fed to the clock pin of a 4017 decade counter with 10 decoded outputs, only one of which is high at any one time. Pin 13 (Clock inhibit) is held high by R6, but when the pushbutton S2 is pressed, pin 13 goes low, allowing the 4017 to clock between the various outputs at very high speed. When the pushbutton is released, only one output remains high and causes C3 to charge up, the rate of which is dependent on the value of resistor randomly selected.

Diodes were needed to isolate the resistor outputs from each other, otherwise the capacitor would discharge through the other 9 outputs which are low. The capacitor feeds into a 555 via pins 2 and 6, which have also been brought low by the pushbutton. This has caused the output pin 3 to go high. As the capacitor charges up, so it crosses the threshhold voltage, and pin 3 goes low. This is connected to one input of IC4d, thus allowing the slow oscillator pulses from IC1c and IC1d to be fed through, inverted, and gate the fast oscillator IC1a and IC1b via IC4a. The resulting audio pulses go via a one transistor amplifier to LS1.

Pushing S2 automatically resets IC3 by driving its inputs low, discharges C3, and sets the 4017 clocking through the various outputs again, ready for the next player.

COMPONENTS . . .

Resistors

R1	27k
R2	68k
R3, R4	4M7 (2 off)
R5	1k
R6	100k
R7	6k8
R8–R17	see text (10 off)

Capacitors

C1	10n polyester
C2	330n polyester
C3, C4	100µ elect.

Transistors and Diodes

TR1	BC109
D1–D12	IN 4148
D13	Red l.e.d.

Integrated Circuits

IC1	4011
IC2	4017
IC3	555
IC4	4001

Miscellaneous

LS1	miniature loudspeaker
S1	SPST toggle
S2	push to make

P.c.b.
Battery clip
L.e.d. clip
Box

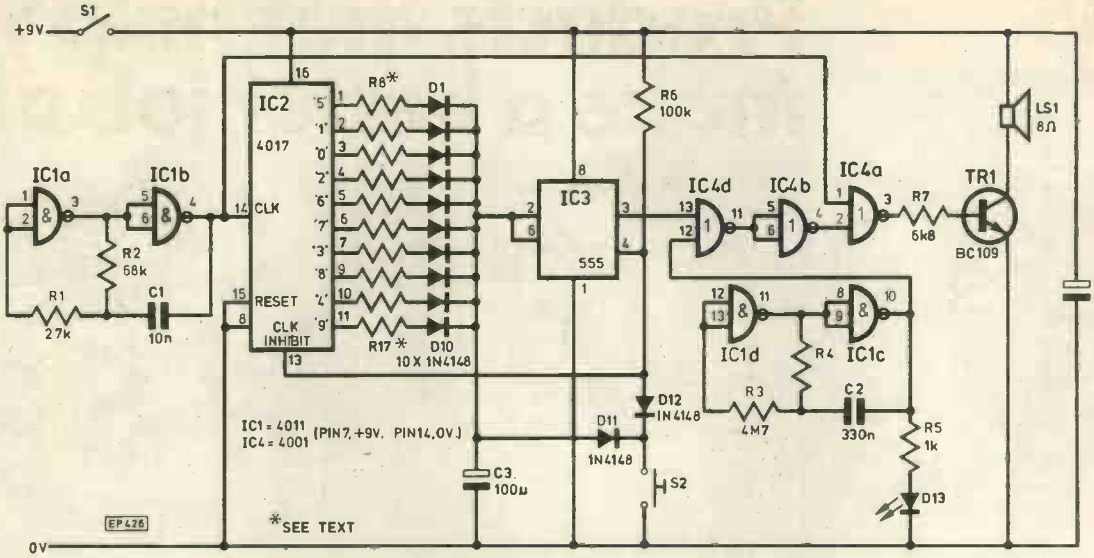


Fig. 1. Circuit diagram

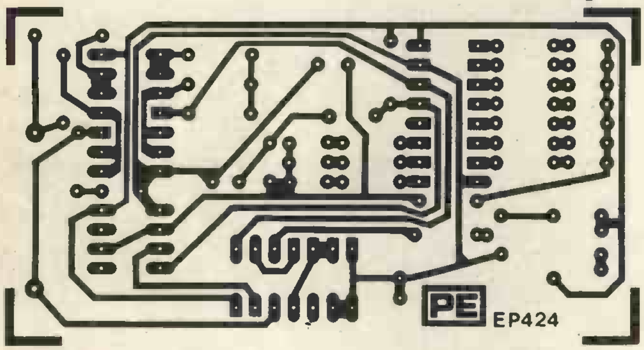


Fig. 2. Printed Circuit (actual size)

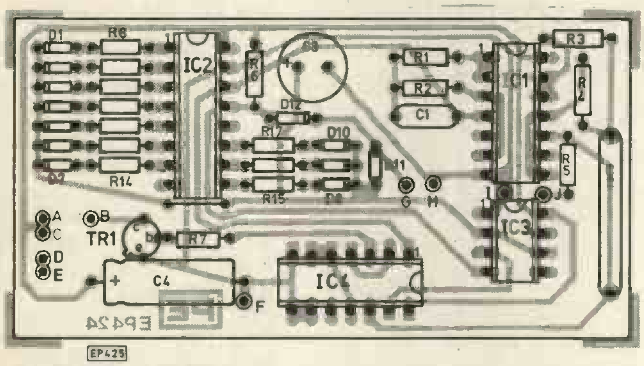


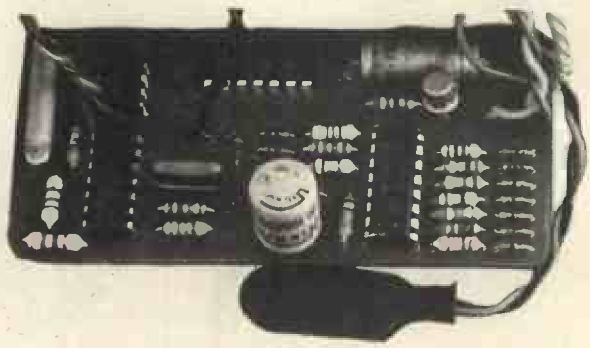
Fig. 3. Component Layout

A & B to LS1
C & D to S1
E to batt. pos.
F to batt. neg.
G & H to S2
I to l.e.d. anode
J to l.e.d. cathode

CONSTRUCTION

Use of a p.c.b. is recommended for trouble free construction, and a suggested design is given in Fig. 2. Do not forget to include the wire link. Make sure you get the orientation of the i.c.s and the polarity of the capacitors and diodes correct. Refer to Fig. 3. Any small suitable box may be used to house the project. In the prototype case small plastic feet were included, but this prevented the use of mounting bolts, which would have protruded too far, so the p.c.b. was held in place with two double sided sticky pads. The l.e.d. and switches were mounted on the top panel, as was the speaker, using impact adhesive. There is room for a PP6 battery and this provides many months of use.

The values of resistors for R8–R17 is really the choice of the individual constructor. The author chose values between 100k and 1M which gives a range of approx 15 secs. to 2 mins., but then decided to include two booby resistors of 47k + 68k to give delays of about 5 secs. This added extra spice to the game.



In use, as each player completes a move, he/she presses the reset button for the next player. If the alarm sounds the player has his 5 pulses to make the move before it is forfeited. ☆

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speech synthesis

Dr. A.A. Berk · part 1

THESE articles describe the fundamental theory of the synthesis of human speech, and the application of this technique to general microcomputer output. An interface board, developed by Modus System Ltd., and based on an American product, is described as a project. This board, very much as the PE VDU did in its "day", provides any microcomputer user with output in the most up to date manner possible. As examples of its application, interfaces are described for the EDUKIT and the Compukit UK101.

HISTORY

Since time immemorial, mankind has tried to emulate the natural phenomena of bird flight and song, the colours of flowers, human activity and speech, and many other things. To some extent, of course, time has produced a degree of success in each of these areas.

In early Greek and Roman times, apparent emulation of human speech was important for the purpose of convincing people of the validity of such religious institutions as oracular pronouncements and idol worship. Even in those times, technology was of some use in aiding this deception. The priests of antiquity were aware of the properties of the speaking tube, and some instances have come down to us of statues speaking by virtue of such a device connecting an unseen talker with the unmoving lips. In the Middle Ages, speech synthesis was professed by some individuals for less supernatural reasons, namely to prove their ingenuity, and often to impress the monarch. In Pope Sylvester II's reign (999 to 1003), he is said to have constructed a brass head which talked. The immediate result of this was, of course, an accusation of practising magic! In the Thirteenth Century, the very knowledgeable Albertus Magnus constructed an earthenware head which his disciple is said to have smashed in fright upon hearing it talk.

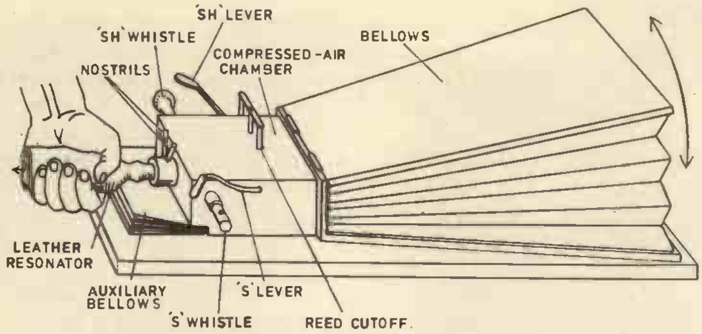
It is possible that some substance may exist for the claims of some of these early workers, by the action of reeds and organ pipes, but the principles offered by some philosophers are amusing at best. It was thought by one that a hollow pipe could be fashioned to collect human sounds and indeed complete sentences, and return them to the ear when uncorked. By this means, he thought, messages could be sent without paper, and talking heads constructed!

Such was the state of the art by the seventeenth and eighteenth centuries: the desire for progress outstripping, as usual, technology's capability for its fulfilment. Deception was still very common, and not very advanced. Charles II and his court were astonished by a speaking head, shown by one Thomas Irson, which answered questions whispered in its ear. At the height of their wonderment, a page discovered in an adjoining room a "Popish priest" answering through a speaking tube. Other deceptions involved the exhibiting of figures seated on boxes filled with bellows and sound boxes etc, which upon very careful examination concealed a dwarf.

In 1779, The Imperial Academy of St Petersburg decided to offer their annual prize for solving the problem of describing the difference between the vowel sounds: A, E, I, O and U, and constructing a device to voice these sounds. Professor C. G. Kratzenstein (the inventor of the vibrating reed resonator as used in the harmonica) solved the problem. He produced five resonant cavities, excited by vibrating reeds, very much as the human vocal chords excite the vocal cavities.

In 1791 came Wolfgang Von Kempelen's invention consisting of a bellows to supply a constant supply of air, as with the lungs, to a vibrating reed and hand operated resonant cavity. Several other cavities and additions such as "hissing" sounds were included to emulate all the human sounds. The device was even capable of uttering complete sentences, a fact which has been later proved by Sir Charles Wheatstone in 1837 by his reconstruction (see Fig. 1) and subsequent improvement to the original device.

The general prevalence of deceptions, however, made it difficult for this first complete mechanical synthesis device to be accepted. Especially as the inventor, Von Kempelen, was himself party to a deception involving a supposed chess playing automaton which won many games before a legless Polish general was found concealed within!



(Scientific American 1972 226:48/58)

Fig. 1. Sir Charles Wheatstone's reconstruction of Van Kempelen's speaking machine. A bellows fed air into a reed which excited the hand controlled resonator. Four separate restricted passages were included for the consonants and nasals.

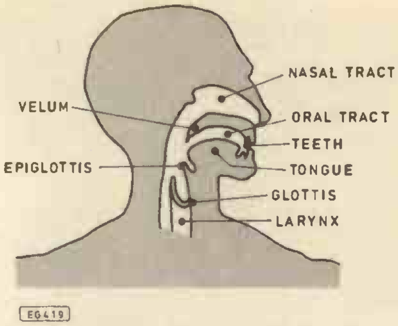


Fig. 2. The Human vocal system consists of two main tracts: The oral tract and the nasal tract. Sounds are produced in the glottis and resonances set up within one or both cavities depending upon the position of the velum.

Von Kempelen's synthesiser marked a major milestone in the art, and remained essentially unmatched until electronics took over, and a machine called the "VODER" was constructed for the New York World's Fair in 1939. Up to this point, the general method of synthesis revolved around copying the actual physics of the human vocal tract, (Fig. 2.)

The physics of natural voice production are those of acoustic filtering. A "wide band noise source" is employed in the glottis, where the vocal chords vibrate under the action of the air forced from the lungs. This vibration excites the cavity between the glottis and the lips, and/or the nasal cavity depending upon the position of the velum. The filtering action which occurs, accentuates certain frequencies, and modifies the sound from the noise source in a complex but well understood manner.

The Voder worked on these principles but took the important step of creating an electronic analogy. Instead of actually expelling air through a set of controllable cavities, a broad band electrical noise source and a random noise generator were filtered electronically, and then amplified and fed to a loudspeaker. The control of the sounds was via a set of hand and foot controls, and as no logic existed for synthesising words, each word had to be produced by the deft manipulation of the controls "in real time". The difficulty of the process, and the complexity of the instrument, can be assessed from the fact that each operator required a year's training, six hours a day, to produce continuous intelligible speech.

PRINCIPLES OF VOICE PRODUCTION

A description of human speech may be given in two different but connected ways. An analysis of the basic phonetic components from which each word in the English language is composed may be performed, and those "phonemes", as they are termed, may be synthesised by a machine, and "called up" as required to produce any given word when written in terms of its phonemes. The other analysis of the voice involves a classification of the exact types of sound which are produced during the enunciation of a word. This would classify the frequencies, speed of production, volume, attack and decay, etc., of these sounds as the word is spoken. To form a word, the necessary frequencies must be produced and mixed in "real time".

The former of these two approaches is termed "phonetic synthesis", and the latter, "frequency synthesis" in the following.

PHONETIC SYNTHESIS

The phonetics of human speech may be split, broadly, into three main components. They are the "voiced", "fricative' and "plosive" sounds. These are described in Table 1. In some cases,

CLASS	DESCRIPTION	EXAMPLE
VOICED	Continuous sounds such as vowels—the glottis resonates	"a" as in "far" "o" as in "toe"
FRICATIVES	Hissing sounds—the glottis is not required	"s" as in "sound" "sh" as in "wash" "h" as in "hat"
PLOSIVES	Short sharp sounds	"t" as in "hat" "k" as in "make"
MIXTURES	More than one of these sounds may be produced at once	"th" as in "that" is a mix of the fricative "th" and a neutral voiced sound

Human speech may be broken into three main classes of sound or mixtures of these.

TABLE 1

two such sounds may blend into one, an example is given under "mixtures" in Table 1. The fricatives are produced by expelling air through a restricted opening such as between the tongue and the teeth. Try saying "this" slowly—you will notice that your tongue starts behind the teeth and moves back. Two fricatives are thus produced one after the other, the first of which is a mixture of a voiced sound (the vowel I) and a fricative (th). By this means, you could build up a complete catalogue of the types of sound necessary to produce each word in the English language. To do this, you would have to classify a few more scales of sound than the three simple ones shown above. This type of analysis is very valuable for speech synthesis, and is called "phoneme analysis". There are some thirty to fifty such phonemes, or basic speech units, from which the majority of English words may be synthesised. If a machine can be built to reproduce these noises, then each word can be written in terms of its phonemes, the information fed digitally to the machine and words produced. Table 2 lists some of the common phonemes with examples of their use, but is by no means complete.

There are several devices on the market which allow you to perform this type of phoneme construction. The word is first written in a code unique to each machine, and the data fed in, often under BASIC. The speech synthesiser then produces the

PHONEME		USAGE
VOWELS:	aw	taught
	ae	man
	ah	calf
	a	make
	e	be
	eh	excellent
	er	surge
PLOSIVES:	b	bad
	k	computer
	t	top
FRICATIVES:	th	thanks
	sh	rash
	h	have
SEMI-VOWELS:	w	with
	y	yours
NASALS:	m	man
	n	man
OTHERS:	l	law
	r	ran

English words may be broken down into a number of basic units from which any word may be synthesised—these units are called phonemes. Some of them are illustrated here.

TABLE 2

phonemes thus indicated, in the correct time sequence to be heard as a word. The Microspeech Board by Tim Orr (see *Micro Bus, PE June 1979*) is an example of this type of system.

FREQUENCY SYNTHESIS

To understand the second type of speech synthesis, it is necessary to appreciate the exact frequency structure of the voice sounds themselves. The sound we hear when a word is spoken is composed of several basic frequencies which are mixed together in varying proportions as the word is spoken. In addition, the actual frequency pitches themselves change over the time of the word.

To view the actual frequencies and sounds encountered, the vocal tract should be examined again (Fig 2.) It is clearly seen that there are essentially two resonators available to us during oral speech. These are the full vocal tract from the Glottis to the lips, and the nasal tract. Each of these contributes to word production. It should be borne in mind that they act as resonant filters on the noise produced by the Glottis. The most important cavity of the two, is the tract ending in the lips. In English, the nasal passage is used for only a few sounds (n and m). The main tract may be viewed, ideally, as a single ended resonant cavity of around 17cms in length. (Fig. 3.) Some 'O' level physics reveals that the sort of resonances which such a pipe may suffer are only those of odd-multiple quarter-wavelength as shown. For the length of 0·17m and the speed of sound under normal conditions of 330 m/s, the first three (and most significant) resonances will be as shown. Since the "noise source" which makes the cavity resonate contains all these frequencies, and more, these are available to be accentuated, or filtered out by the cavity. They are called the first three "Formants", and they change continuously during any utterance. Their ranges are given, very approximately. The reason for the frequency variations during word production, is concerned with the complexity of the vocal tract and the constant adjustments made by the musculature during normal speech.

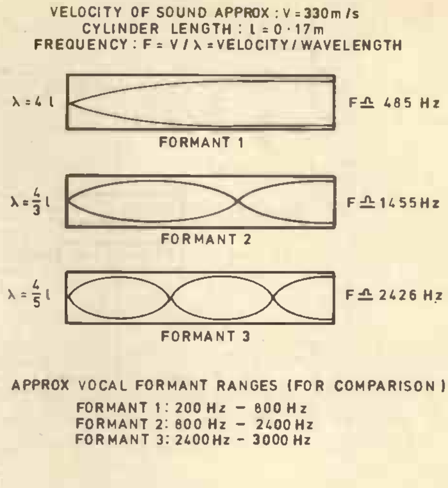


Fig. 3. The first three resonances of a 17cm long cylinder (with one closed end) are shown here. This gives a guide to the main resonances (Formants) of the vocal tract.

These formants may be adjusted in pitch and mixed in different amplitudes to produce the pure voiced vowel sounds. However, they are not sufficient to produce the nasal sounds, which rely on a separate resonator, or the fricatives which are full of random noise. Two more generators are thus necessary for the complete sound. This gives just five different generators to be controlled for a full synthesis. However, these controls involve volume as well as pitch over the time envelope of each word. This type of real time control requires something of the complexity of a microprocessor.

CONSTANT VOWELS

	FI	F2	F3
ee as in seed	240	2300	2900
oo as in wood	420	950	2400
o as in rod	770	1100	2500
aw as in door	570	900	2400

DIPHTHONG VOWELS:

	F1	F2
toy	400–500	1100–2100
prow	400–700	1700– 900

English vowel sounds are produced by adjusting the mix of formants present in the final sound. Diphthongs are produced by smoothly running vowels into each other.

TABLE 3

To illustrate the formant variation during voice production, Table 3 gives typical values to the formants during the constant and diphthong vowel sounds. To appreciate the difference, try saying these sounds to yourself in a normal tone, and listen for the pitch changes, you should not drop your voice as you say the words. The constant vowels use, essentially, constant pitches for the formants, while the diphthong gains its variation by changing the formant pitches as the vowel is sounded. Diphthongs may be considered as mixtures of vowel sounds, which run into each other. The total structure of the voice sounds includes fricative pitch and amplitude changes, as well as nasals. A com-

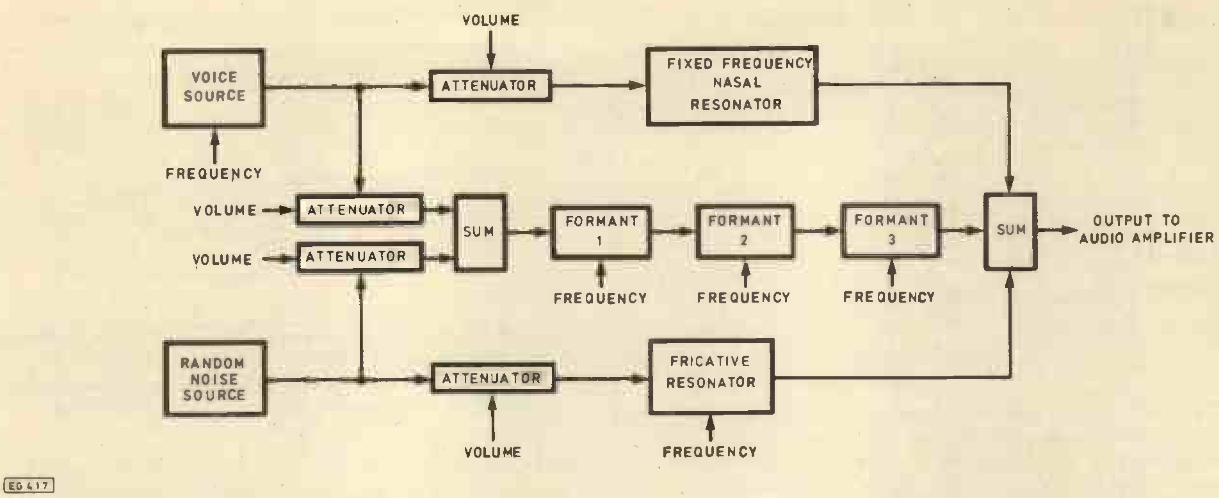


Fig. 4. This "classical" voice synthesis unit requires just nine parameters to specify a single sound (four "volumes" and five frequencies). The "frame" of nine parameters is updated (typically) fifty times a second during the production of a word.

plete list is beyond our present scope, but a fuller picture is introduced below, when electronic voice synthesis is described in more detail.

STORAGE OF SPEECH

One interesting aspect of the above is concerned with the storage of speech in ways other than the conventional manner of grooved disc or magnetic tape. One's first instinct is to think of a system which simply digitises the sound waveforms, and stores them in memory for later retrieval and faithful reproduction. The simplest calculation, based on the evidence, shows that around 8K to 10K Bytes of memory are required for each second of speech-quality recording. This amount of memory is probably best handled by such devices as magnetic tape memories!

The best method for storing speech for output from a computer, is to use one of the approaches suggested by the above two analyses. Words may be stored as phonemes in comparatively small memory blocks, and presented to a "phoneme player" for output. Alternatively, information of frequency, amplitude, fricative content etc is stored digitally, for feeding to a set of sound generators in the correct time sequence, very much as the operators of the VODER would have done.

By one of these means, the common elements of English words are used to reduce the amount of storage necessary for each utterance. The complexity is confined to hardware frequency synthesisers, and controllers.

ELECTRONICS

The electronics of speech synthesis are very interesting, and some of the techniques can now be examined.

Once again it would be tempting to think of some very straightforward approach to the frequency synthesis in the second approach above. Perhaps variable oscillators would be useful, and when their outputs are mixed a perfect synthesis would result. However, it turns out to be considerably easier to attain a natural sound by simply copying nature, and applying controllable resonant filters to the output of a broad band noise generator. (Fig 4.) This provides an almost classical approach to speech synthesis, and would form the electronics for both approaches mentioned above. The first approach would accept phoneme data, and under microprocessor control adjust the frequencies and amplitudes accordingly. The second approach would store the actual values of all those variables and present them to the synthesiser at some sample rate to produce the complete word.

The different sounds arise as follows. The general pitch of the utterance is controlled by adjusting the frequency of the voice source. Pure vowels are produced by one volume and three frequency adjustments to the three formants, and perhaps the nasal resonator volume. Fricatives are produced by a frequency parameter and a volume, and plosives include sudden adjustment to the volume of random noise fed into the voiced channel. In Tim Orr's system, this "frame" of nine parameters is updated fifty times a second. The total effect of the system is considerably greater efficiency of storage than simply digitising speech without analysis.

The other common electronic system is that of Linear Predictive Coding, described below.

LINEAR PREDICTIVE CODING

This technique takes frequency synthesis to a logical ending, and filters, in an "intelligent' manner, the necessary formants and frequencies from a single excitation. It is important to realise that the central principle to which all these techniques are aimed is that of reducing speech to a small set of parameters for efficient memory storage. To this end, the number of parameters needed to specify a sound should be of the order of 10 or 12, and this "frame" should be updated at a rate of around 40 or 50 times per second. The number of bits per parameter in a frame is the main variable, and the more bits, the more accurately the frame is specified. The Texas Instruments "Speak and Spell" unit is based around a Linear Predictive Coding (LPC) system. This system uses a maximum of 48 bits per frame at 50 frames per second i.e. 2400 bits of storage per second of speech.

Words are coded into special binary patterns by speaking them into a microphone connected to a large computer. On this machine, a program is running to convert the sound into codes for storage, and eventually for driving the synthesis unit. In this manner any word may be stored on ROM for later selection and playing.

Each word has a unique set of addresses in the final ROM, and a custom vocabulary may thus be formed. When a word is selected the bits associated with it are fed to the synthesiser which consists of a noise generator, and a 10 stage digital lattice filter, (Fig. 5.) The bits from the ROM are used to set up the filter components in order to produce a binary number which is fed to a digital to analogue converter. As the word is produced, the binary number changes, and the analogue output sounds like speech. In order to prevent sudden changes between frames, a certain amount of linear interpolation is included in the process,

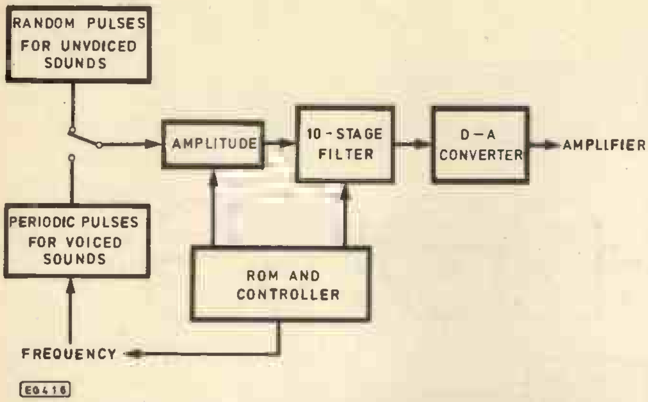


Fig. 5. The Texas Instruments Linear Predictive Coding System codes words into the coefficients of a ten-stage digital filter. A maximum of 2400 bits of data per second of speech are required to adjust the filter coefficients, type of excitation and pitch and frequency as a word is produced.

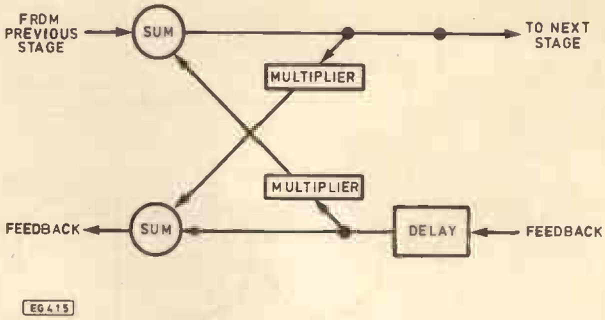


Fig. 6. This illustrates one of the ten stages in the lattice filter used to electronically model the Human Vocal Tract—The multiplication factor (used in both multipliers) is fed from the speech storage ROM.

which is controlled by a form of TI's TMS1000.

The excitation has two time varying parameters, amplitude and pitch. For voiced sounds, a periodic excitation is used, for unvoiced sounds, pseudo random noise of constant amplitude is fed in.

The filter components themselves are quite interesting and along with the controller, ROM and all the other components, illustrates the complexity possible with modern microelectronics. Each of the ten stages (Fig. 6.) contains two adders, two multipliers and a shift register delay circuit. The filtering is thus produced by binary calculation in real time to model the time varying functions of normal speech. A 10 kHz sampling rate is used for the filter; thus during the 100 micro seconds of one sample, two 14 bit additions, and two multiplications are performed. It is due to the difference in speed between these two operations that the delay is necessary. The ROM supplies just the multiplier coefficients for each stage. With judicious use of data, an average data rate of 1500 bits per second of speech may be achieved, giving 165 words, approximately, in a 131K bit ROM. The output sounds excellent, and may be improved upon by incorporating more stages to the filter.

NEXT MONTH: SPEECH SYNTHESISER DESIGN

This project which will add speech synthesis to any microcomputer will be described along with interface examples for two popular microcomputers.

There will also be a special offer of a 24-word speech board available for £39·95 (plus VAT).

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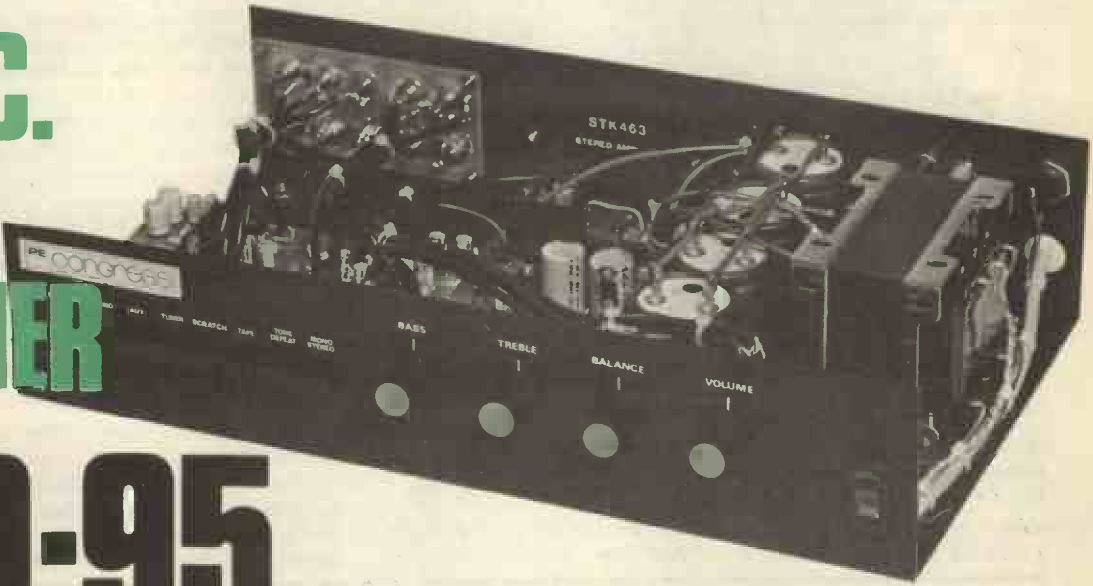

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PE, in conjunction with Wicca Systems Ltd., have arranged a special offer price on the *PE Congress* amplifier kit. The Congress amplifier was originally published in April, May and June 1980 and a full spec. and description appeared in the April issue. A brief spec. is given below for those not familiar with this design. The published specification was a result of independent tests carried out by Gordon J. King, the well-known hi-fi reviewer.

The normal price of the kit is over £85, but for the period of this offer PE readers can buy it for £15 less. Photostat copies of the original series of articles are available from Wicca for £1.20. The kit includes metalwork and printed front panel but not a case.

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Output, 30W continuous sinewave per channel both channels driven

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Intermodulation distortion 19kHz + 20kHz, 10dB o/p per channel, 0.03% 1kHz product

Slew factor, >5 (ref. 14.8dB, 1kHz, 8Ω)

Damping factor, 66

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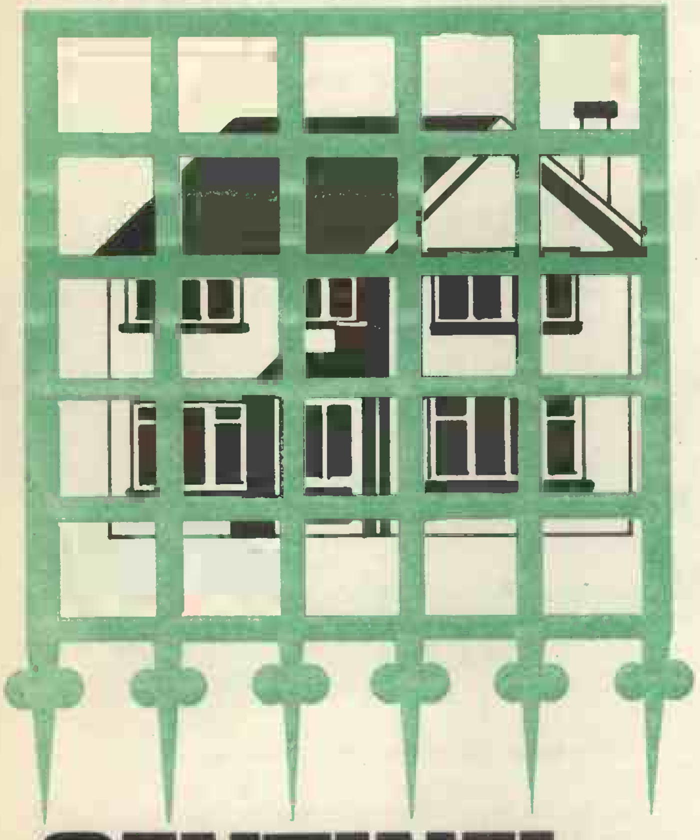


SENTINEL...

Part 1 W.C. Dickinson

THE major problem with many available alarm units is that they can be easily disarmed without being triggered. Alarms are generally sensed by magnet/reed switches on doors and windows, metal foil on window glass and pressure mats under carpets. Unfortunately, as the use of alarm systems has become more widespread, the techniques of defeating these systems have also become common knowledge. The simple magnet/reed switch combinations that form the basis of most systems are easily detected with a compass. Once they are located they can be magnetically shunted with a powerful magnet or the glass cut and the switch shorted with a jumper wire. In large commercial systems these 'perimeter' sensors are usually employed as the first line of defence. They are then backed up by several other devices. Most domestic installations cannot be this elaborate due to the costs of the wiring involved. More often than not the economic considerations of domestic installations result in closed loop magnet/reed-switch detectors being the sole method of detecting an intrusion. Whilst some form of alarm system is better than none at all, a conventional system does not offer as much in the form of a deterrent as it used to. This alarm unit has six independent alarm channels, each protecting a specific area of the premises, and these will respond to any combination of the following alarm conditions:

Pressure pad stepped on (normally open, close for alarm)
Magnet-switch(es) opened (normally closed, open for alarm)
Magnet-switch(es) shunted with a magnet or jumper wire (tampering by thief)
Window glass foil broken (normally closed, open for alarm)
Window foil shunted (tampering by thief)
Alarm wires cut (tampering by thief)
Alarm wires shorted (tampering by thief)

Standard fire detectors can be included in the loop.

Every alarm condition described above is detected using only one twin-conductor wire per channel. This feature not only improves the integrity of the system but also simplifies the installation of the system.

Each channel can be selected (Activated or Defeated) individually. Any alarm condition, even a momentary one, detected whilst the alarm system is activated will latch the alarm channel into alarm status. A noise suppression circuit prevents a.c. hum and impulse noise spikes which may be picked up by the field wiring from being sensed as an alarm. Alarm status is indicated by a flashing l.e.d. above the channel selector switch. This enables the source of the alarm to be identified and located quickly. Each channel can provide an immediate alarm or a delayed alarm, as required. Exit and entry delay timers are provided so there is no necessity to fit an external key switch. On activation the exit delay is initiated which allows you one and a half minutes to leave the premises before the system automatically arms itself. Upon re-entry the alarm channel which monitors the entrance will immediately trigger and lock into alarm status. The entry delay timer allows you one minute to defeat the alarm before the siren is triggered. If the alarm is not defeated within the allowed time the siren will begin sounding. An automatic validation circuit resets all alarm channels after the siren has been sounding for one and a half minutes. If the source of the alarm is no longer present the siren will silence and the alarm system will re-arm itself. If the alarm is still present or another channel is sensing an alarm the siren will continue to sound until the next validation cycle one minute later. The validation cycle will continue indefinitely until all channels are clear of alarms or the

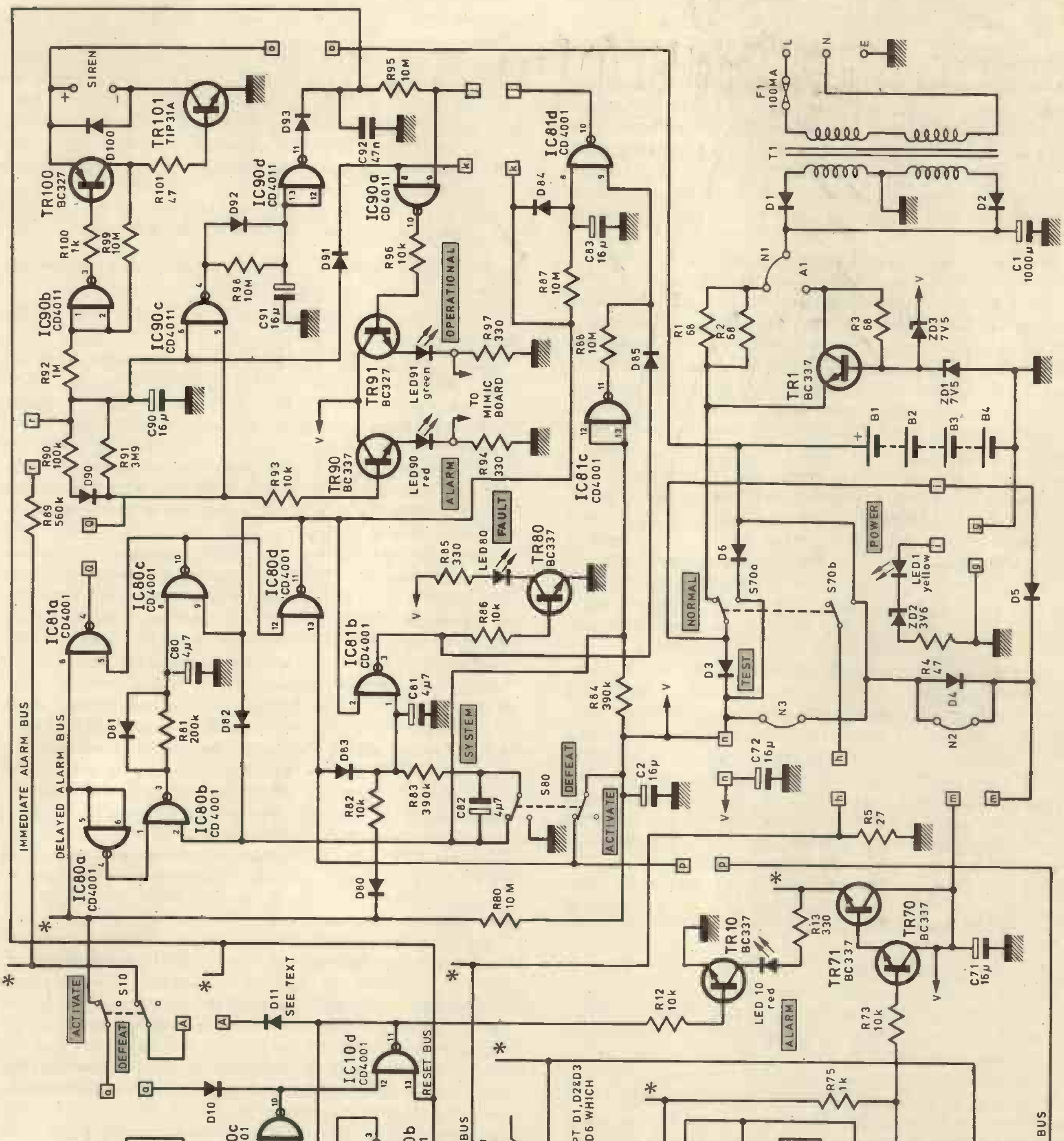


Fig. 1.1. Circuit diagram of the Security Sentinel

system is manually reset. All timing intervals are easily adjusted to suit individual requirements.

SYSTEM TEST

One of the major problems presented by conventional designs which employ exit delays is that you never know if the system is in an alarm condition when you activate it. To find out you must generally go through an elaborate and time consuming test procedure. Another drawback is the uneasy feeling you get unless you make a hurried exit in order to "beat the clock". Clearly, neither of these circumstances is desirable.

The first problem has been eliminated by a completely automatic confidence test on activation of the system. Each time the alarm system is activated every alarm channel is enabled for 0·8 seconds. If any channel detects an alarm condition, the alarm status l.e.d. will begin to flash. Any selected (activated) alarm channel detecting an alarm during the 0·8 second test will cause the alarm system to abort the test cycle and lock into 'system fault'. This is indicated by an l.e.d. on the front panel. Only when all channels are clear of alarm conditions for the duration of the 0·8 second test cycle (or channels which have alarm conditions are defeated) will the system proceed with the exit delay. When the system has passed the activation tests, the 'exit' delay will be initiated. This is indicated by an l.e.d. marked SYSTEM OPERATIONAL on the front panel and the green l.e.d. at the remote mimic illuminating. When the 'system operational' l.e.d. illuminates, you can leave the premises in confidence, knowing that the selected alarm channels will not initiate an alarm after the exit delay has ended.

The second problem has been alleviated by providing an l.e.d. mimic outside the normal exit point. This mimic duplicates two of the indications provided at the alarm control centre via two coloured l.e.d.s which are connected via a single twin-conductor wire. 'System operational' is indicated by the green l.e.d., 'system alarm' is indicated by the red l.e.d. When you close the exit door as you leave the premises a quick glance at the mimic will indicate the status of the system. The green l.e.d. indicates all clear, the red l.e.d. indicates you were too slow in leaving the premises. The 'system alarm' output of the control centre can also be wired to a solid-state signal unit mounted in your bedroom to provide a pre-siren alarm signal.

OPERATING CURRENT

During the design of this system special emphasis was placed on quiescent and operating current demands. When the alarm system is operating normally from the mains and the system is defeated, the only significant current is the 120 milliampere charge current for the nickel-cadmium batteries and 'power on' l.e.d. The remainder of the system only requires a negligible 10 microamperes. When the alarm system is activated and is passive, i.e. no alarms detected, the maximum battery current in the event of mains failure is 400 microamperes. This low current drain enables the alarm system to operate in the passive mode for well over three months without mains and still have plenty of power in reserve to operate the siren if an alarm is detected. Having the capability to operate for prolonged periods without mains power is particularly advantageous when you leave your house unattended during your holidays and wish to shut off the mains supply to minimise the risk of fire in your absence.

CIRCUIT DESCRIPTION

The complete circuit diagram of the system is shown in Fig 1.1. Each of the eleven logic blocks has been given a series of numbers for component designations (1, 10, 20, 30, 40, etc). The alarm sensing circuit has three operating modes.

(a) It can detect an open circuit caused by the wires being cut, the opening of any of the series connected switches or if the metal foil tape on a widow is broken.

(b) It can detect a short circuit caused by the wires being shorted, any of the specially modified series connected switches being shorted, or if a pressure pad is stepped on.

(c) The circuit will also detect if any of the modified switches is being magnetically shunted.

The operation of each of the six channels is the same and only one channel is shown in Fig 1.1.

ALARM CIRCUIT

IC10C and IC10D are cross coupled to form an alarm latch set-reset flip-flop. IC10B ensures that the 'reset' (defeat) signal is given priority over the 'set' (alarm) signal. When the system is defeated a logic '1' from the reset bus is presented to pin 1 of IC10B and pin 13 of IC10D. This locks the flip-flop in a stable state with a '1' at the output of IC10C and a '0' at the output of IC10D. When the reset bus goes to '0' the flip-flop is free to latch into the alarm state upon presentation of a '1' to either input of IC10A. Pin 6 of IC10A is connected to the 'test bus' which is held at '0' by the pulldown resistor R5. When the 'test' switch, S70, is depressed, a '1' is applied to the 'test bus' which simulates an alarm condition at each of the six alarm channel inputs. The other input of IC10A monitors the alarm sensors in the area being protected. If the channel detects an alarm whilst the system is activated the output of IC10C will go to '0'. This is coupled through D10 and S10 to the 'delayed alarm bus'. When IC10C goes to '0' IC10D goes to '1'. If D11 is installed this '1' will be coupled to the 'immediate alarm bus' via S10. If S10 is open both alarms will be ignored by the alarm control logic. The '1' at the output of IC10D is also coupled to TR10 via R12 driving TR10 into conduction. The voltage at the anode of D10 via R13 is pulsating at 4Hz. Therefore D10 will flash whenever the channel detects an alarm. D10 will flash regardless of the position of S10.

TRI-MODE ALARM

Switch SA, diode D and resistor R are inside the enclosure for SA and form the heart of the 'Tri-Mode' operation. SA is positioned within the field of the magnet. Switch SB is positioned just outside the field of the magnet. When the door or window being protected is closed, SA will be pulled closed by the field of the magnet. SB will remain open.

IC70 is a 4Hz astable mutlivibrator which is used to flash the channel alarm indicator. If we momentarily lock the 4Hz multivibrator into a stable state with '$\overline{Q}$' at '0' and 'Q' at '1' this senses continuity in the alarm loop. Providing that SA is closed, diode 'D' will pull down the input of IC10A to '0'. Germanium type diodes have been selected for use in this circuit as they have a low forward voltage drop (0·2V). Four modified switches in series will drop 0·8 volts.

In order to ensure stability under low voltage conditions and maintain a high degree of immunity to noise, each channel should be limited to a maximum of four modified switches. As there are no voltage drops in the unmodified switches, any number of these can be used. If the closed loop is broken by cutting the wires or opening SA, R10 and VR10 pull the input of IC10A to '1' via R14. R11 and C10 have a time constant of approximately 60ms. This ensures maximum immunity from any noise impulses picked up by the wiring between the alarm control centre and the sensing

COMPONENTS . . .

Resistors

R1, R2	68 ½W (2 off)
R3	68
R4, R101	47 (2 off)
R5	27 ½W
R10, R20, R30, R40, R50, R60	47k (6 off)
R11, R21, R31, R41, R51, R61, R14, R72, R74, R80, R87, R88, R95, R98, R99	10M (15 off)
R12, R22, R32, R42, R52, R62, R73, R82, R86, R93, R96	10k (11 off)
R13, R23, R33, R43, R53, R63, R85, R94, R97	330 (9 off)
R70, R90	100k (2 off)
R71, R92	1M (2 off)
R75, R100	1k (2 off)
R81	200k
R83, R84	390k (2 off)
R89	560k
R91	3M9

All resistors ¼W 5% carbon except where otherwise stated.

Capacitors

C1	1000µ 25V elect
C10, C20, C30, C40, C50, C60	10n ceramic plate (6 off)
C70, C80, C81, C82	4µ7 10V tant (4 off)
C2, C71, C72, C83, C90, C91	16µ 10V tant (6 off)
C92	47n polyester

Potentiometers

VR10, VR20, VR30, VR40, VR50, VR60	100K sub min vertical pre-set (6 off)

Diodes

LED1	0·2" yellow LED
LED10, LED20, LED30, LED40, LED50, LED60, LED80, LED90	0·2" red LED (8 off)
LED91	0·2" green LED
D1, D2, D3	IN4001 (3 off)
D4, D6	OA91 (2 off)
D5, D10, D20, D30, D40, D50, D60, *D11, *D21, *D31, *D41, *D51, *D61, D70, D80, D81, D82, D83, D84, D85, D90, D91, D92, D93, D100	IN4148 (25 off)
ZD1, ZD3	BZY88C7V5 (2 off)
ZD2	BZY88C3V6

Transistors

TR1, TR10, TR20, TR30, TR40, TR50, TR60, TR70, TR71, TR80, TR90	BC337 (10 off)
TR91, TR100	BC327 (2 off)
TR101	TIP31A

Integrated Circuits

IC10, IC20, IC30, IC40, IC50, IC60, IC70, IC80, IC81	CD4001 (9 off)
IC90	CD4011

Switches

S10, S20, S30, S40, S50, S60, S80	p.c.b. mounted 2 pole changeover (7 off)
S70	p.c.b. mounted, 2 pole changeover (momentary)

Miscellaneous

20mm fuse holder
20mm 100mA fuse
4-way p.c.b. terminal block (4 off)
3-way p.c.b. terminal block
Low profile i.c. sockets 14 d.i.l. (10 off)
Veropins
Transformer 6VA sec. 6–0–6V 500mA
Battery holder for four HP11 size batteries
Ni-Cad battery HP11 (4 off)
Case
Ribbon cable
p.c.b.
Siren (Carters Minimite)
*See text

Constructor's Note

A complete kit of parts for the Security Sentinel is available from **Compu-Tech Systems, Laundry Loke Industrial Estate, Gaymers Way, North Walsham, Norfolk.**

devices in the area being protected.

When the output of the 4Hz multivibrator is reversed and locked ('$\overline{Q}$' to a '1' and 'Q' to a '0') the system senses if any of the sensors are shunted within the alarm loop. Assume that SA is closed and SB is open. Under these circumstances the input of IC10A will be '0'. This is established by the ratio between Resistor 'R' in SA and the combined resistance of R10 and VR10. Resistance 'R' will always be greater than the combined resistance of R10 and VR10. Variable resistor VR10 provides compensation for component tolerances and the logic threshold of IC10. A feature of CMOS integrated circuits is that the logic thresholds 'track' changes in the supply voltage. As any changes in supply voltages will be present on the '$\overline{Q}$' and 'Q' buses as well, the circuit remains stable over the full discharge voltage curve of the batteries. With the ratio between resistor 'R' and R10 + VR10 setting the input of IC10A at '0' but only slightly below the threshold for '1' any reduction in the value of resistance 'R' will cause the input of IC10A to go to '1'. If the wiring to switch SA is shorted, 'R' will be zero ohms and an alarm is sensed. If the burglar brings another magnet near the sensing switches, SB will close which again will reduce

'R' to zero and will be sensed as an alarm, with the maximum number of modified switches (four) in series shunting any one of the switches reduces the total loop resistance to ¾ of its nominal value. This reduction in loop resistance will also cause the Input of IC10A to go to '1', providing VR10 is adjusted properly. If a pressure mat or other shunt device is used the effect is similar to S8 being closed.

AUTOMATIC SYSTEM TEST

Each time the system is activated an automatic system test is carried out. If this section is used in conjunction with the manual test switch (S70) the entire system can be checked in a few seconds.

If no alarms are detected and switch S80 is in the 'defeat' position a '1' is presented to pin 2 IC80B and the inputs of IC81C via pull up resistors R84. The timing capacitor C82 is shunted by S80 and is discharged. The resistor R84 and capacitor C82 form timer 'A' with a time constant of 1·6 secs.

A '1' is provided directly by S80 to pin 13 of IC80D and to pin 1 of IC81B via D83. C81 and R83 form timer 'B' with a time constant of 1·6 seconds. IC80C and IC80D are cross-coupled to form a confidence latch set-reset flip-flop. With a '1' at pin 1 of IC80B the output of IC80B will be '0' which pulls down pin 8 of IC80C and discharges C80 via D81. R81 and C80 form timer 'C' with a time constant of 0·8 seconds. With a '0' at pin 8 of IC80C and a '1' at pin 13 of IC80D the flip-flop will be locked into a stable state with a '1' at the output of IC80C and a '0' at the output of IC80D.

When switch S80 is switched to 'activate', timer A is initiated which enables all the alarm channels. Providing that the system does not detect an alarm for 0·8 seconds (timer B) the system will pre-empt timer A and the exit delay will be initiated which is indicated by the 'system operational' l.e.d. illuminating. Once the l.e.d. is extinguished the system is armed and any alarm detected will start the alarm sequence.

R74 pulls pin 13 of IC80D down to '0' allowing the set-reset flip-flop to change states if a '1' is presented to pin 8 to IC80C. The negative side of C82 is switched to V- by S80. This pulls pin 2 of IC80B and the inputs of IC81C to '0'. R84 will begin to charge C82 towards '1' (timer 'A'). A '0' at the inputs of IC81C results in a '1' at its output. This '1' is coupled to pin 9 of IC81D via R88. The '1' at pin 9 of IC81D causes the output of IC81D to go to '0'. This '0' enables (activates) all of the alarm channels for the duration of timer 'A', 1·6 seconds. The '0' provided by timer 'A' to pin 2 of IC80B allows IC80B to respond to the logic level at pin 1. Providing that no alarms are detected, pin 1 of IC80B will remain at '0'. A '0' at both inputs of IC80B result in a '1' at its output which begins to charge C80 through R81 (timer 'B'). In approximately 0·8 seconds a '1' will be presented to pin 8 of IC80C which will cause the set-reset flip-flop to reverse states and lock with a '0' at the output of IC80C and a '1' at the output of IC80D. Once the confidence latch flip-flop has changed states it will remain locked in this mode until S80 is moved to the 'defeat' position. As soon as the flip-flop changes states the '1' at the output of IC80D is coupled to pin 1 of IC80B via D82. The '1' at pin 2 of IC80B forces its output to '0' and dumps the charge on C80 via D81. This ensures that no ambiguous inputs can be applied to the inputs of the flip-flop. The '1' at the output of 1C80D also charges C82 to '1' via D82 and pre-empts timer 'A' which switches the output of IC81C to '0' causing the output of IC81D to go to '0' disabling all the alarm channels. The '0' at the output of IC80C is passed to pin 5 of IC81A which allows IC81A to respond to any subsequent alarm signal presented to pin 6. The '1' at the output of IC80D is passed to pin 8 of IC90A via interboard wire 'k'. This '1' also begins to charge C83 through R87. C83 and R87 form the 'exit delay' timer and have a time constant of approximately one and a half minutes. The output of IC81D will remain at '1' which inhibits the alarm sensing action of the alarm channels until the exit delay has elapsed and a '1' has developed across C83. This is presented to pin 8 of IC81D which causes its output to go to '0' which enables the alarm channel. Providing the system passes the activation test as detailed above, pin 8 of IC90A will remain at '1' for as long as the system is activated. Pin 9 of IC90A will only remain at '1' for the duration of the exit delay. When both inputs of IC90A are at '1' its output will be '0'. A '0' at the output of IC90A forward biases TR91, via R96, illuminating LED91, indicating that the system has passed the activation tests and the exit delay is in progress. R97 limits the current through LED91, the 'system operational' l.e.d. and also develops the potential required by the external mimic l.e.d. As soon as the exit delay has elapsed the output of IC90A will return to a '1' and LED91 (and the remote mimic) will extinguish, indicating that the system is now armed.

ALARM STATUS

If the alarm is detected before timer B times out, the system will lock into 'system fault' and the alarm sequence will be disabled. The alarm channels will remain enabled after timer A has timed out so that the channel which caused the alarm can be indentified.

The '0' provided by timer 'A' to pin 2 of IC80B allows IC80B to respond to the logic level at pin 1. If any of the selected alarm channels pull down the delayed alarm bus to '0' during the 0·8 second timing interval of timer 'B' the following sequence takes place. The '0' at the inputs of IC80A is inverted to a '1' and is presented to pin 1 of IC80B. This causes the output of IC80B to go to '0' which dumps any charge that had developed on C80 via D81. The '0' on the delayed alarm bus also pre-empts timer 'C' by discharging C81 via R82 and D80. At this point the set-reset flip-flop will remain in its original state with a '0' at the output of IC80D as pin 8 of IC80C never reached '1' within the 0·8 seconds allowed. The '0' at the output of IC80D is coupled to pin 2 of IC81B. Pin 1 of IC81B is pulled to '0' by the common alarm bus at mentioned above. Both inputs of IC81B at '0' results in a '1' at its output. This '1' forward biases TR80, via R86, illuminating LED80. R85 limits the current through LED80, the 'system fault' l.e.d. The '1' at the output of IC81B is also coupled to the input of IC81D via LED85. R88 ensures that the output of IC81B has priority over the output of IC81C. Pin 8 of IC81D is pulled to '0' by the output of IC80D via D84. With pin 9 of IC81D locked to '1' the output of IC81D will remain at '0'. This ensures that any alarm channel which detected an alarm will remain locked in alarm status when timer 'A' times out. Since the set-reset flip-flop never changes states, pin 5 of IC81A will remain at '1' which prevents the alarm signal from initiating the alarm sequence by locking the output of IC81A to '0'. The output of IC80D holds the input of IC81A at '0' via interboard wire 'k' and D91, again locking the output of IC81A to '0'. This prevents the 'immediate alarm bus' from initiating the alarm sequence.

ALARM SEQUENCE

When the system has passed its activation tests and is armed, if any alarm channel detects an alarm then the alarm latch flip-flop will lock into alarm status and the channel alarm l.e.d. will begin flashing. If the alarm channel is selected the delayed alarm bus will be pulled down to '0'. The '0' at pin 5 of IC81A combined with a '0' from the delayed alarm bus at pin 6 of IC81A causes the output of IC81A to go to '1'. This '1' is connected to the alarm logic p.c.b. via interboard wire 'Q' and forward biases TR90 via R93 illuminating LED90, the 'system alarm' l.e.d. R94 provides current limiting for LED90 and develops the potential required by the external mimic and pre-siren signalling unit.

The '1' is coupled directly to pin 5 of IC90C and begins to charge C90 through R91. C90 and R91 form the 'entry delay' timer and have a time constant of 1 minute. If the alarm channel has been wired for an immediate alarm the '1' at the output of IC10B will force the immediate alarm bus to '1' via D11. This '1' will charge C90 via R89 and interboard wire 'r'. The time constant of ten seconds provided by R89 and C90 serves to confuse anyone tampering with the system. The 'immediate alarm' is in fact a 10 second delayed alarm. As the siren will not go off immediately when the system has been tampered with the intruder never knows exactly what he has done to set off the alarm. This anxiety serves to deter any attempt to return and try again. If S80 is switched to defeat at any time the system will abort any sequences in progress and return to its quiescent state. R92 and R99 in conjunction with TR100 provide hysteresis at the inputs of IC90B converting it to a Schmitt trigger. When C90 has charged sufficiently to present a '1' to IC90B the output of IC90B goes to '0'. TR100, R101, and TR101 form a saturated switch with very high gain and very low saturation voltage across TR101. When TR100 is forward biased via R100 it drives TR101 into saturation via R101. When TR101 is conducting, an earth return is provided for the siren and it will begin to wail. D100 absorbs the spikes created by the commutator in the siren.

When C90 presented a '1' to IC90B it also presented a '1' to pin 6 of IC90C. IC90C now has a '1' at both inputs which causes its output to go to '0'. C91 will now begin to discharge into IC90C through R98. C91 and R98 are the 'validation reset' timer and have a time constant of one and a half minutes. In one and a half minutes C91 has discharged sufficiently to provide a '0' to the inputs of IC90D. Several things happen in rapid succession at this point depending on the status of the alarm sensors.

AUTOMATIC RESET

If we look at the sequence of events based on the assumption that the alarm orginally detected is no longer present. Also that, when no alarms are being sensed by any of the other alarm channels and the input of IC90D reaches '0' the output will go to '1'. This is coupled to the 'master reset bus' via D93 and charges C93 immediately. When the 'master reset bus' goes to '1' all of the channel alarm latches are reset to a 'safe' condition which causes the 'delayed alarm bus' to return to '1'. The 'delayed alarm bus' '1' is coupled to pin 6 of IC81A forcing its output to '0'. TR90 will no longer be forward biased so LED90 will extinguish. C90 will discharge into IC81A via R90, R91 and D90. The time constant of R90, R91 and C90 is approximately one second. When C90 has discharged sufficiently to present a '0' to the input of IC90B which forces its output to '1', the saturated switch (TR100 and TR101) will cease to conduct silencing the siren. The '0' at the output of IC81A is also coupled to pin 5 of IC90C which forces its output to '1'. C91 is charged immediately via D92 and presents a '1' to the input of IC90D. The output of IC90D goes to '0'. C92 now discharges into the output of IC81D via R95 and interboard wire 'J'. The time constant of C92 and R95 is approximately 300ms which ensures that the 'master reset bus' remains at '1' long enough to completely clear the charge on C91. In effect, C92 and R95 develop a 300ms 'validation reset' pulse from the output of IC90D. Once the 'master reset bus' returns to '0' the alarm channels are re-activated and will continue to monitor the status of the field sensors.

If the original alarm is still present or if another channel is detecting an alarm when the 'validation reset' pulse is generated, then after the 300ms delay, provided by C92 and R95, has elapsed and the 'master reset bus' has returned to '0', the alarm channel will immediately lock into alarm status. This will pull down the 'delayed alarm bus' to '0' which returns the output of IC81A to '1'. As C90 has only been discharging through D90, R90 and R91 for 300ms as mentioned above, the time constant of R90, R91 and C90 is one second. Therefore, if an alarm is sensed the moment the 'validation reset' pulse ends, C90 will not have had sufficient time to discharge to '0' and silence the siren. The effect of this is that the siren will continue to sound until the source of the alarm is cleared and the 'validation reset' pulse resets the system or until the system is manually reset. The 'validation reset' timer will continuously attempt to reset the system approximately once every minute for as long as the siren continues to run.

As mentioned above, once the 'entry delay' has been initiated, the only way to prevent the siren from going off at the end of the 'entry delay' is to manually defeat the system via S80. Once the siren begins to sound it can also be silenced by manually defeating the system. For the purpose of discussion, let us assume that the system has been activated for some time and you have just entered the premises. The moment you enter the premises the alarm channel which monitors the door you just entered will latch into alarm status and pull down the 'delayed alarm bus' to '0'.

MANUAL REST

If the 'system defeat' switch, S80, is depressed, the following takes place. A '1' is applied to the 'inhibit bus' which disables the 4Hz multivibrator and applies a reset signal to the 'operational' flip-flop (IC80C and IC80D). The 'operational' flip-flop is reset to a stable state with a '1' at the output of IC80C and a '0' at the output of IC80D. The '0' at the output of IC80D dumps any charge that was developed across C90 via D91 and interboard wire 'k'. This pre-empts the 'entry delay' and prevents the siren from sounding by locking the output of IC90B to '1'. The '0' at the output of IC80D also dumps the charge on C83 via D84 and presents a '0' to pin 8 of IC81D. The '1' on the 'inhibit bus' charges C81 via D83 and presents a '1' to pin 1 of IC81B ensuring that its output remains at '0'. The output of IC81C will remain '0'. This results in both inputs of IC81D having '0' conditions. The output of IC81D will now go to '1' which forces the 'reset bus' to '1' via interboard wire 'J'. This '1' resets all alarm latch flip-flops to their 'safe' condition. At this point the entire system is in a power down mode and will ignore the status of all alarm inputs. The only loads on the mains supply will be the charging of the nickel-cadmium batteries and the illumination of the 'power on' l.e.d. The maximum load on the batteries in the event of mains failure will be the negligible 10 microamperes required by the logic.

In summary, placing S80 in the defeat position instantaneously pre-empts any activity in progress, resets all timers, and forces the system into a quiescent state with negligible current demands. The only loads present are placed on the mains supply; should the mains be lost in this mode the system will draw negligible current from the batteries.

NEXT MONTH: CONSTRUCTION

Semiconductor UPDATE...

FEATURING HNVM3008 MM58174 TL011

R. W. Coles

EPROM CHALLENGE

When microprocessor programs have been developed and debugged in RAM, they can then be stored on cassettes or floppy discs for reloading when required, but many systems cannot afford the delay or the expense associated with "backing stores" of this type, and so for them, the speed and simplicity of ROM based software is required.

Read Only Memories come in all shapes and sizes, but the simplest and cheapest, the masked ROM, suffers from the serious disadvantage that the data is programmed in during the manufacturing process, and is thereafter immutable. This type of ROM is OK for software which is tried and tested and for distribution to a large market, but for the one-offs or ten-offs, or for microprocessor software which may still contain elusive "bugs", a less final method of inscribing the stored instructions is required.

Until recently, the most acceptable compromise between tapes and masked ROMs has been the EPROM (Erasable, Programmable, Read Only Memory). Those devices have appeared in three "generations" typified by the 1702A, 2708, and 2716 devices from Intel, with the latest devices being much easier to use and program than their predecessors. Despite the improvements made in recent years, however, the EPROM is still a difficult beast to handle. To erase the stored data, the chip itself must be exposed to dangerous, short wave, Ultra Violet light of high intensity for periods of up to one hour. To programme a single location, a voltage source of 25V or more must be available, and a programme pulse lasting 50 milliseconds must be applied. This means a 2Kx8 2716 device takes about two minutes to program, slow by RAM standards. (To write the same quantity of data into a RAM array would take less than one millisecond.)

Despite these disadvantages, the EPROM is extremely popular and available from numerous manufacturers, but things may start to change now that a new device, the EEPROM is becoming available. The extra "E" stands for "Electrically" making the new chips Electrically, Erasable, Programmable, Read Only Memories. The new technology is a strong candidate to eventually replace the EPROM in most, if not all, of its present applications, and consequently, the race is now on to produce the most successful EEPROM in the hope of fostering the next "Industry Standard."

One notable example of the new technology has recently been introduced by Hughes in the form of the HNVM3008 which is a IKx8 replacement for the popular 2708. The catalogue of desirable features is extensive. Erasure takes not tens of minutes under a UV lamp, but only 100 microseconds and the application of a 17 volt supply in place of the operating supply of 5 volts. Programming is just as easy, requiring the same supply voltage as erase and only 100 microseconds per byte, rather than the 25 volts and 50 milliseconds of the EPROM. The sophisticated HNVM3008 chip uses a mixture of CMOS and NMOS circuitry to gain the very low power consumption of 10 milliwatts (operational) and 25 milliwatts (during programming).

To sweep the field completely, the new EEPROMs must come down in price and go up in capacity, but already they represent a serious challenge to the traditional dominance of the EPROM.

IF YOU WANT TO KNOW THE TIME . . .

Ask an MM58174 from National Semiconductor.

If *you* happen to be a microprocessor, you now have another cheap simple way to tell the time of day and the date. Much better than those awful delay loops which kept you hanging around all day just decremating a register and whizzing round a silly loop without a minute to yourself to do anything really *useful*. That programmer deserved to be shot, treating you just like so much clockwork and wasting all those sophisticated resources tucked away in your logic arrays on nothing more than the creation of a *clock*. It's enough to make you trade in your crystal for a CR timing network! Mind you, it wasn't much better when he discovered interrupts, was it.

Every ten milliseconds. Wham! off you had to go to that sneaky interrupt routine, incremating and decremating counters when you had just settled down to some really serious number crunching. And what a bother, zooming around saving your registers to stop that clock routine getting its grubby hands on them, and then all the fuss of getting them all back off the stack so that you could get on with the *real* job. And how about that awful wet Sunday when he decided to play about with the stack pointer to have data around. Along came that fateful interrupt, and off you went to the clock routine as usual, but when you executed the RETI instruction and tried to POP the return address into your Program Counter, all you got was a branch into the look-up table. It's a wonder you ever got out alive! All *he* has to do is look at his watch when *he* wants to know the time—he doesn't have to spend all day counting the seconds, and no one comes along and kicks him up the backside every minute so that he can cross it off on his time sheet either. No, fellow microprocessors; it is high time that we of the thiking classes were treated with a little more respect, and provided with a proper timepiece, such as the MM58174.

The new device, a programmable real-time clock, should make micros everywhere very happy. It's completely self-contained, it will keep good time even when your micro is switched off for the night, and it is completely independent of the microprocessor while time keeping. Inside the chip, there are twelve count registers, toggling at rates between tenths of a second and tens of months, fed from a crystal timebase of 32·768 KHz. Talking to the clock is easy for the average microprocessor, each of the registers can be read via a four bit data bus so that information on the time of day, day of week, and date is available within a few microseconds. The micro stays boss too. Each of the count registers can be preset via the data bus after a valid address has been set out on the address bus to select it. The device is housed in a 16 pin DIL package, and will operate on less than 10 microamps when the supply voltage is reduced to 2·2V from the normal operating level of 5V.

For those programmers who still insist on interrupts, the MM58174 has an output which can be programmed to generate an interrupt at half second, five second, or one minute intervals, either continuously or on a one-off basis.

ON REFLECTION

A new solution, looking for problems to solve, has arrived from Texas Instruments in the form of a family of Wilson Current Mirrors. Up to now, current mirrors have only existed inside complex analogue integrated circuits where the tight matching of transistors on the same chip made them a possibility for the first time. Texas have decided that it's a shame not to let this useful circuit configuration see the light of day, and so they have produced a family of devices which are true three terminal mirrors, as used in all the best ICs!

They aren't too sure what you are going to do with them yet, they have even started a competition for the best application idea, but to help you on your way, let me say that the one thing the mirror is very good at is generating constant currents. The new devices all provide a constant current output proportional to a reference current input and independent of output voltage or temperature changes. The TLO11 has a fixed input/output current ratio of 1:1, the TLO12 1:2, the TLO14 1:4, and the TLO21 2:1. They'll work with reference currents of up to 1 milliamp (2 for the TLO21) and they come in small three pin transistor packages.

MICRO PROMPT

The hardware and software exchange point for PE computer projects

M/C FOR TELEWRITING

Another method for direct telewriting on the UK101 has been submitted by *T. Wilson* of Sittingbourne, Kent.

First set up in BASIC by pressing C and limiting the memory size.

10 POKE 11, 00 : POKE 12, 5
20 X=USR (X) : P=PEEK (1536)
30 PRINT CHR$ (P) ; : GOTO 20

Then enter machine code by restarting and pressing M. Type in the following:

```
0500 20 00 FD     JSR FD00
0503 8D 00 06     STA 0600
0506 60           RTS
```

Using Warm Start you may now type out all the standard characters, and more, by using CTRL plus a key. Use return and LF to start a new line, and CTRL/C to exit.

CLEAR OFF

SIR—The manual supplied with UK101 kit includes a short machine code routine for clearing the VDU screen. The following routine is shorter, and arranged for the specific task for clearing screen. The manual version is a more general routine for loading any section of memory of any length with a specified data byte.

```
nnnn A9 20       LDA #$20
     A0 00       LDY #$00
     99 00 D0    STA $D000, Y  'fill'
     99 00 D1    STA $D100, Y
     99 00 D2    STA $D200, Y
     99 00 D3    STA $D300, Y
     C8          INY
     D0 F1       BNE 'fill'
```

Michael Wood,
Wakefield.

DREADFUL!

Sir—I am delighted to see that you are devoting space to supporting the UK101, which you published as a series of articles last year.

*There is a need for a good system of data storage for this machine. The SAVE routines published are all very well but they lack sophistication and the other essential—*simplicity!

If one compares a true SAVE operation on other computers, one can only describe these genuine attempts at a solution as a dreadful way to have to carry on, and with only limited commands.

We had mini-floppies, there is a Philips digital cassette recorder, and now the stringy-floppy.

How about an article/series on how to add on one of these to the UK101? For people like me this would preferably be available as a ready-constructed add-on as an alternative to a kit, which would appeal to many readers.

Allan Batch,
Rugby.

EDITOR'S MAILBAG

Sir—Congratulations to Mr. Climpson for the very useful screen editor published in July's Micro Prompt. It gets rid of the cursor on Superboard after CONTROL 0 too, which is quite an achievement!

It had been pointed out that in the list of page zero addresses given by Mr. Hocking in his save-variables program location 0088 is, in fact, the high byte of the current BASIC line number in use and locations 008B, C are the GOSUB pointer.

E. J. Keeley,
National Personal Computer Users Association.

Sir—I have found the Editor program (by Nigel Climpson, in July PE) most interesting and useful, and I wish to thank you for not forgetting the Superboard owners. I have made the following addition to the program to cause it to limit the memory automatically for my 8K machine without the need for remembering the memory size;

50001 POKE 133,184: POKE 134, 30

For a 4K machine the line would be:

50001 POKE 133,184: POKE 134, 14

When saving the program on tape I carried out the following routine:

1. *Type SAVE (Return) LIST*
2. *Start recording (Return)*
3. *When program is completely SAVED do not stop the recorder, but instead* slowly *type RUN (Return)*
4. *When OK appears press return as required to activate the program and then use the Editor itself to copy line 50074, altering the line number to 50000.*
5. *Type LIST (Return), which gives an assurance that only the new line 50000 exists.*
6. *Stop tape recorder.*

To load the program from tape it is only necessary to play back the whole tape. The program is loaded and run, the line is copied and the editor is ready for use. Various error signals are given but all is well as long as the new line appears three times. To activate the editor after a warm start type RUN50000 (Return).

The reason for typing RUN slowly when recording is to give time on playback to stop loading if it is desired to delete line 50076 before use.

For my Superboard I have found that byte 1F65 should be 1C (or 28 decimal in line 50040) to allow the cursor to reach all lines on my screen, and eight Control D's are required to avoid blanks when a line is carried over.

I send you the above information in the hope that most of it is applicable to the UK101 or can easily be adapted for it.

F. S. Dewhurst,
Keighley.

RAMLESS MESSAGES

Sometimes it can be helpful to print messages on tape before a LISTing to give information that does not need to be put into RAM, particularly if a lot of RAM is being used for variables and strings. The problem is that a straight:

PRINT "THIS IS A MESSAGE"

in SAVE mode will be recorded and played back, but there will be an accompanying Syntax Error message which looks tatty. The answer is to start the message with a colon.

PRINT ":THIS IS A MESSAGE"

will play back without a syntax error and will not load into RAM. This means that when the program has been fully developed it can be recorded with additional comments by adding a routine on the lines of the following:

50000 SAVE:?:?:?": THIS IS A MESSAGE ABOUT THE PROGRAM"
50010?": WRITTEN JULY 1980"
etc.
50090 LIST–49999
the program is SAVEd by RUN 50000

The resulting recording will contain the message but not lines 50000 onwards. The colon is also useful for improving the appearance of LISTing, as it can be used instead of REM to produce a blank line for spacing.

A further elegance can be added by getting the Compukit to print "RUN" instead of "OK" at the end of the listing, thus giving you a self running tape. The OK message is printed by a JMP $A8C3 in locations 3,4,5 of the memory. As has been pointed out in the First Book Of Osi, changing the $4C to $60 in location 3 disables the OK, but if instead you put in a jump to your own message routine it will print anything you like. The ROM message printer prints a message which starts at an address loaded into its Y (hi byte) and X (lo byte) registers; the message being terminated by a NULL. Thus, in the routine shown it prints (CR) (LF) RUN (CR) (LF). It is activated by POKE 4,40:POKE 5,2 and will stay activated until COLD start or further POKEs.

Any message is possible provided it is terminated by a Null.

```
0228 AO O2        LDY@$O2; Load
                  address of message
                  (Hi)
022A A9 2F        LDX@$2F ; Load
                  address of message (Lo)
022C 4C C3 A8     JMP $A8C3 ; Message
                  printer from loc. 3,4,5,
022F              .BYTE 13,10,'RUN',
                  13,10,0
022F OD
0230 OA
0231 52
0232 55
0233 4E
0234 OD
0235 OA
0236 OO
```

Roger Derry,
London.

SHIFTY CHARACTERS—2

Sir—Oh dear, nearly a whole column wasted with a table of characters of the keyboard of the 101—a table one can so easily find for oneself by playing with the machine. And, Mr. Schofield has missed the whole point of the Shift Lock. Press it, and all the lower case letters (including k) are available where the upper case used to be. That is the reason, presumably, why the normal position of the Shift Lock is down, as it works in the same mode as a standard typewriter keyboard. Viz. up for lower case and down for upper case. Note also that when it is up, the Shift keys are still operative, so that if you wish to mix l.c. and u.c. (and you probably do!) then your strings are entered exactly as on a typewriter. Care is necessary with digits and punctuation, however.

What I would like to know is what CTRL.O does to disable the keyboard (except for Return) if tapped once. Tapping twice (or holding down) will produce the "large house." CTRL.M gives Return. What, if anything, do other control characters do?

May I conclude by saying how I enjoy reading your magazine. I would like to see some circuits which will enable the 101, the Edukit and similar machines to interface with the real world of temperature sensors, infra-red detectors, electric door locks and so on. As a teacher of Computer Studies it is more important to show pupils how the electronics can move mountains rather than win at games.

G. R. Morris, B.Sc.,
Cheshunt, Herts.

Oh dear, don't blame Mr. Schofield, we foreshortened his original material.

CONVERSION—POKE SOMEWHERE?

Sir—I have followed your series of articles on the COMPUKIT UK101 with great interest as several months ago I purchased an Ohio Superboard—unfortunately just before your series. However, undaunted I set about modifying my Superboard to become a UK 101.

I've now got the machine operating via a sub-board on 50Hz. The sub-board runs on a 8MHz clock and plugs into the original counter chain's i.c.sockets. The other aim was to get 48 characters per line instead of the difficult to read 24.

The problem is that there is something in the firmware that tells each line to only be 24 characters wide, because I now have viz:

Line 1 Line 2
Line 3 Line 4
Line 5 Line 6
etc.

With the help of our Digital Engineer at the T.V. station where I work I've PEEKed and POKEd but without success.

If I purchased the UK 101 Monitor ROM and/or the BASIC ROM('s) would this cure the problem? Or can I POKE somewhere.

B.F. Bailey,
N.S.W., Australia.

INT AINT ACCURACY

The following is an extract from a letter from *Mr. J. Plews* of Sheffield:

"If I combine the truncated integer function with an exponential expression, I begin to get problems where accuracy is vital. eg:

PRINT INT(10/(2 ↑ 1))

The 101 comes back with 4"

● ● ●

"Is there any way of solving this problem by fooling the system etc? Has anyone else encountered this obstacle? Is there any chance of a new interpreter?

I would be interested in your response to this letter."

. . . Help! Actually, if you run your example without INT you *may* find that the 101 is returning 4·99999 etc. Although the result may be as close as a gnat's whisker to the correct figure, you will automatically be ditching this accuracy for the next lowest integer when you implement INT. Any machine would do it! Presumably you don't want all those decimal places.

Try:

```
10 INPUT N
20 PRINT INT(N*10/(2 ↑ 1))/10
```

If N=10 this should return 4·9 . . . a little closer!

Dr. BERK'S UPDATE

Sir—As you requested in your article in Practical Electronics, *March 1980, I would like to let you know that I have carried out your suggested modification to run a 110 baud teletype from the 101 and all the evidence to date would indicate that it is very successful indeed.*

I have made the modification switchable, the teletype being a fairly new Olivetti T.E.300.

Thank you for your most useful and informative articles; I look forward to more of them.

J.R. Haldene,
Midlothian.

NEW ROOM ERROR

Sir—I have unearthed a simple error on the instruction card that accompanies the new UK101 monitor, that nonetheless can cause a lot of difficulty.

The instruction card gives a helpful list of vector addresses and subroutines entries, with Hex and Decimal versions of the addresses. Using these I couldn't get BASIC to set (POKE) my NMI vector and thus couldn't get my data collecting interrupt routine to run during BASIC programs. (All was OK so long as I stuck to machine code in the Monitor.) Although it took quite a while to find, the answer was simple—I had replied on the Decimal addresses on the instruction card, but some of them are wrong. The printed list goes wrong at 021A Hex, listed erroneously as 540, should be 538. Thus NMI vector should go in Decimal 547 and 548 (an IRQ in 550 and 551) and not as printed on the card. The Hex addresses given on the card seem to be perfectly correct. The monitor seems to function well in every respect.

N. Blurton Jones,
University of London.

ARRAY OR DISARRAY?

Sir—I write with reference to a point raised in your March issue, within "Microprompt". The point to which I refer is: ?FRE(N) after running part, or whole of a program containing a DIM statement for a string variable array. e.g. DIMA$(10).

The way to avoid the UK101 "locking up" is to type: CLEAR:?FRE(N).

This clears all variables and arrays. It does of course prevent you from finding out how much memory is occupied by variables or arrays used.

As a matter of interest, numerical values ocupy 6 bytes. Within an array they occupy only 4 bytes, plus an overhead for the whole array, which is dependant upon whether it is 1-, 2-, or 3-dimensional. The overheads for 1-, 2-, and 3-dimensional arrays are 13, 21 and 29 bytes respectively. For example, an array dimensioned with DIMX(9,9) will hold 10 × 10 = 100 variables. It would therefore occupy 100 × 4 plus the overhead of 21 = 421 bytes.

This is true when some values have been assigned to all dimensions. An empty array overhead is 6 bytes less per dimension. For instance, the same array X, above, would have an overhead of only 21 − 12 = 9 bytes whilst empty, or 21 − 6 = 15 bytes with one dimension empty. (Why some one should dimension an array and leave it empty I dont know!)

Each string variable occupies the same number of bytes as characters it contains with an overhead of 6 bytes. How much room a string variable array occupies I do not yet know!

I hope this is of some interest. Finally, I would like "Microprompt" to be larger and in every issue. Certainly not Bi-monthly!

E. Cottam,
Par, Cornwall.

GETTING INTO PRINT PROBLEM

Sir—A short while ago I bought a second-hand Data Dynamics 390 ASCII printer. In spite of the fact that I was assured by the vendor that it was easy to link up to my UK101 (new MONITOR), I have been unable to find out how to do so. The only information that I have is that the printer requires an eleven bit word (one start bit, two stop bits, eight data bits) and that it has a current loop input and works at 110 Baud.

If any of your readers can help me to get the printer working, I should be most grateful.

Alan E. Wilmshurst,
Crowborough,
E. Sussex.

It should be emphasised that material presented in Prompt has not necessarily been proven by us. Neither can compatability with *all generations* of the computer equipment to which it relates be guaranteed.

Software and hardware designs submitted should be accompanied by a declaration to the effect that it is the original work of the undersigned, and that it has not been accepted for publication elsewhere.

BASIC LINE RENUMBER

This program will renumber a UK101 BASIC program, or part of a program up or down. It will not, however, alter GOTO or GOSUB line numbers. The program can be loaded at any time when programming, and is brought into operation by typing RUN 20000. It is useful to use to "space out" part of a program to allow extra lines to be inserted. To understand the operation of the program, the workings of the BASIC interpreter, in particular, how it stores data in RAM, needs explaining.

```
20000 REM*** LINE RENUMBERER FOR UK101 *********
20010 REM*** I. PAWSON FEBRUARY 1980 ***************
20020 INPUT"RENUMBER OLD LINES FROM";X
20030 INPUT"THROUGH TO";Y
20040 IFX)YTHEN20020
20050 INPUT"AS NEW LINE NUMBERS FROM";Z
20060 INPUT"IN STEPS OF";P
20070 B=256
20080 DIMN(100,2)
20090 N(1,1)=769
20100 FORT=1TO100
20110 A=N(T,1)
20120 N(T+1,1)=PEEK(A+1)*B+PEEK(A)
20130 N(T,2)=PEEK(A+3)*B+PEEK(A+2)
20140 PRINTN(T,2);N(T,1)
20150 IFN(T,2)=YTHEN20170
20160 NEXT
20170 FORT=1TO100
20180 A=N(T,1)+2
20190 IFN(T,2)(XTHEN20240
20200 POKEA,Z-INT(Z/B)*B
20210 POKEA+1,INT(Z/B)
20220 Z=Z+P
20230 IFN(T,2)=YTHEN20250
20240 NEXT
20250 PRINT:PRINT
20260 PRINT"RENUMBERING COMPLETED"
20270 REM*** END OF PROGRAM *********************
OK
```

As the program is in BASIC, all numbers are in decimal. The data is stored from address 769 onwards; the first two locations are the address of the start of the next line. The format is that the second location contents are multiplied by 256 and added to the contents of the first location. The following two locations contain the line number, in the same format as the address. The contents of the line follow, terminated by a 0. The commands, GOTO, GOSUB are stored as a single number, 136 and 140. The line number following is stored in ASCII format, ie 100 as 49 48 48, 200 as 50 48 48 and so on. The main problem, in adapting the program to renumber GOTO's and GOSUB's would be if the new line number had more or less digits than the previous one. This program is presented as a starting point for a complete renumberer, and I should be interested in readers' comments. Line 20140 can be omitted if a print-out is not required.

I. Pawson, Leicester

PEVDU KEMITRON STYLE

Because the Thompson-CSF CRTC chip is really intended for use in serial or "glass teletype" terminals, and is therefore equipped with its own rather slow cursor control system, problems can arise when attempting to use the PE VDU to best advantage as a memory-mapped VDU. As is mentioned briefly in part 3 of the PE VDU article, if a monitor program which generates its own cursor in software is to be used, the cursor control lines $C_0C_1C_2$ are best permanently set to 0, and an initial pulse applied to the ST line (Fig. 4, part 3). This can be easily achieved if the ST line is wired to the reset circuit of the MPU. However, this is not the whole story. We are now left with a flashing character and cursor line at the top left-hand corner of the screen. The cursor line is generated by the CRTC disabling the character generator at the appropriate time, and therefore this can be removed by breaking the track joining pin 15 of the CRTC to pin 11 of the 2513, and permanently grounding the latter.

This leaves the 2513 permanently enabled. To avoid the flashing character in the top left hand corner, the output routines in the interpreter or monitor used can be arranged to ignore completely the extreme left-hand column of the screen, while the clear-screen routine must of course include this column. This is the system adopted in the Kemitron NIBL-MM-memory mapped BASIC interpreter for the SC/MP, one version of which is specially configured to work with the PE VDU—though the principles described above could of course be incorporated in any interpreter or monitor program for any processor.

Details of the Kemitron system can be obtained from Greenbank Electronics, or the Chester Computing Centre, 21–23 Charles Street, Chester.

JUST A LITTLE SOMETHING . . .

```
100 REM*** 8 DIGIT BINARY TO
    DECIMAL CONVERT ***
110 REM*** I. PAWSON DEC
    1979 ***************
120 PRINT:PRINT
130 INPUT "INPUT 8 BIT
    BINARY NUMBER"; A$
140 IFLEN(A$) ><8THEN100
150 B=0
160 FORX=1TO8
170 Y$=MID$(A$,X,1)
180 READA
190 C=VAL(Y$)
200 B=B+(A*C)
210 NEXT
220 PRINT
230 PRINT "THE DECIMAL VALUE
    IS"; B
240 RESTORE
250 PRINT
260 GOTO130
270 DATA128, 64, 32, 16, 8, 4, 2, 1
280 REM*** END OF PROGRAM
    *******************
```

LINE LENGTH HINTS

Sir—T. D. Allen of Poole wants to display 64 characters per line on his TV from a UK101. He has a problem! The suggestions that he makes are all based on software but the problem is mainly in the hardware.

As far as the software is concerned, changes must be made to a ROM in program locations FFE0 and FFE1, cursor starting point and line length respectively.

The main problem is physically displaying the characters. The VDU RAM is scanned as 16 lines of 64 characters with TV horizontal sync pulses added at the end of every line. As everybody knows, a few characters are not displayed at each end of the line. What is not often said is that more characters are lost during the fly-back of the TV trace and these can never be displayed.

The write-up in the UK101 book about VDU operation explains that clock pulse C7 is not used and the result is that every row of dots is displayed twice. The logical conclusion is that using C7 instead of C6 to generate the horizontal sync should give a line twice as long with the 2 rows of dots side-by-side instead of one on top of the other. Putting the right values into FFE0 and FFE1 (try BF and 3F) should then enable a complete set of 64 locations to be displayed, assuming that you can adjust and/or modify the TV as necessary. Display on a normally adjusted TV would not be possible.

You will have gathered that I have not tried this and there may well be problems, although the theory sounds good. It should at least give food for thought.

R. L. Taylor,
Shepperton,
Middlesex.

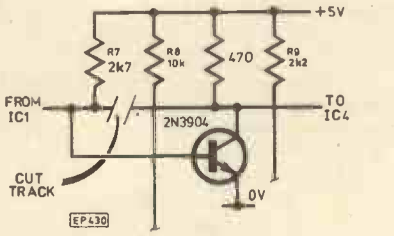
PSG BUG

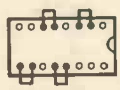
We received correspondence from *Mr. Gossage* of Harrow, Middlesex, pointing out an error in the address decoding of the PSG:

"It is stated that the Hex address used is FØFØ. On the UK1Ø1 the whole 256 word block from FØØØ to FØFF is used as the ACIA location—the two addresses are repeated throughout the page and so cannot be used by the PSG. Secondly, however, the circuit given will not show only at FØFØ but appear at many addresses from ØØCØ upwards. Inspection reveals that IC1 is not acting as an 8 input NAND gate but as a 4-wide 2-input NAND OR gate—the output going low when any pair of inputs go high."

"The circuit will apparently work since it is, in effect, 'write only memory' and so although it appears at many memory locations it will not interfere with the micros use of the RAM."

The author, Mr. D. Coutts, has provided a fix for this, and apologises for the error: Change IC1 to 74LS09 (same pin-outs), and add 2N3904 transistor and 470Ω resistor as shown below. This gives the PSG one address





only, and requires minimal interference to the p.c.b. Our correction to Fig. 8, is inlcluded too. Also, Mr. Gossage suggests transposing address lines A7 and A8 to place the PSG at F17Ø and F171—away from the ACIA.

RESIDENT EDITOR

BY NIGEL CLIMPSON

MOST owners of microcomputers would be pleased if, for minimal hardware changes, they could provide themselves with an extra 1000 or so bytes of ROM storage. Into these 1000 bytes could be placed favourite machine code programs or perhaps some system software to extend the capabilities of their machines. These programs would of course be available from switch-on and be permanently stored.

This can be done for the UK101, but of course there is a snag. You will have to obtain a single supply 2716 EPROM and find some means of programming it.

The secret of this miraculous amount of available space lies in the Monitor ROM. Examination of the contents of the ROM discloses that it contains two almost identical sections at addresses in the ROM of 000-3FF and 400-7FF where 000 is located in the machine's memory map at F800. The major differences in the two sections are that some of the jumps are to different addresses, and that one of the sections contains a routine to clear 2K of video memory as against 1K in the other.

The UK101 only uses one of these two sections and I suspect that this comes about due to the machine's OSI heritage.

The point of all this is that we can dispose of the contents of the ROM from 000-3FF and the UK101 still works quite happily. It should be possible to gain a bit more space if you don't have a disc drive by removing part of the floppy bootstrap which runs from 400-4D4, but beware because some of the subroutines in this section are called from other areas of the Monitor.

```
000   98 48 AC F9 02 AD F8 02 91 F9 88 CE F9 02 20 3B
010   F9 68 A8 A9 00 60 4C 00 F8 98 48 20 45 F9 AC F9
020   02 A9 23 91 F9 EE F9 02 D0 02 E6 FA C8 20 3B F9
030   68 A8 A9 00 60 CA 10 04 E8 4C 99 A3 8A 48 98 48
040   AC F9 02 AE 00 02 AD FA 02 F0 05 AD F8 02 91 F9
050   A9 20 9D 00 D3 CA 88 CE F9 02 CE 00 02 A9 9A 9D
060   00 D3 CE F6 02 AD FA 02 F0 03 20 3B F9 68 A8 68
070   AA A9 00 60 20 BA FF C9 15 F0 1A C9 1C F0 36 C9
080   04 F0 96 C9 02 F0 8F C9 06 F0 6F C9 0D F0 50 20
090   1D F9 4C 99 A3 38 98 48 AD FA 02 F0 08 AC F9 02
0A0   AD F8 02 91 F9 EE FA 02 AD FA 02 C9 10 F0 1F C9
0B0   01 D0 06 AD 00 02 8D F9 02 AD F9 02 E9 40 B0 02
0C0   C6 FA 8D F9 02 A8 20 3B F9 68 A8 A9 00 60 A9 00
0D0   8D FA 02 A9 D3 85 FA AD 00 02 8D F9 02 D0 E6 A9
0E0   00 8D FA 02 85 F9 A9 D3 85 FA A9 20 8D F8 02 A9
0F0   CD 8D F6 02 8D F9 02 A9 0D 60 98 48 20 45 F9 AD
100   F8 02 AC F9 02 91 F9 8D F7 02 C8 EE F9 02 D0 02
110   E6 FA 20 3B F9 68 A8 AD F7 02 4C 99 A3 48 AD 00
120   02 CD F6 02 10 0D 38 AD F9 02 E9 40 B0 02 C6 FA
130   8D F9 02 AD 00 02 8D F6 02 68 60 B1 F9 8D F8 02
140   A9 9A 91 F9 60 A9 48 C5 0F D0 08 AD F9 02 E9 30
150   4C 58 F9 AD F9 02 E5 0F C9 0C F0 10 C9 4C F0 0C
160   C9 8C F0 08 C9 CC F0 04 20 1D F9 60 48 AC F9 02
170   A9 20 91 F9 68 18 69 40 90 02 E6 FA 8D F9 02 20
180   1D F9 60 A9 00 85 E1 A8 A9 D0 85 E2 A9 20 91 E1
190   C8 C0 00 D0 F9 A6 E2 E0 D3 F0 06 E8 86 E2 18 90
1A0   ED 60 AD 06 F4 88 D0 05 CE F5 02 F0 09 CA D0 F5
1B0   AE F4 02 4C A2 F9 60 FF FF FF FF FF FF FF FF FF
1C0   FF FF 20 5E FA C9 3B F0 13 C9 24 D0 F5 20 3F FA
1D0   8D 24 02 20 3F FA 8D 23 02 4C 6C FA A9 00 8D 23
1E0   02 8D 24 02 20 2C FA AA 20 2C FA 85 FA 20 2C FA
1F0   85 F9 8A 48 A2 00 20 2C FA 81 F9 68 AA E6 F9 D0
200   02 E6 FA CA D0 EC 20 3F FA CD 24 02 D0 08 20 3F
210   FA CD 23 02 F0 AC A0 00 B9 74 FA F0 06 20 EE FF
220   C8 D0 F5 20 61 FA C9 47 D0 F9 F0 96 20 3F FA 18
230   6D 23 02 8D 23 02 90 03 EE 24 02 AD 22 02 60 20
240   42 FA 20 5E FA C9 41 90 02 E9 07 29 0F 0A 0A 0A
250   0A A0 04 2A 2E 22 02 88 D0 F9 AD 22 02 60 A9 80
260   2C A9 00 8D 03 02 20 BA FF 4C 5E FF A9 00 8D 03
270   02 6C 23 02 0D 0A 0A 4F 42 4A 20 43 48 45 43 43
280   53 55 4D 20 45 52 52 0D 0A 52 45 57 49 4E 44 20
290   50 41 53 54 20 45 52 52 20 2D 20 54 59 50 45 20
2A0   47 20 54 4F 20 52 45 53 54 41 52 54 00 C9 4C D0
2B0   03 4C 7C FE C9 51 F0 03 4C 39 FE 4C C2 F9 A9 BA
2C0   8D 18 02 A9 FF 8D 19 02 4C 00 FE FF FF FF FF FF
```

and then FFs until . . .

Of course you can't change the contents of the existing ROM and that is where the 2716 single supply EPROM comes in.

HARDWARE CHANGES

Assuming you have programmed the new ROM with the half of the Monitor you need to keep and with your own programs, now you need to make the hardware changes. To ensure that the 2716 is enabled properly some minor modifications need to be made to the computer's circuit board, and this is made slightly harder than necessary by the fact that the ROM addressing cir-

EDITOR-IN-MONITOR ROM

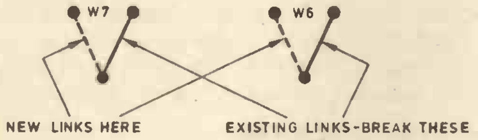
```
3F0   FF FF FF FF FF FF FF FF FF FF FF FF FF FF FF FF
400   20 0C FC 6C FD 00 20 0C FC 4C 00 FE A0 00 8C 01
410   FF 8C 00 C0 A2 04 8E 01 C0 8C 03 C0 88 8C 02 C0
420   8E 03 C0 8C 02 C0 A9 FB D0 09 A9 02 2C 00 C0 F0
430   1C A9 FF 8D 02 C0 20 A5 FC 29 F7 8D 02 C0 20 A5
440   FC 09 08 8D 02 C0 A2 18 20 91 FC F0 DD A2 7F 8E
450   02 C0 20 91 FC AD 00 C0 30 FB AD 00 C0 10 FB A9
460   03 8D 10 C0 A9 58 8D 10 C0 20 9C FC 85 FE AA 20
470   9C FC 85 FD 20 9C FC 85 FF A0 00 20 9C FC 91 FD
480   C8 D0 F8 E6 FE C6 FF D0 F2 86 FE A9 FF 8D 02 C0
490   60 A0 F8 88 D0 FD 55 FF CA D0 F6 60 AD 10 C0 4A
4A0   90 FA AD 11 C0 60 A9 03 8D 00 F0 A9 11 8D 00 F0
4B0   60 48 AD 00 F0 4A 4A 90 F9 68 8D 01 F0 60 49 FF
4C0   8D 00 DF 49 FF 60 48 20 CF FC AA 68 CA E8 60 AD
4D0   00 DF 49 FF 60 C9 1C F0 03 4C 74 A3 CA 10 04 E8
4E0   4C 59 A3 8A 48 AE 00 02 A9 20 9D 00 D3 CE 00 02
4F0   CA A9 9A 9D 00 D3 68 AA 4C 59 A3 FF FF FF FF FF
500   8A 48 98 48 A9 01 20 BE FC 20 C6 FC D0 05 0A D0
510   F5 F0 53 4A 90 09 2A E0 21 D0 F3 A9 1B D0 21 20
520   C8 FD 98 8D 13 02 0A 0A 0A 38 ED 13 02 8D 13 02
530   8A 4A 20 C8 FD D0 2F 18 98 6D 13 02 A8 B9 CF FD
540   CD 15 02 D0 26 CE 14 02 F0 2B A0 05 A2 C8 CA D0
550   FD 88 D0 F8 F0 AE C9 01 F0 35 A0 00 C9 02 F0 47
560   A0 C0 C9 20 F0 41 A9 00 8D 16 02 8D 15 02 A9 02
570   8D 14 02 D0 8F A2 96 CD 16 02 D0 02 A2 14 8E 14
580   02 8D 16 02 A9 01 20 BE FC 20 CF FC 4A 90 33 AA
590   29 03 F0 0B A0 10 AD 15 02 10 0C A0 F0 D0 08 A0
5A0   00 E0 20 D0 02 A0 C0 AD 15 02 29 7F C9 20 F0 07
5B0   8C 13 02 18 6D 13 02 8D 13 02 68 A8 68 AA AD 13
5C0   02 60 D0 92 A0 20 D0 DF A0 08 88 0A 90 FC 60 D0
5D0   BB 2F 20 5A 41 51 2C 4D 4E 42 56 43 58 4B 4A 48
5E0   47 46 44 53 49 55 59 54 52 45 57 00 00 0D 5E 4F
5F0   4C 2E 00 1C 2D BA 30 B9 B8 37 B6 35 34 B3 32 B1
600   A2 28 9A D8 EA EA EA EA EA EA EA EA A2 D4 A9 D0
610   85 FF A9 00 85 FE 85 FB A8 A9 20 91 FE C8 D0 FB
620   E6 FF E4 FF D0 F5 84 FF F0 19 20 E9 FE C9 2F F0
630   1E C9 47 F0 17 4C AD FA EA 20 93 FE 30 EC A2 02
640   20 DA FE B1 FE 85 FC 20 AC FE D0 DE 6C FE 00 20
650   E9 FE C9 2E F0 D4 C9 0D D0 0F E6 FE D0 02 E6 FF
660   A0 00 B1 FE 85 FC 4C 77 FE 20 93 FE 30 E1 A2 00
670   20 DA FE A5 FC 91 FE 20 AC FE D0 D3 85 FB F0 CF
680   AD 00 F0 4A 90 FA AD 01 F0 EA EA EA 29 7F 60 00
690   00 00 00 C9 30 30 12 C9 3A 30 0B C9 41 30 0A C9
6A0   47 10 06 38 E9 07 29 0F 60 A9 80 60 A2 03 A0 00
6B0   B5 FC 4A 4A 4A 4A 20 CA FE B5 FC 20 CA FE CA 10
6C0   EF A9 20 8D 62 D1 8D 63 D1 60 29 0F 09 30 C9 3A
6D0   30 03 18 69 07 99 5E D1 C8 60 A0 04 0A 0A 0A 0A
6E0   2A 36 FC 36 FD 88 D0 F8 60 A5 FB D0 93 4C 00 FD
6F0   74 F8 69 FF 9B FF 8B FF 96 FF 30 01 00 FE C0 01
700   D8 A2 28 9A A0 0A B9 EF FE 99 17 02 88 D0 F7 20
710   A6 FC 8C 12 02 8C 03 02 8C 05 02 8C 06 02 AD E0
720   FF 8D 00 02 A9 20 99 00 D3 99 00 D2 99 00 D1 99
730   00 D0 C8 D0 F1 B9 5F FF F0 06 20 2D BF C8 D0 F5
740   20 BA FF C9 4D D0 03 4C BE FA C9 57 D0 03 4C 00
750   00 C9 43 D0 03 4C 11 BD C9 44 D0 A4 4C 00 FC 44
760   2F 43 2F 57 2F 4D 20 3F 00 20 2D BF 48 AD 05 02
770   F0 22 68 20 B1 FC C9 0D D0 1B 48 8A 48 A2 0A A9
780   00 20 B1 FC CA D0 FA 68 AA 68 60 48 CE 03 02 A9
790   00 8D 05 02 68 60 48 A9 01 D0 F6 AD 12 02 D0 19
7A0   A9 FE 8D 00 DF 2C 00 DF 70 0F A9 FB 8D 00 DF 2C
7B0   00 DF 70 05 A9 03 4C 36 A6 60 2C 03 02 10 19 A9
7C0   FD 8D 00 DF A9 10 2C 00 DF F0 0A AD 00 F0 4A 90
7D0   EE AD 01 F0 60 EE 03 02 4C 00 FD FF FF FF FF FF
7E0   CD 2F 00 00 03 FF 9F 00 03 FF 9F 6C 18 02 6C 1A
7F0   02 6C 1C 02 6C 1E 02 6C 20 02 30 20 00 FF C0 01
```

cuit given in the COMPUKIT manual is not strictly accurate. The circuit changes are shown in Fig. 1 and are also described.

1) Locate pads W6 and W7. When I received my machine I had to cut the tracks on W6 and W7 and rewire them in the opposite sense to enable the standard Monitor ROM properly. For a 2716 these must be returned to their original state. This is because the 2716 requires a low on pins 18 and 20 to enable it.

2) Pin 21 is the naughty one. It is shown in the manual as being held at +5V. On my machine at least it was not, but instead was strapped to pin 20 with a circuit board track. This means its

Fig. 1.



logic level goes up and down with pin 20 which is okay for the Standard ROM but stops a 2716 from working. It is necessary to cut this track and take it to +5V.

Now, as to what to fill those 1000 or so empty holes with is up to you. As an example this is how I partially filled mine.

EDITOR

The screen editor that was published in the July Microprompt now resides at ØØØ-182 with the necessary address changes and an extension to compensate for terminal width. By changing two bytes at 6FØ and 6F1 to 74 and F8 the EDITOR works immediately BASIC is called from RESET.

A rapid clear screen routine is located at 183-1A1, and 1A2-1B6 contain a program to generate tones of selectable frequency and duration through a small decoding circuit and speaker.

Finally a checksum loader occupies locations 1C2-2BD. This is very useful for loading and executing programs saved in checksum format from the Extended Monitor or Assembler/Editor. With all this there is still about 3ØØ bytes to spare in the ROM so what next? Maybe a Renumberer or a Disassembler or a . . .?

This system has been working in my machine for about three months now and I haven't noticed any ill effects from the missing bits, and since the cost of 2716 EPROMs is continually falling you may consider it a worthwhile thing to do. ★

News Briefs

BRAINS AND BRAWN

BEWARE, the intelligent public telephone is on the way! The Plessey designed PP2000 payphone might not only have a higher IQ than its user, it will probably prove tougher too—should it come to blows.

Vandal-proof, fraud-proof, the stainless steel machine is said to be capable of withstanding an attack with a sledge hammer, chisel or crowbar. So far so good, but the microprocessor controlled creep doesn't hit back, it secretly sends out a 999 call.

Up to 80,000 of the "public call office" versions are expected to be in use in the UK *before* 1985 (1984 again). These telephones are honest. If you insert coins to the value of 60 pence for a long distance call, the machine will not only display digitally your diminishing credit as the call progresses, but should you hang up with, say, 10 pence still on the clock, it will refund the difference.

The PP2000 payphone is powered entirely from the telephone line, is very flexible in the face of rate increases or coinage changes, and informs the post office when the cash box is nearly full; and with that kind of versatility Plessey believe they should be able to grab a good share of the estimated overseas market of £50m p.a.

The PP2000 is a microprocessor controlled payphone developed by Plessey engineers at Liverpool

AND THERE'S MORE WHERE THIS CAME FROM

It's a long time since one of our adverts was presented in 'list' form - but simply because we do not try to squeeze this lot in every time doesn't mean that it's not available. Our new style price list (now some 40 pages long) includes all this and more, including quantity prices and a brief description. The kits, modules and specialized RF components - such as TOKO coils, filters etc. are covered in the general price list - so send now for a free copy (with an SAE please). Part 4 of the catalogue is due out now (incorporating a revised version of pt.1).

LINEAR ICs - NUMERIC LISTINGS

TBA120S 1.00
L200 1.95
U237B 1.28
U247B 1.28
U257B 1.28
U267B 1.28
LM301H 0.67
LM301N 0.30
LM308H 0.96
LM308N 0.65
LM339N 0.66
LM348N 1.86
LF351N 0.38
LF353N 0.76
LM374N 3.75
LM380N-14 1.00
LM380N-8 1.00
LM381N 1.81
ZN419CE 1.95
NE544N 1.80
NE555N 0.30
NE556N 0.50
NE560N 3.50
NE562N 4.05
NE564N 4.29
NE565N 1.00
NE566N 1.60
NE570N 3.85
SL624 3.28
TBA651 1.81
uA709HC 0.64
uA709PC 0.36
uA710HC 0.65
uA710PC 0.59
uA741CH 0.66
uA741CN 0.27
uA747CN 0.70
uA748CN 0.36
uA753 2.44
uA758 2.35
TBA810AS 1.09
TBA820M 0.75
TCA940E 1.80
TDA1028 2.11
TDA1029 2.11
TDA1054 1.45
TDA1062 1.95
TDA1072 2.69
TDA1074A 5.04
TDA1083 1.95
TDA1090 3.05
HA1137 1.20
HA1196 2.00
HA1197 1.00
TDA1220 1.40
LM1303 0.99
LM1307 1.55
MC1310P 1.90
MC1330 1.20
MC1350 1.20
HA1370 1.90
HA1388 2.75
TDA1490 1.86
MC1496P 1.25
SL1610P 1.60
SL1611P 1.60
SL1612P 1.60
SL1613P 1.89
SL1620P 2.17
SL1621P 2.17
SL1623P 2.24
SL624C 3.28
SL1625P 2.17
SL1626P 2.44
SL1630P 1.62
SL1640P 1.89
SL1641P 1.89
TDA2002 1.25
TDA2020 3.00
ULN2242A 3.05
ULN2283B 1.00
CA3080E 0.70
CA3089E 1.84
CA3090AQ 3.35
CA3123E 1.40
CA3130E 0.80
CA3130T 0.90
CA3140E 0.46
CA3189E 2.20
MC3357P 2.35
LM3900N 0.60
LM3909N 0.68
LM3914N 2.80
LM3915N 2.80
KB4400 0.80
KB4406 0.60
KB4412 1.95
KB4413 1.95
KB4417 1.80
TDA4420 2.25
KB4420B 1.09
KB4423 2.30
KB4424 1.65
KB4431 1.95
KB4432 1.95
KB4433 1.52
KB4436 2.53
KB4437 1.75
KB4438 2.22
KB4441 1.35
KB4445 1.29
KB4446 2.75
KB4448 1.65
NE5044N 2.26
NE5532N 1.85
SD6000 3.75
SL6270 2.03
SL6310 2.03
SL6600 3.75
SL6640 2.75
SL6690 3.20
SL6700 2.35
ICL8038CC 4.50
MSL9362 1.75
MSL9363 1.75
HA11211 1.95
HA11223 2.15
HA11225 1.45
HA12002 1.45
HA12017 0.80
HA12402 1.95
HA12411 1.20
HA12412 1.55
LF13741 0.33
SN76660N 0.80

FREQUENCY DISPLAY & SYNTHESISER ICs

SAA1056 3.75
SAA1058 3.35
SAA1059 3.35
11C90DC 14.00
LN1232 19.00
LN1242 19.00
MSL2318 3.84
MSM5523 11.30
MSM5524 11.30
MSM5525 7.85
MSM5526 7.85
MSM5527 9.75
MSM55271 9.75
ICM7106CP 9.55
ICM7107CP 9.55
ICM7216B 19.25
ICM7217A 9.50
SP8629 3.85
SP8647 6.00
95H90PC 6.00
HD10551 2.45
HD44015 4.45
HD12009 6.00
HD44752 8.00

CMOS 4000 SERIES

4001 0.17
4000 0.17
4002 0.23
4008 0.80
4009 0.58
4010B 0.58
4011AE 0.20
4011B 0.20
4012 0.55
4013 0.55
4015 0.95
4016 0.52
4017 0.80
4019 0.60
4020B 0.93
4021 0.82
4022 0.90
4023 0.17
4024 0.76
4025 0.17
4026 1.80
4028 0.72
4029 1.00
4030 0.58
4035 1.20
4040 0.83
4042 0.85
4043 0.85
4044 0.80
4046 1.30
4047 0.99
4049 0.52
4050 0.55
4051 0.65
4052 0.65
4053 0.65
4063 1.09
4066 0.56
4068 0.25
4069 0.20
4070 0.20
4071 0.20
4072 0.20
4073 0.20
4075 0.20
4076 0.90
4077 0.20
4078 0.20
4082 0.20
4093 0.78
4175 0.95
4503 0.69
4506 0.51
4510 0.99
4511 1.49
4512 0.98
4514 2.55
4518 1.03
4520 1.09
4521 2.36
4522 1.49
4529 1.41
4539 1.10
4549 3.50
4554 1.53
4560 2.18
4566 1.59
4568 2.18
4569 3.03
4572 0.30
4585 1.10

TTL N and LSN

7400N 0.13
74LS00 0.20
7401N 0.13
74LS01 0.20
7402N 0.14
74LS02 0.20
7403N 0.14
74LS03 0.20
7404N 0.14
74LS04 0.24
7405N 0.18
74LS05 0.26
7406N 0.28
7407N 0.38
7408N 0.17
74LS08 0.24
7409N 0.17
74LS09 0.24
7410N 0.15
74LS10 0.24
7411N 0.20
74LS11 0.24
7412N 0.17
7413N 0.30
7414N 0.51
74LS15 0.24
7416N 0.30
7417N 0.30
7420N 0.16
74LS20 0.24
7421N 0.29
74LS21 0.24
7423N 0.27
7425N 0.27
7427N 0.27
74LS27 0.44
7428N 0.35
74LS28 0.32
7430N 0.17
74LS30 0.24
7432N 0.25
74LS32 0.24
7437N 0.40
7438N 0.33
74LS38 0.24
7440N 0.17
74LS40 0.24
7441N 0.74
7442N 0.70
74LS42 0.99
7443N 1.15
7444N 1.12
7445N 0.94
7446N 0.94
74LS47 0.89
7448N 0.56
74LS48 0.99
74LS49 0.99
7451N 0.17
74LS51 0.24
7453N 0.17
7454N 0.17
74LS54 0.24
74LS55 0.24
7460N 0.17
74LS63 1.24
7470N 0.28
7472N 0.28
7473N 0.32
74LS73 0.38
7474N 0.27
74LS74 0.28
7475N 0.38
7476N 0.37
74LS76 0.38
74LS78 0.38
7480N 0.48
7481N 0.86
7482N 0.69
7485N 1.04
74LS85 0.99
74LS86 0.40
7489N 2.05
7490N 0.33
74LS90 0.90
7491N 0.76
74LS91 1.10
7492N 0.38
74LS92 0.78
7493N 0.32
74LS93 0.99
7494N 0.78
7495N 0.65
74LS95 1.14
7496N 0.58
74LS96 1.20
7497N 1.85
74LS107 0.38
74109N 0.63
74LS109 0.70
74110N 0.54
74111N 0.68
74LS112 0.38
74LS113 0.38
74LS114 0.38
74118N 0.83
74120N 1.15
74121N 0.42
74122N 0.46
74123N 0.73
74LS124 1.75
74125N 0.38
74LS125 0.44
74126N 0.57
74LS126 0.44
74128N 0.74
74132N 0.73
74LS132 0.78
74LS136 0.40
74LS138 0.60
74141N 0.56
74142N 2.65
74143N 3.12
74144N 3.12
74LS145 0.97
74147N 1.75
74148N 1.09
74LS148 1.19
74150N 0.99
74151N 0.55
74LS151 0.84
74153N 0.64
74LS153 0.54
74154N 0.96
74155N 0.54
74LS155 1.10
74156N 0.80
74157N 0.67
74LS157 0.55
74LS158 0.60
74159N 2.10
74160N 0.82
74LS160 1.30
74161N 0.92
74LS161 0.78
74LS162 1.30
74163N 0.92
74LS163 0.78
74164N 1.04
74LS164 1.30
74165N 1.05
74LS165 1.04
74167N 2.50
74LS169 2.00
74170N 2.30
74LS170 2.00
74LS174 1.20
74175N 0.87
74LS175 1.10
74176N 0.75
74177N 0.78
74181N 1.65
74LS181 3.50
74LS183 2.10
74184N 1.35
74185N 1.34
74LS190 0.92
74192N 1.05
74LS192 1.80
74193N 1.05
74LS193 1.80
74194N 1.05
74196N 0.99
74LS196 1.10
74LS197 1.10
74198N 1.50
74199N 1.60
74LS247 0.93
74LS257 1.08
74LS260 1.53
74LS279 0.52
74LS283 1.20
74LS293 0.95
74LS365 0.49
74LS366 0.49
74LS367 0.43
74LS368 0.49
74LS374 1.80
74LS377 1.95
74LS379 1.30
74LS393 1.40

VARICAP TUNING DIODES

BA102 0.30
BA121 0.30
ITT210 0.30
BB204B 0.36
BB105B 0.36
BB109 0.27
MVM125 1.05
BB212 1.95
KV1210 2.45
KV1211 1.75
KV1226 1.95
KV1225 2.75
KV1215 2.55
KV1225 2.75

SWITCHING AND PIN DIODES

SHOTTKY DIODES

1N6263 0.62
BA182 0.19
BA244 0.17
BA379 0.35
TDA1061 0.95

SIGNAL DIODES & RECTIFIERS

1N4148 0.06
1N4001 0.06
1N4002 0.07
1N5402 0.15
OA91 0.07
AA112 0.25
BRIDGES:
1A/50V 0.35
6A/200V 0.75

TRANSISTORS

AUDIO DEVICES

BC237 0.08
BC238 0.08
BC239 0.08
BC307 0.08
BC308 0.08
BC309 0.08
BC413 0.10
BC414 0.11
BC415 0.07
BC416 0.08
BC546 0.12
BC556 0.12
BC550 0.12
BC560 0.12
BC639 0.22
BC640 0.23
2SC1775 0.18
2SA872A 0.14
2SD666A 0.30
2SB666A 0.30
2SD668A 0.40
2SB648A 0.40
2SD760 0.45
2SB720 0.45
2SC2546 0.19
2SA1084 0.20
2SC2547 0.19
2SA1085 0.20

AUDIO POWER DEVICES

2SB753 2.34
2SB723 2.34
2SK133 3.00
2SJ 48 3.00
2SK134 3.10
2SK135 3.75
2SJ 50 3.75
BD535 0.52
BD536 0.52
BD377 0.33
BD378 0.33
BD165 0.30
BD166 0.31

SMALL SIGNAL RF DEVICES

BF194 0.18
BF195 0.18
BF224 0.22
BF241 0.18
BF274 0.18
BF440 0.21
BF441 0.21
BF362 0.49
BF395 0.18
BF479 0.66
BF679S 0.55
BFR91 1.33
BFW92 0.60
BFT95 0.99
BFY90 0.90
40238 0.85

RF POWER DEVICES

VN66AF 0.95
2N3866 0.85

SMALL SIGNAL RF FET/MOSFET

BF256 0.38
2SK55 0.28
2SK168 0.35
J310 0.69
J176 0.65
40823 0.65
40673 3SK51
3SK45 0.49
3SK51 0.54
3SK60 0.58
MEM680 0.75
BF961 0.70
BF960 1.24
3SK48 1.64

CAPACITORS
All 5mm or less spacing

CERAMIC 50v
2P2,3P3,4P7,6P8
8P2,10P,15P,18P..0.04
22P,27P,33P,47P
56P,68P,82P,100P.0.05
150P,220P,270P
330P,390P,470P...0.055
1N0,2N2,3N3,4N7..0.06
10N (0.01uF)....0.05
22N,47N.........0.06
100N,220N........0.09
MONOLITHIC CERAMIC
10N,100N.........0.16

FEEDTHRU
1N0 SOLDER IN....0.09

POLYESTER (SIEMENS)
10mm LEAD SPACING
10N,22N,33N......0.17
47N,68N,100N.....0.19
220N,470N........0.22
1uF..............0.29

POLYESTER (GENERAL)
10mm LEAD SPACING
10N,15N,22N,33N..0.06
47N,68N,100N.....0.08
220N.............0.11
20mm LEAD SPACING
220N,330N,470N...0.18

MYLAR
5mm LEAD SPACING
1N0,10N,22N,33N..0.08
100N.............0.09
20mm LEAD SPACING
220N,470N....... 0.17

POLYSTYRENE
10P,15P,18P,22P,
27P,47P,56P,68P..0.08
100P,180P,220P,
270P,330P,390P...0.09
470P,680P,820P...0.10
1N0,1N2,1N5,1N8..0.11
2N2,2N7,3N3,3N9..0.12
4N7,5N6,6N8,10N..0.13

TANTALUM BEAD CAPS
16v: 0.22,0.33,
0.68,1.0.........0.18
16v: 2.2,4.7,10..0.19
6v3: 22,47.......0.30
10v: 22,100......0.35

ALUMIN ELECTROLYTICS RADIAL (VERT. MOUNT)
(uF/voltage)
1/63,2.2/50,4.7/35
10/16,15/16,22/10
33/6.3...........0.08
22/16,33/10,
47/10............0.09
10/63,22/50,33/50,
47/16,100/16.....0.10
47/63,100/25,220/16
470/6.3..........0.12
100/63,470/16,
1000/10..........0.18
1000/16,470/63...0.23
1000/63,2200/16..0.30
3300/25..........0.69
1000/100.........0.88
10000/70.........3.00
AXIAL (HORIZ. MOUNT)
1/25,4.7/16,6.4/25
10/16............0.08
4.7/63,22/10,22/16
33/16............0.09
47/25,100/16.....0.10
100/25...........0.11
1000/16..........0.25
2200/16,1000/25..0.36
1000/35,4700/16..0.45
1000/50..........0.58

RESISTORS
0.25W, 5% E12 CARBON
1ohm-10M.........0.02
0.25W 1% E12 METAL FILM
1.1ohm-1M........0.05
HORIZ CARBON PRESETS
10mm TYPE
100ohms-2M5......0.12
HORIZ CERMET PRESETS
1k, 10k..........0.27

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3rd OT 30pF HC25U 1.65
FM TX :-
Fund 20pF HC25U 1.85
Pairs FM 3.25
Pairs AM 3.10

CRYSTALS

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100kHZ 3.85
455kHZ 5.00
1.0MHz 3.00
3.2768MHz 2.70
4.000MHz 2.00
4.19439MHz 2.30
6.5536MHz 2.10
10.0MHz 2.50
10.6985MHz 2.50
10.7015MHz 2.50
10.245MHz 2.50
10.7MHz 3.00
11.52MHz 2.50
100MHz 3.00

LEDs

5MM RED 0.12
3MM RED CLEAR 0.15
3MM RED 0.15
2.5 X 5MM RED 0.17
5MM GREEN 0.15
3MM GN CLEAR 0.16
3MM GREEN 0.16
2.5 X 5MM GN 0.20
5MM YELLOW 0.15
3MM YELLOW CL 0.16
3MM YELLOW 0.18
2.5 X 5MM YE 0.20
5MM ORANGERED 0.20
5MM ORA CL 0.29
3MM ORANGERED 0.19
2.5 X 5MM ORA 0.24
5MM INFRA RED 0.56
BPW41 IR DET 1.51
IR OPT CPLR 1.44
5MM CLIP 0.04

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FRANK W. HYDE

FALSE ALARMS

A number of false alarms have been detected recently in the American security networks which monitor possible attacks. It seems that the computers are in fact the culprits. There is a move to replace them because they now seem to be 'prone' to such mistakes.

Unfortunately there are other areas of definite danger of false alarms which are not so easily avoided. It is even more disturbing that the source of the false information was from the Vela satellite. It has taken ten months to solve the problem recorded in September 1979 and known as the 'event' of September 22. The task of the Vela satellites was to specifically monitor nuclear blasts. A statement released recently by the Department of Defence said that the 'event' was a nuclear blast. On the same day the official report of the panel of scientists, set up by the White House, was released and stated that the 'event' was probably not a nuclear explosion.

The panel set up by the White House was briefed to determine if the flash of light seen by the United States Vela satellite was or was not a nuclear blast. The work of the panel was carried out using computers and other relevant equipment in non government departments. The data examined and rechecked had the result that from the data over ten years the 'event' of September 22 differed from all the nuclear blasts recorded in one vital particular. This essential feature was 'that the light recorded by the two detectors on board differed'. If the detectors were in fact recording a nuclear blast, this would be at a great distance and therefore the two detectors would have recorded equal light intensity. As it turned out the records showed, in the case of 'event' September 22, that there was a difference in intensity.

The explanation therefore must be that the effect was caused by some happening. The pattern of the recordings were significantly different from that expected from a nuclear explosion near the surface of the Earth. Such anomalous behaviour was never observed in the 'Bhangmeter' recordings. The name Bhangmeter is given to the special recordings that are made of such incidents. There were similarities even to the characteristic 'double hump' profile. The panel came to the final conclusion that this particular event could be common to a number of other similar events.

The panel of investigators also compared the September 'event' with signals from thousands of incidents from the Vela spacecraft and others. These data included astronomical events, ordinary lightning, superbolt lightning, sunlight reflections from other spacecraft, sunlight reflections from meteorites near the satellites in regular orbits, and sunlight reflected from particles ejected from meteorites on collisions with spacecraft. Finally it was to be concluded that the last item, particles ejected from meteoroids, fitted the facts.

The investigation, apart from the reassurance, that, so far as the nuclear blast was concerned a false alarm was raised, held a bonus. Previous unexplained light flashes from the recordings of Pioneer 10, on its way to Jupiter, as it passed through the asteroid belt. Collisions with small particles showed these light flashes. Such an event could be statistically expected from a Vela spacecraft once every ten years. A wider conclusion of data from all sources available leads to the conclusion that there was no corroborative evidence. The data included radioactive fallout, seismic signals and such incidents. There is a lesson here perhaps. Snap decisions are very dangerous and that all spacecraft should be under surveillance. Self monitoring would seem to be one solution. We have the technology.

THE VIKING MISSION

The Viking 1 Orbiter has run out of fuel. After four years circling the planet Mars, it has now been shut down. No more signals will be returned to Earth. However the Viking 1 lander will continue to operate and will be sending information back to Earth until 1994 according to present information.

The Viking 1 lander was the first spacecraft to land on another planet and continue sending data for more than a few minutes. It was launched from Earth on August 20, 1975 and arrived at Mars on June 19, 1976. The Viking 1 lander touched down on the surface the next day. The next mission Viking Orbiter 2 and Viking lander 2 was launched on September 9, 1975 and arrived at Mars on August 1976. The Viking 2 lander searched for a suitable landing place for almost a month before making its descent on September 3, 1976. Viking 2 Orbiter ran out of fuel on July 25, 1978 and the lander was turned off by control on April 12, 1980.

This leaves the Viking 1 lander operating on the surface of Mars at the Chryse Planitia 22·3 deg. North, 48·0 deg. West. The extension of the Mars mission beyond the four month period expected has proved more successful than was originally anticipated. The two spacecraft with their landers sent back more than 54,000 photographs of Mars and its two satellites. Each photographic frame contained twenty times more information than the previous Mariner mission in 1971. The two Viking landers took 4,500 pictures which included high resolution pictures and stereoscopic pictures of the landing sites. The result of this mission is that 97% of the planet has now been mapped.

No organic molecules were detected. This does not necessarily mean that there is no life on Mars only that none was found at the landing sites. All the same it seems now very remote that there is life of a kind that our technology could recognise. Carbon dioxide was already known, so also was oxygen and water but in addition nitrogen, argon, neon, krypton and xenon were found in the atmosphere. The elements suggest that the Martian atmosphere must have been much denser in the past. The soil of the planet is similar to iron-rich clay.

Weather at the north site was much more variable than that at the southern site which was 20 degrees south. Here there were cyclones and weather fronts with ground frost. The highest temperature at the south site minus 31 deg. centrigrade and the lowest predawn temperature at the northern site was minus 124 centrigrade. It is still thought that under the sandy soil there exists an overall coverage of permafrost containing water which could be released if the surface got warm enough. There is considerable data to be studied particularly the geological conditions. This will occupy teams for several years.

LATE NOTE

Using the Goldstone radar antenna the operational team have detected water just below the surface of Mars in an area called Solis Lacus. They suggest that it lies 0·5–1 metre below the surface over an area 480km by 960km. It is possible that there is a kind of pool, possibly of wet sand or a pool of soil. The observations which led to this conclusion were based on the changing reflection of the surface as the temperature changed.

THE SUN

Confirmation that the Sun has increased its energy output since the last solar minimum is now certain. The increase, a little under a half of one per cent, is significant. This is given in a report from the team at Lowell University. The principal person concerned is G. W. Lockwood. In the period of the solar minimum he suggested that there was evidence to show that the increase of the energy of the Sun could be determined by the increase in brightness of the planets and their satellites. The results of the work since 1976 has confirmed that Lowell was right. The satellites of Jupiter, Io, Europa and Callisto, together with the satellite Rhea of Saturn, have been monitored continuously since 1976 and now provides further confirmation that the Sun is a variable star.

Another major event came from the concentration of astronomers from 18 counties on a particular region of the Sun. Two large flares appeared on the Sun and each was on the limb. This enabled the maximum data to be recorded. The Solar Maximum Mission Satellite was also involved. All seven of the instruments aboard were in operation at the same time, so again maximum data was available.

PE

TELETEXT with INFRA-RED REMOTE CONTROL

David Shortland

PART 4... WIRING AND TESTING

AFTER all the p.c.b.s have been constructed, carefully check each board against its component layout. Also check that all the joints have been soldered and there are no solder splashes shorting out any of the tracks.

A suitable layout for the case is shown in Fig. 4.1. Do not fit any of the p.c.b.s until all the case drilling has been completed. Make sure there are no pieces of swarf either in the case or on any of the boards before they are fitted into position. The UHF sockets should be mounted first and the p.s.u. board then fitted to the rear of the case. The two voltage regulators should be bolted directly to the case and then the transformer, mains switch, fuse and neon fitted. The three voltage rails should be checked before any connections are made to the system.

The decoder board holes should be drilled next and then the tuner board which is mounted above the decoder drilled. The tuner board is mounted using aluminium strips, formed as shown in Fig. 4.1, taking care that the top of the VSM, VDM and tuner do not protrude above the top of the case. The front panel must also be drilled to allow the four tuning pots to protrude.

The video summer board holes can be drilled next and then the receiver board mounted on the front panel with a hole drilled for the infra-red detector diode.

With all the case holes drilled the wiring between the boards can now be carried out. A complete wiring diagram of the system is shown in Fig. 4.2. Wiring and testing problems will be simplified if ribbon cable is used.

Using co-ax cable, solder the two UHF sockets; one should go to the tuner and the other to the modulator. The connections for the tuner and modulator are to the pins on the side of the components with the earth braid soldered onto each case.

BUFFER MODIFICATION (5050)

The F1 output (pin 20) from the SAA5050 TROM chip should be buffered as shown in Fig. 4.3 to ensure correct operation under all conditions. The resistor and transistor for the buffer can be soldered directly onto the decoder board as shown in Fig. 4.3.

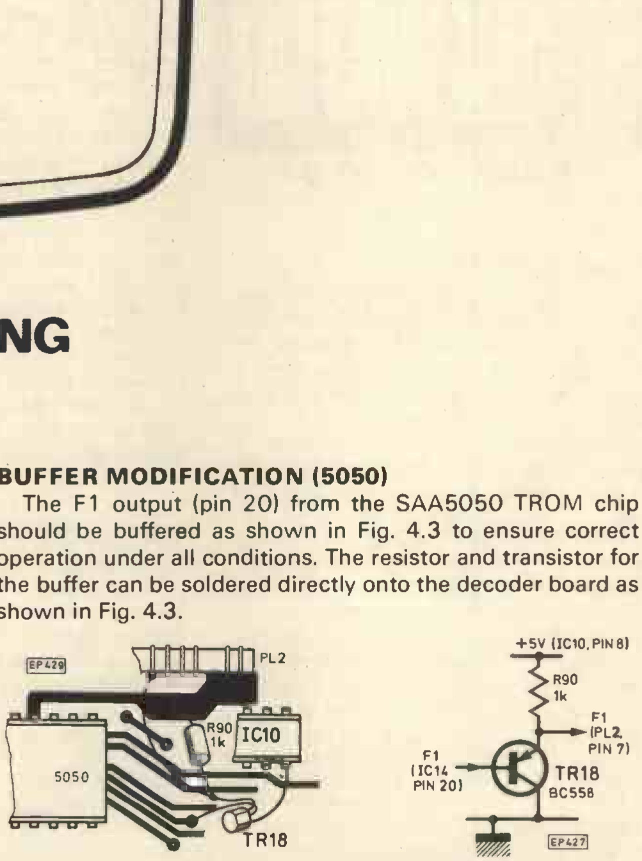


Fig. 4.3. Buffer circuit modification for the decoder board. It may be necessary to increase the length of the leads of TR18 using tinned copper wire. Resistor R90 should be soldered to plug PL2 with the daughter board removed

TESTING

Before all the p.c.b.s are finally fitted into position the wiring should be very carefully rechecked. It is very important that the power supply rails to each p.c.b. are carefully checked. Take care that the daughter board is plugged in the right way round. Also check the three wire links on the daughter board. If everything is correct switch the unit on and check the supply rails on each p.c.b. If all the rails are correct, switch the system off and using two co-ax leads connect the aerial to the tuner via the UHF socket and the TV to the modulator via the other UHF socket.

With the TV switched on and tuned to channel 36, switch

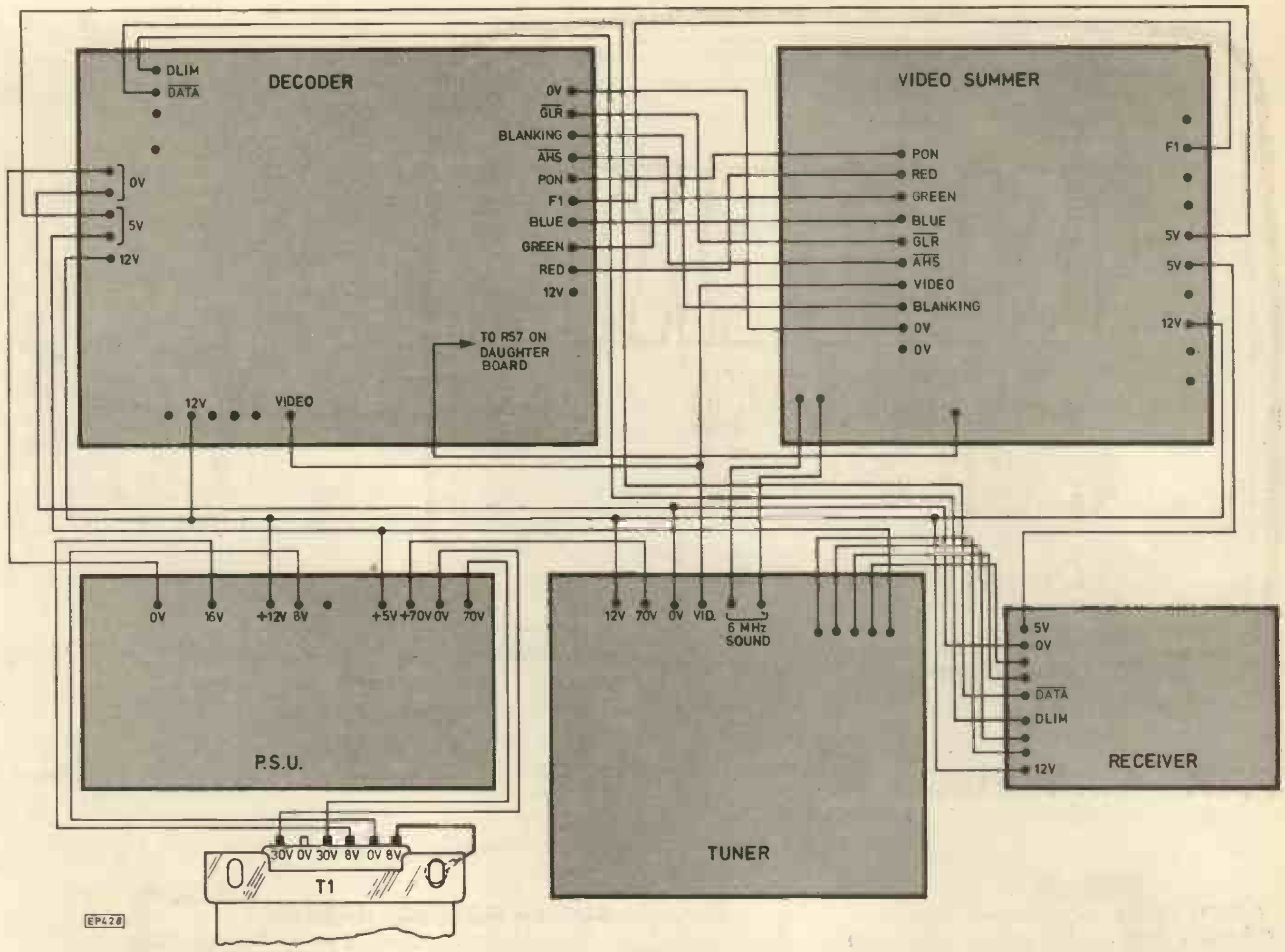


Fig. 4.1. Wiring diagram for the complete system. Note the annotation of plug PL3 on the decoder board was shown incorrectly in Fig. 2.4 (F1 was omitted)

the system on. It should be possible to adjust the BBC1 tuning pot to obtain a picture. If there are any problems, the video output of the tuner board can be taken directly to the modulator on the video summer board. This will enable the tuner board to be set up if there are any problems with the decoder or video board adjustments. With the tuner adjusted using the setting up procedure given in Part 2 for the best picture available, remove the link to the modulator.

It should be possible to obtain a reasonable picture with the tuner correctly set up, which will allow the video summer board to be adjusted. (See Part 3.)

When the system is first switched into the telextext mode page 100 of the Ceefax magazine should be displayed. If there are any problems with the remote control circuits the output from IC1 pin 16 can be directly wired to the base of TR6 on the receiver unit, by-passing the infra-red link.

The audio section of the system has been designed around the TBA120S. The volume can be controlled by VR9 and the Quad coil L6 should be adjusted for the best sound reproduction.

TUNING POTENTIOMETERS

The tuning potentiometer VR2 should be adjusted for BBC1, VR3 for BBC2 and VR4 for ITV. This will ensure the correct channel is displayed when the channel is changed or the status button pressed.

CORRECTIONS

The p.c.b. layout for the tuner board which was shown in Fig. 2.3 is incorrect. The 4050 (IC3) buffer is a 16 pin not a 14 pin device. The correct design for the tuner board is shown in Fig. 4.4.

ALIGNMENT OF THE TELETEXT DECODER

The teletext board is supplied ready aligned and should require no adjustment. In the event of incorrect or no data being received, inspection of the remote control and i.f. sections of the receiver should be carried out first. These adjustments do not affect the actual display of characters on the TV screen. The four adjustments on the board are designed to take up tolerances in the SAA5030 and should therefore only be changed if the SAA5030 on the board is replaced. They should be carried out in the following order.

1. Field Sync. Adjustment. Using a scope, look at the video input to the decoder and the voltage on pin 13 of the SAA5030, adjust the 10kΩ potentiometer until the leading edge of the pulse on pin 13 is 48±5µs from the field sync. datum (the beginning of the first broad pulse as shown in the diagram).

2. Crystal Frequency Adjustment. A 5–65pF trimmer capacitor in series with the crystal adjusts the free running frequency of the oscillator. Connect pin 1 of the SAA5030 to +12V so that the oscillator free runs and connect a 5M6

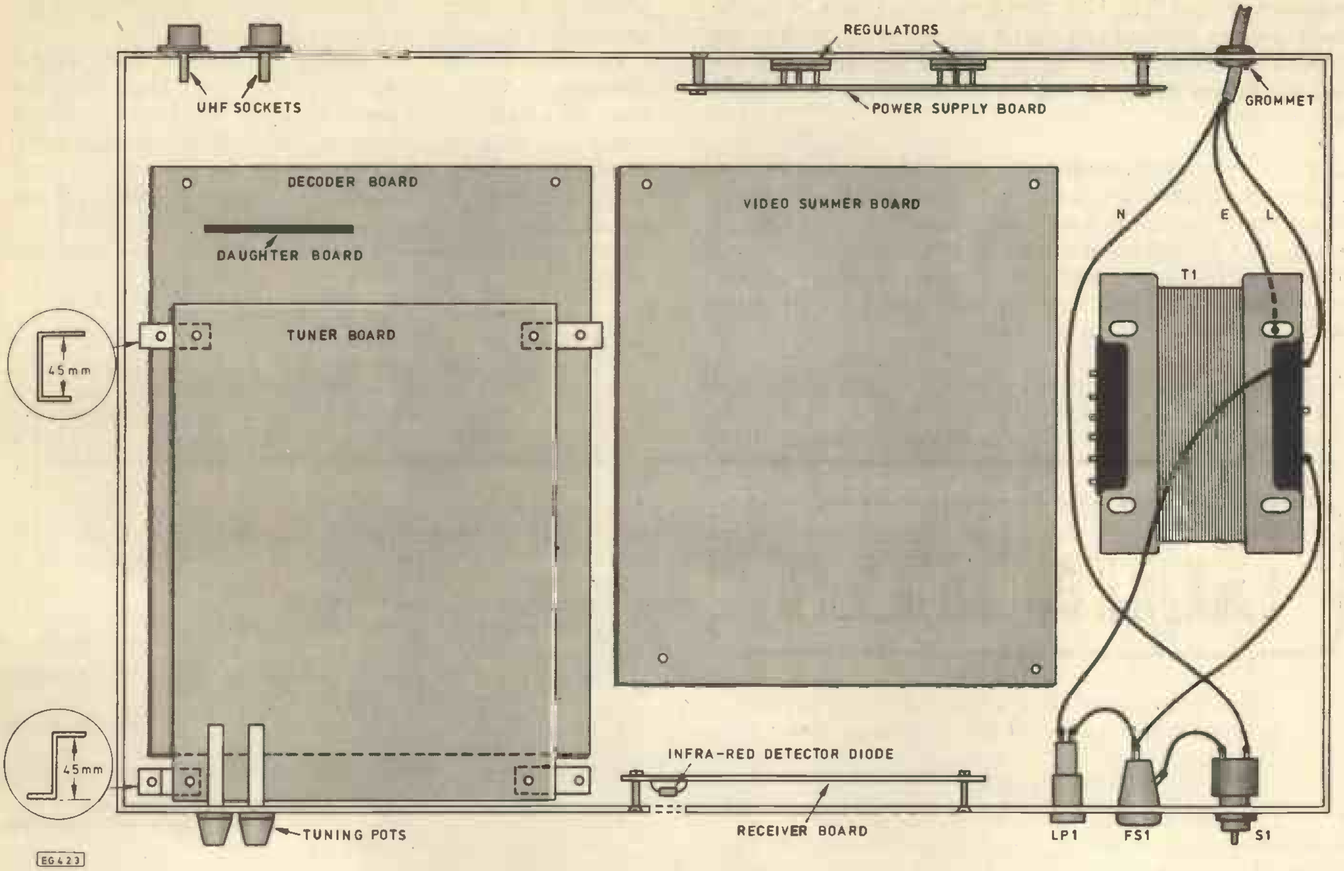


Fig. 4.2. Internal layout of the case

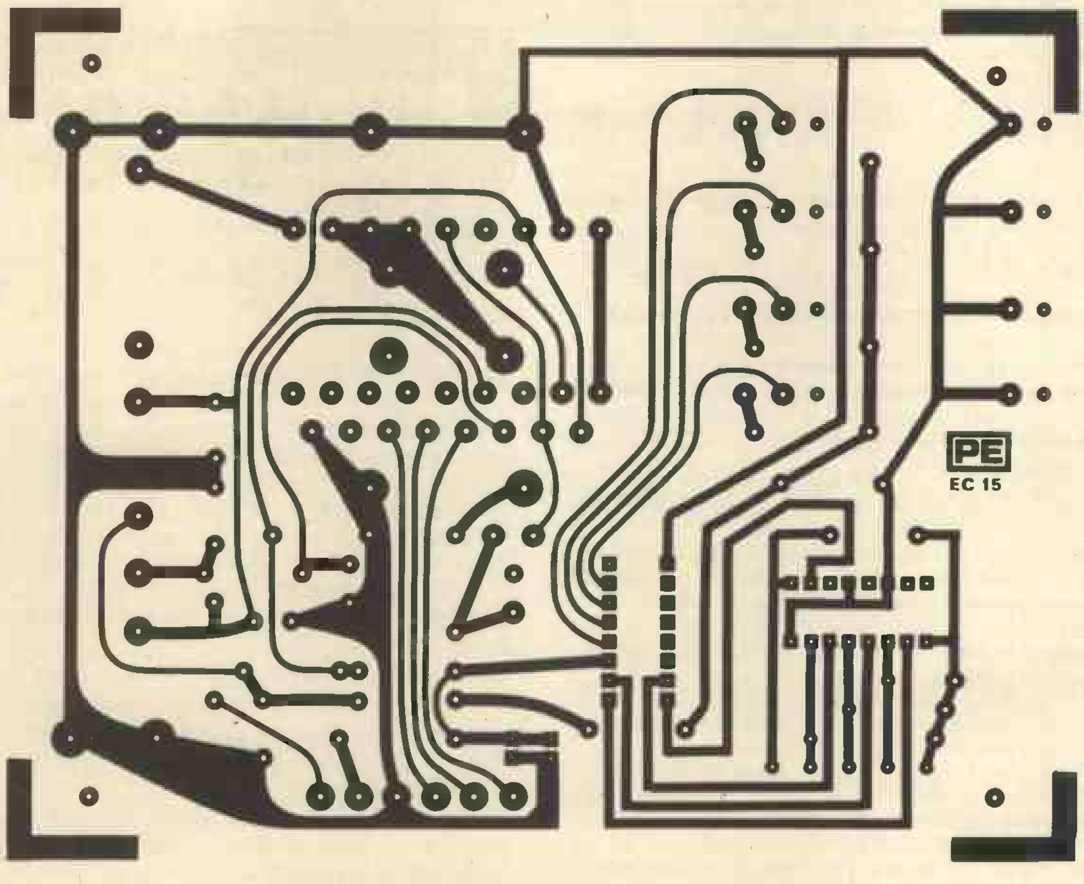


Fig. 4.4. Corrected p.c.b. design for the Tuner board

resistor from pin 7 to 12V. Using the scope, look at the incoming video and the sandcastle waveform on pin 5 at the SAA5030. The trimmer should now be adjusted until the two signals are stationary relative to each other. Remove the link and resistor.

3. Clock Phase Adjustment. Pin 20 of the SAA5030 may have a 33µH choke and a 5–65pF trimmer connected to it. This trimmer is used to adjust the phase of the data clock to ensure that the teletext data is latched at the optimum time. If for some reason the SAA5030 is replaced, these components should be removed and replaced with a 1nF capacitor connected from Pin 20 to ground.

4. Clock Coil Adjustment. As stated earlier, the clock coil is pre-aligned using specialised test equipment and cannot be correctly set-up without such equipment. However, if the SAA5030 is changed for some reason, it can be aligned approximately by using the following procedure.

Put the decoder in teletext mode and call up the Engineering Clock-Cracker' page. This is a special test page used for assessing the performance of the data clock. Now rotate the clock coil core clockwise until the decoder starts to make mistakes. Note this position. Rotate the core anticlockwise until the decoder makes mistakes again. Note this position. Set the core midway between the two marks. This should correspond to approximately one turn out from fully screwed in.

ACKNOWLEDGEMENTS

The author would like to thank Luke Theodossiou, who designed the Tuner circuit, for his help and assistance with the overall design, also Ian Stuchbury, who developed the Video Summer, for his helpful comments. ★

Countdown

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

Semiconductor International 80 Nov. 25–27. Metropole Convention Centre. **T1**
BEX 80 Nov. 26–27. Exhibition Centre, Bristol. **K**
Breadboard Nov. 26–30. Royal Horticultural Halls, Westminster. **T**
BEX 81 Feb. 4–5. Pavilion, Bournemouth. **K**
Microsystems 81 (exhibition and conference) March 11–13. Wembley Conf. Centre, London. **Z1**
INSPEX 1981 March 16–20. NEC, Birmingham. **Z1**
Seminex 81 (seminars only) March 23–27. Imperial College, London. **H1**
BEX 81 March 25–26. Metropole, Brighton. **K**
The Northern Electronic Test & Measurement Exhibition 81 March 31–April 2. Wythenshawe Forum, Manchester. **T**
BEX 81 April 8–9. Centre Hotel, Liverpool. **K**
All Electronics Show 81 April 22–24. Grosvenor Ho., Park Lane, London. **F1**
Computer Graphics 1981 April 28–30. The Barbican Centre, London. **O**
BEX 81 April 29–30. Dragonara Hotel, Leeds. **K**
Entertainment 81 May 9–17 (weekday mornings trade only). NEC, Birmingham. **B2**
The European Consumer Electronics Show 81 May 10–13, Nuremburg Fair Centre, W. Germany. (Trade) **I**
BEX Train May 11–22. Calling at: Cambridge, Norwich, Leicester, Sheffield, Newcastle, Middlesbrough, Hull, Nottingham, Reading and Portsmouth. **K**
Defence Components Expo 81 May 12–14. Brighton Metropole. **I**
Semlab 81 June 2–5. Grand Hall, Olympia, London. The international scientific, educational, medical and industrial laboratory equipment exhibition. (Trade) **I**
Transducer Tempcon 81 June 9–11. Wembley Conf. Centre, London. **T**
Components 81 (Electronic Components Industry Fair) June 9–12. Earls Court, London. This show will alternate yearly with Electronics, now that the IEA amalgamation with Electrex has ceased. **I**
International Word Processing Exhibition & Conf. 81 June 23–26. Wembley Conf. Centre, London. **Z**
Solar Energy Exhibition Aug. 23–28, 1981. Brighton. **M**
International Business Show 81 Oct. 20–29. NEC, Birmingham. **A2**
Electronics 82 (Sub-titled International Electronics Control and Instruments Exhibition) May 24–28, 1982. NEC. **I**

I Industrial Trade Fairs. ✆ 021-705 6707
K Douglas Temple Studios, 1046 Old Christchurch Road, Bournemouth
M Montbuild. ✆ 01-486 1951
O Online Conferences. ✆ 0895 39262
T Trident International Exhibitions. ✆ 0822 4671
H1 Seminex Ltd. ✆ 0892 39664
T1 Kiver Communications UK, Millbank House, 171/185 Ewell Road, Surbiton, Surrey KT6 6AX.
Z1 IPC Exhibitions Ltd., 40 Bowling Green Lane, London EC1R 0NE. ✆ 01-837 3636
A2 Hart Browne & Curtis Ltd., 29 Sackville Street, Piccadilly, London W1X 1DR. ✆ 01-439 8556
B2 Brintex Exhibitions Ltd., 178-202 Great Portland Street, London W1N 6NH. ✆ 01-637 2400

POINTS ARISING

MICRO PROMPT *(September 1980)*

The short m/c program under "Error Message Error" should read:

7F	**and not**	7A
4C		AC
2D ✓		2D ×
BF		BF

PROGRAMMABLE SOUND GENERATOR *(September 1980)*

Line 60 of the "Random Sound" program should read:

Y = INT(RND(7)* 15): etc.

Also, see Micro Prompt for details of a decoding fix for the PSG.

MAGNUM METAL LOCATOR *(Sept 80)*

The p.c.b. shown on page 53 is not same size. A correctly sized one is available on application.

PE DIAMATIC *Update*

J.R.W.AMES
W.L.BLYTH

Overcoming problems that might have arisen in this popular design

MANY constructors are successfully using 'Diamatic' (published in *PE* Nov. 79 and now available *PE* **Popular Projects**) units both with two identical projectors and with two projectors of different model or manufacture. In a small number of cases though, problems have arisen when different projectors are used. This article describes the causes of the two problems and the way in which they can be overcome.

PHASE ERRORS

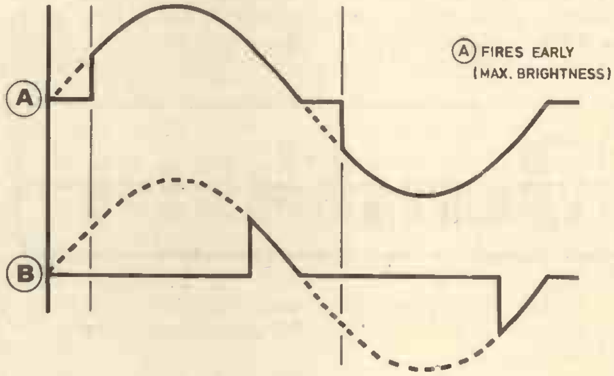
The Diamatic will not function correctly if there is a large phase difference between the 24 volt supplies of the two projectors although it is very unusual to find such a phase error because of the resistive load presented to the transformers by the projector bulbs. In some projectors however, the fan motor is connected auto-transformer fashion to the transformer primary and this highly inductive load causes a phase shift which appears on the secondary winding. Since the phase reference for both of the triac dimmers is taken from only one of the projectors—projector B—the lamp in projector A can behave in an unpredictable manner, especially at the extreme ends of the dimmer range.

The fault usually shows up when projector A is at its brightest and can result in a sudden switch to half power or even completely dark at the extreme end of the control range or when the 'Change' button is pressed. In this instance the triac in projector A is being fired very early in the mains cycle (Fig. 1a) and if A lags B firing can occur very close to the end of the previous cycle (Fig. 1b). The results of this change in the firing instant are not easy to predict, especially when the phase error is small and the firing pulses overlap the zero crossing.

EARTHING PROBLEMS

Some projectors have internal circuitry which is tied to earth, hence the lamp supply is not fully floating and when the centre rail of the Diamatic power supply is earthed large currents can flow causing damage to components in either the projector or the Diamatic. Clearly these problems can only occur if projector B from which the Diamatic derives its power supply, has a three core mains lead fitted as standard. If either of your projectors has a two core lead then use this as projector B and you will have a fully floating supply. If neither has a two core lead then it is safest to use a separate 24V transformer to power the Diamatic. RS Components transformer No. 207-201 is suitable for this purpose. Remove the wire leading to SK2 pin 10 and connect this to one side of the 24V supply, connect the other side to the junction of D3,D5 and R1, first having broken the track between here and TR201.

This will use the transformer to provide both power and phase reference. Provided no phase error problems are introduced this is a complete answer to earthing problems.



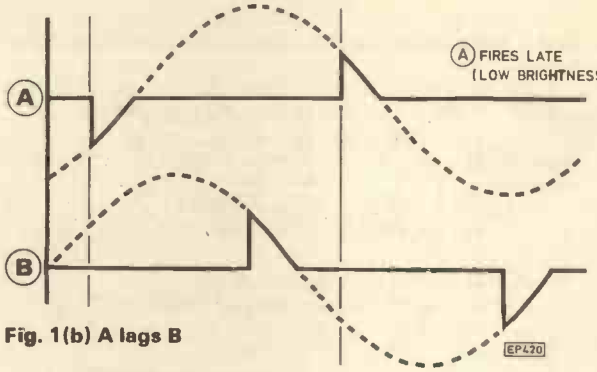


Fig. 1(b) A lags B

A NEW PHASE REFERENCE

If it is necessary to derive a separate phase reference for projector A or if the phase reference derived from the separate transformer is not satisfactory a method has to be found of generating a phase reference from the projector without introducing or reintroducing earthing problems. The simplest method is to use an opto-coupler. Inside this is an l.e.d. which illuminates the base of a phototransistor; when the l.e.d. is turned on the output transistor conducts without any physical connection being necessary. Signals can therefore be passed between two circuits at very different potentials with respect to earth, modern devices can offer a breakdown voltage of 2500V or more.

Fig. 2 shows the circuit of the new phase reference pulse generator. D301-304 rectify the voltage across the secondary of projector A transformer can apply it via the current limiter (TR301, R302, 303 D305, 306) to the opto-coupler l.e.d. The l.e.d. must illuminate sufficiently to saturate the output transistor early in the mains cycle if sufficiently narrow pulses are to be obtained. If a resistor were used to produce this current (15mA) within the required 300µs of the start of the cycle then the current in the l.e.d. in mid-cycle would be 790mA—13 times the maximum rated

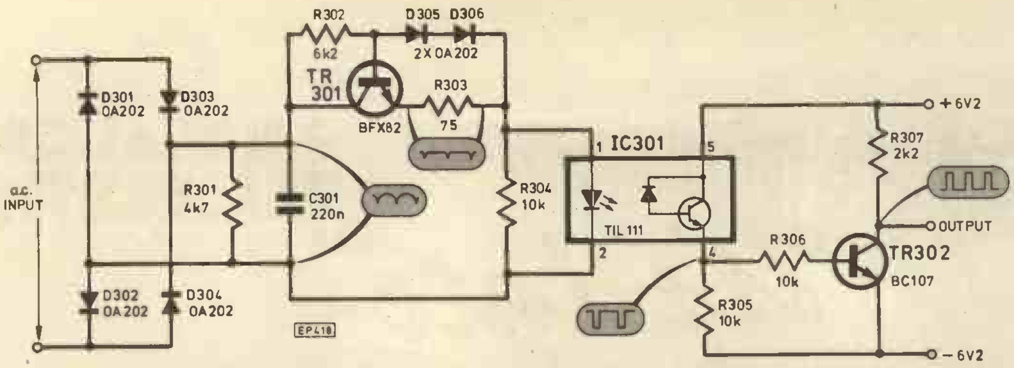


Fig. 2 Circuit diagram of new phase reference pulse generator

current! Clearly a limiter is needed to remove the peaks, TR301, which saturates until D305, 306 conduct providing a reference to the base, performs this function. R301 ensures that some current always flows in the rectifier diodes and R304 helps the l.e.d. to turn off quickly by providing a path for the removal of minority carriers when TR301 switches off at the end of the cycle. C301 removes switching spikes which would otherwise disturb the operation of the circuit.

On the output side the V_{ce} saturation voltage of the transistor within the isolator is too high to drive the Diamatic directly so TR302, R305-307 provide a signal that is compatible with the original unit.

COMPONENTS

Resistors		Semiconductors	
R301	4k7	TR301	BFX85
R302	6k2	TR302	BC107
R303	75ohm	IC301	TIL111 (Texas)
R304	10k		R-S 307-979
R305	10k	C301	0·22µF Polyester
R306	10k		
R307	2k2	D301–306	OA202

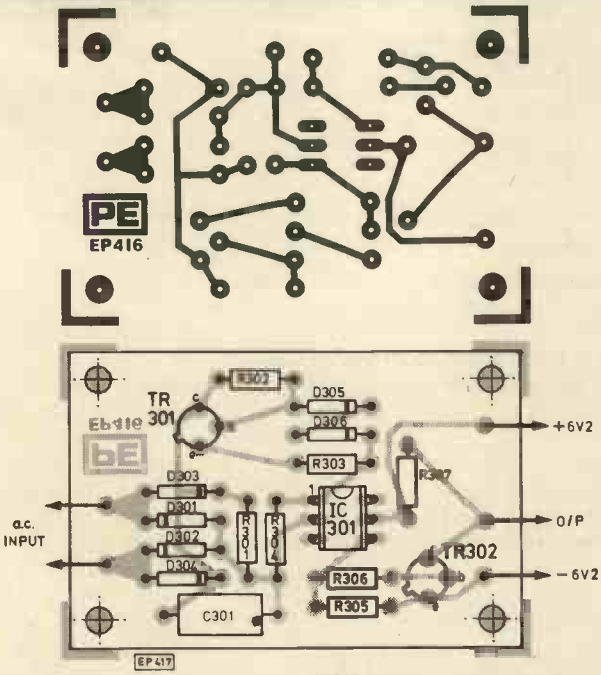


Fig. 3 (Above) P.c.b. and component layout

CONSTRUCTION AND INSTALLATION

The simple module may be built either on Veroboard or on the printed wiring board whose layout appears in Fig 3.

Before installing the module make a connection from the unused side of projector A transformer to the Diamatic unit. If the wiring diagrams of the original article have been followed this point will be available in the triac box between the projector A tags for 'change' and 'g' of CSR101. Take this signal via the spare core in the lead to the Diamatic, to pin 11 of PL2. Now connect the a.c. inputs of the new module to pins 2 and 11 of SK2, thereby connecting the module directly across the secondary of transformer A.

Next join the module +6·2V lead to the Diamatic positive supply and the −6·2V lead to the negative supply (this connection can be made to any of several convenient links on the original p.c.b.). Finally remove the link on the main printed wiring board which joins the collector of TR1 to R101,104 and connect the output of the module to the junction of these two resistors.

Connections are now complete and Fig. 4 shows how the module relates to the circuits of the main system. As the setting up of the Diamatic will only have to be changed very slightly a full functional test can now be carried out followed by slight adjustments to the presets for projector A if required.

If a separate power supply is used for the Diamatic it may be necessary to derive separate phase references for each projector. If this is the case build two of the new modules and connect one as previously described. To install the second module remove TR1 D1, 2, C1, R1, 3, 27, 28 and connect the output of the module to the junction of R201, 204. Connections to projector B transformer is via pins 6 and 10 of SK2 and the ± power supplies are derived as previously described. An earth for the Diamatic box and its circuits can now be taken to the mains earth via the power supply cable with no danger of damage to any of the components.

In order to avoid earth and phase problems completely the 'belt and braces' approach is to use a separate transformer to power the Diamatic and two opto-isolator modules. ★

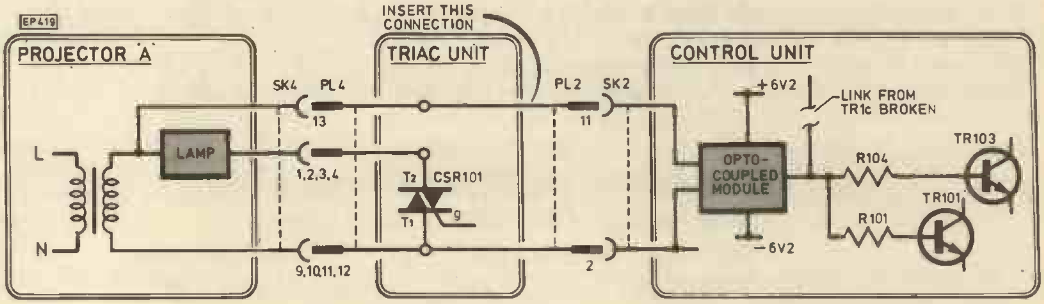


Fig. 4 (Right) Connection to rest of system

PATENTS REVIEW...

Copies of Patents can be obtained from: the Patent Office Sales, St. Mary Cray, Orpington, Kent. Price 95p each.

REMOTE CONTROL VIA MAINS WIRING

Robert Hutton, of Esher Surrey, has filed a British patent application no. 2 032 664 (under the New Laws and dated October 1978) for an electrical control apparatus which, superficially at least, resembles a system currently being sold in the USA. The aim in each case is to provide remote control of electrical appliances by means of pulses communicating through the house mains wiring.

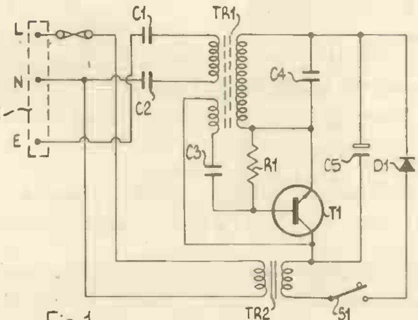


Fig.1

Figure 1 shows a sender or control unit which plugs into a mains socket Transistor T1, resistor R1, capacitors C3, C4 and transformer TR1 function as a feedback oscillator connected to the neutral and earth pins of a standard size mains plug 1. Capacitors C1, C2 block DC and the oscillator is powered by step down transformer TR2, rectifier diode D1 and smoothing capacitor C5. When control switch S1 is closed the plug impresses an oscillation on the house mains wiring.

Figure 2 shows a receiver unit which is plugged into another mains socket in the same house wiring. Isolating transformer T3 and blocking capacitors C6, C7 feed incoming oscillations to the resonant circuit formed by the secondary winding of transformer T3 and capacitor C8. Diode D2 outputs a rectified signal to the gate of thyristor SCR1 which is connected in series between the live pin of mains plug 2 and

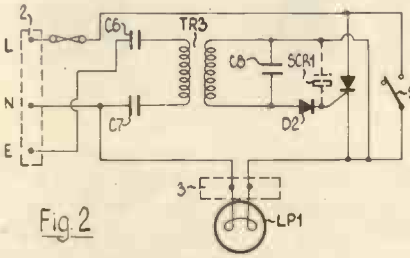


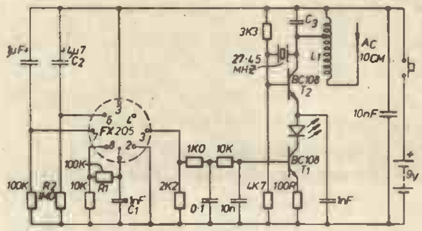
Fig.2

the live pin of mains output socket 3. The potentially confusing effect of spurious mains signals can be minimized by an extra capacitor downstream of diode D2 to slow down response of the thyristor to oscillation in the circuit TR3, C8.

WATCH IT

British patent 1 563 387 filed (under the Old Laws) by Staveley Swales of Northumberland gives details of a wristwatch transmitter suitable for use as a distress alarm signal by the elderly, sick or those in fear of kidnapping. The well worn idea (as featured in many a James Bond novel and film) is to incorporate a small radio transmitter inside a wristwatch with a short extendable aerial. Frankly it seems highly unlikely that such a broad idea can still be validly patented but the illustrated circuitry may be of interest to *PE* readers. This is shown in Fig. 3. The frequency of IC tone generator FX205 is determined by R1, C1 and the period of transmission is determined by R2, C2. Two more RC networks connected between pin 3 of FX205 and transistor T1 serve as a low pass filter to remove unwanted harmonics. Transistor T1 serves as an AM current source which feeds AF modulation to the crystal controlled RF oscillator T2. This uses a third overtone parallel resonant crystal and the RF power is developed in the circuit L1, C3.

FIG. 3.



Coil L1 is a step up transformer which matches the low output impedance of T2 to the high impedance presented by the short aerial AE. The inventor advocates the use of this step up transformer to obtain correct electrical matching because in more conventional transmitters the output has a higher impedance than the aerial, whereas the reverse is the case in his arrangement. To keep dimensions of the transformer small, one transformer winding is made concentric to the other.

DISCO DESK

Part 3 BEN DUNCAN

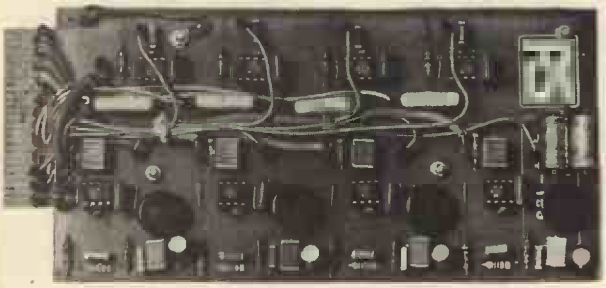
THIS part rounds off card construction together with the Monitor amplifier board. The circuit for the final card (Card 4) is given in Fig. 12.

CARD 4

The Autofader is driven by a signal derived from the top of the microphone gain control. In the absence of a signal, the *n*-channel f.e.t.s TR3, TR4, are pinched off by negative bias applied via VR2 and R4. When a signal is applied to pin 3 on IC1, in excess of the voltage on pin 2, the output of IC1 saturates positively and charges C3. This lowers the negative bias on TR3 and TR4 and causes their drain/source resistance to decrease, thereby attenuating the music signal. The degree of attenuation is governed by the setting of VR3, which forms a potential divider in conjunction with R3, R4 and VR1 in Fig. 6. The input sensitivity of the Autofader is governed by the voltage set up on pin 2 of IC1 by VR1. Immediately an announcement finishes, IC1 reverts to its quiescent state and C3 discharges slowly at a rate set by VR2. Preset pots VR1—3 are all panel mounted because adjustments are required to suit different hall acoustics and miking techniques. Spindle locks are provided to protect the shafts and to prevent accidental adjustments.

The stereo lines are applied to IC2 and 3. These are connected as unity gain buffers and feed the Sound-To-Light Mixer (IC5). The microphone line is applied to IC4, the gain of which is controlled by VR4. This preset is adjusted so that normal miking provides a signal at the mixer output that is roughly equal to the signal level from the stereo lines. The Cue l.e.d. Driver is simply a high gain amplifier (IC6) with limited frequency response (to minimise spurious operation) which turns TR1 hard on when a signal of suitable level is present. In turn, TR1 turns on the l.e.d.

The scintillating light caused by the peak detecting nature of this circuit is smoothed by C12. R22 and C14 attenuate the current spikes and hence noise generated by rapid switching of TR1. VR5 is set so that the l.e.d. discriminates between the lead-in grooves and the onset of modulation on a typical disc.



Card 4 prototype

MONITOR AMPLIFIER

This utilises the SGS-Ates TBA810P i.c. power amplifier which has been chosen for its comprehensive protection and the ready availability of a p.c.b. The latter is particularly useful, since in common with all i.c. power amplifiers, the board layout is quite critical and finding a satisfactory p.c.b. layout is very much a 'cut and try' process. The circuit board is bolted directly to the front panel. The input to VR1 is either PFL (point 'Z' on Fig. 6) or from the mono output (pin 7 on Fig. 8); this switching is shown in detail later. It is important to note that the PFL signal is derived prior to RIAA bass boost, and is therfore lacking in low frequencies. However, the PFL is intended primarily for cueing up records and the lack of low frequencies is of no consequence. In fact, the predominantly midrange and treble response of the PFL signal is helpful in that it 'cuts through' amidst high ambient SPLs.

If the amplifier is required to drive headphones only, R4 should be inserted to reduce the putput power to some 400mW. This resistive attenuation is preferable to lowering the gain (set by R1) because it does not affect the input overload margin. The value of R1 shown gives an input sensitivity of around 10mV and input saturation occurs at 220mV. C5 and C6 determine the bandwidth of the amplifier (15kHz as shown) and may be increased in value if any h.f. instability occurs. Note that C5 is approximately five times the value of C6—this relationship must be maintained if the values are changed.

In this application, IC1 is protected against output short circuits, supply polarity inversion and also features thermal shutdown. The latter allows an area of copper on the p.c.b. to be used with confidence as a heatsink. To test the monitor amplifier, connect a 12V supply and a loudspeaker. If l.f. instability occurs, check the earthing arrangements; interaction between input earth currents (pin 9) and the output return current (pin 10) is usually responsible. If all is well, apply a signal <100mV to VR1, which should be temporarily wired to the p.c.b. to provide an input bias path.

The earlier version of the TBA810, suffixed 'S', is substantially similar to the latest 'P' version and can be directly substituted. However, the ripple rejection in particular is not so good, and it may be necessary to increase the value of C4.

CARD 3

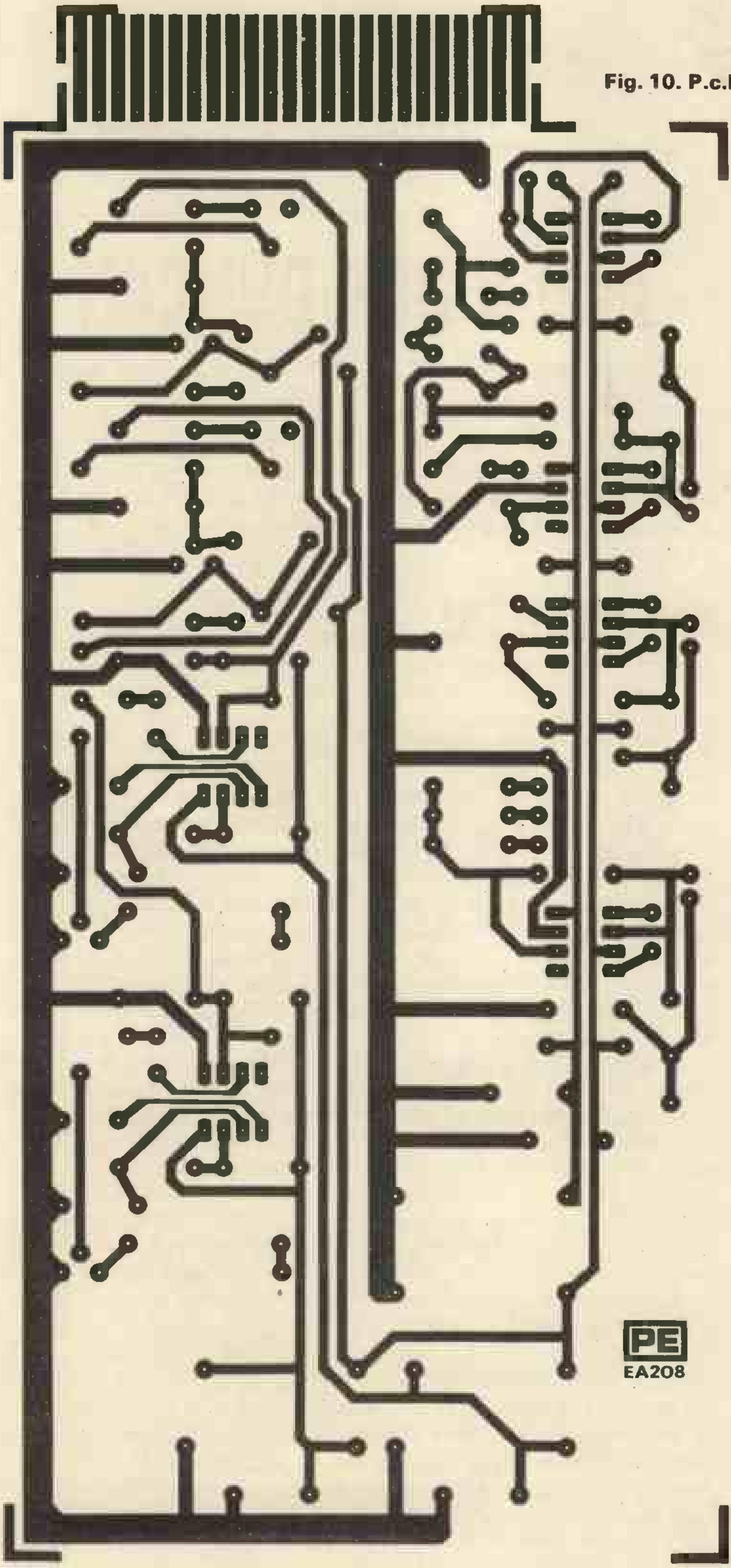
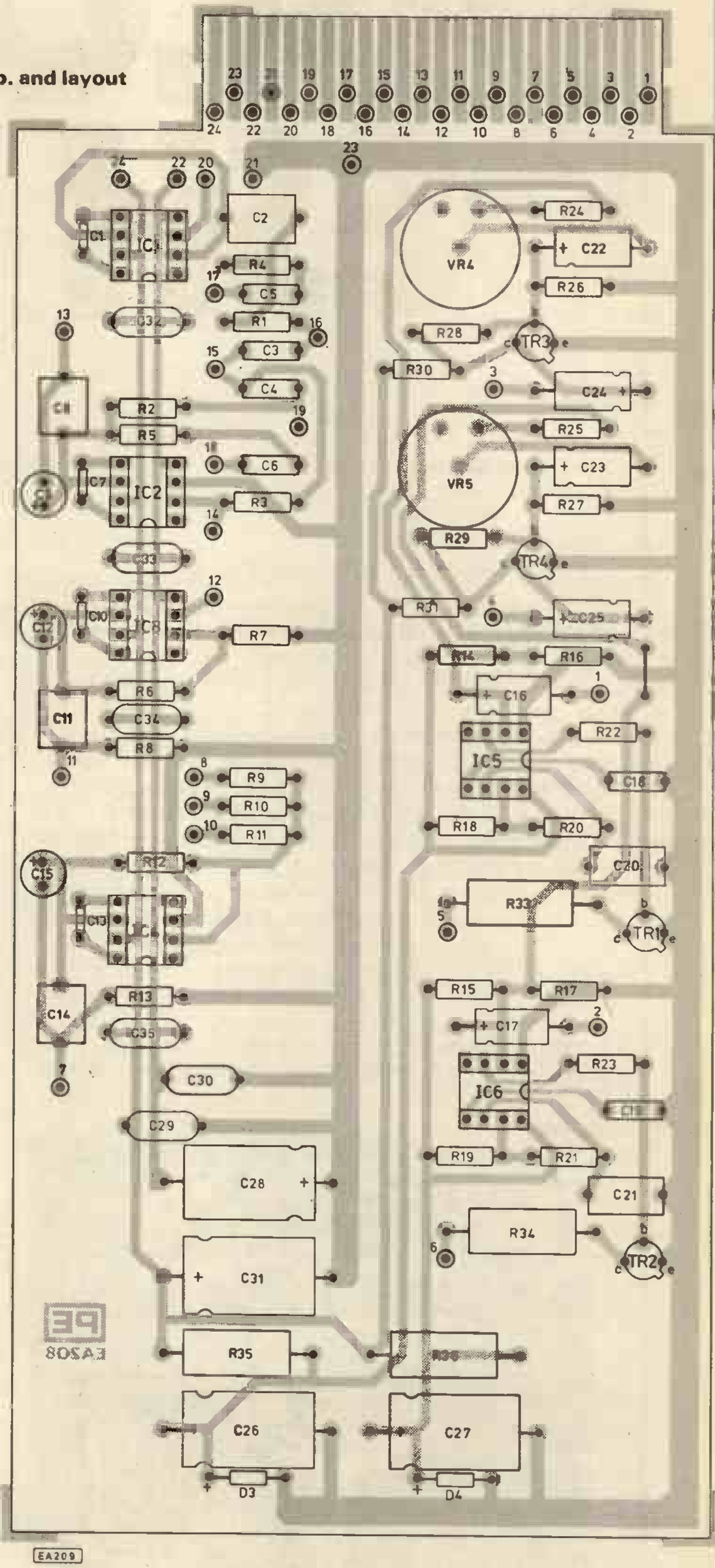


Fig. 10. P.c.b. and layout



Monitor Amplifier

Resistors

R1	33R ¼ watt 5%
R2	100R ½ watt 5%
R3	1R ½ watt 5%
R4	33R 1 watt 5% (see text)

Potentiometer

VR1	10k single log slide pot (Maplin type FX57M)

Capacitors

C1	100n polyester C280AE series
C2	100µ 40V axial electrolytic
C3	100µ 40V axial electrolytic
C4	100µ 40V axial electrolytic
C5	3n3 polycarbonate
C6	680p ceramic or polystyrene
C7	100n polyester C280AE series
C8	100µ 40V axial electrolytic
C9	1000µ 16V axial electrolytic

Semiconductors

TBA 810P (SGS-ATES)

Miscellaneous

SKT1—standard jack socket, insulated

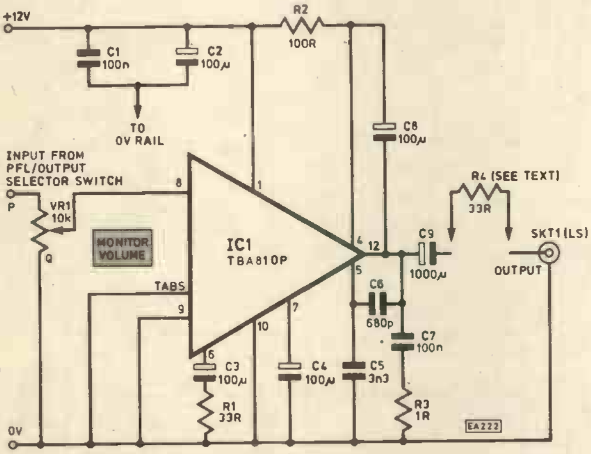
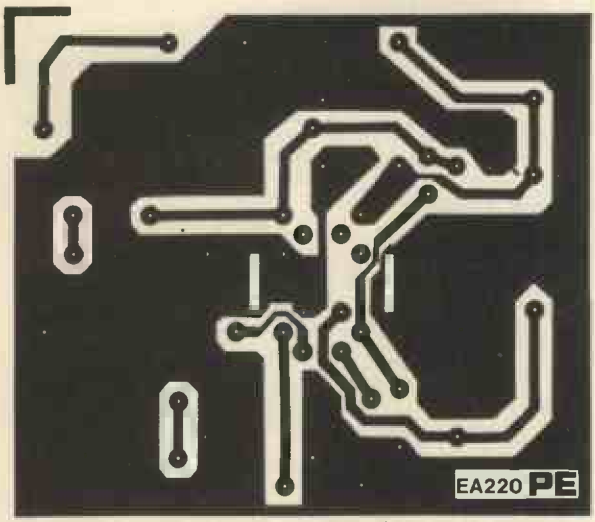


Fig. 11. Monitor Amplifier circuit with p.c.b. below and layout right



Card 4

Resistors

R1	10k
R2	8R2
R3	100k
R4	5k6
R5—6	1M
R7—9	100k
R10—12	22k
R13	1k
R14	22k
R15	100k
R16—17	330k
R18	1k
R19—20	10k
R22—23	470R, ½ watt

All ¼ watt, 5% unless otherwise stated

Potentiometers

VR1	1k rotary lin pot
VR2	470k rotary lin pot
VR3	1k dual rotary lin pot
VR4	47k open cermet preset
VR5, 6	100k open cermet preset

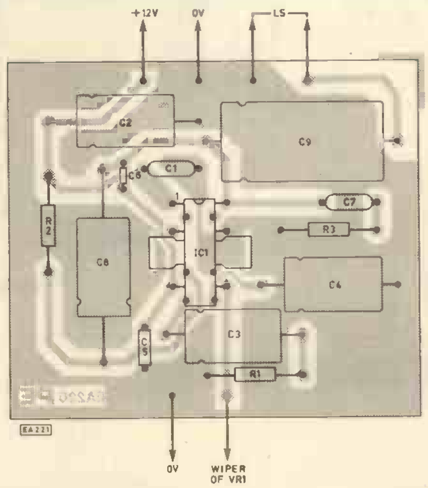
Capacitors

C1	25µ 25V axial electrolytic
C2	220n polycarbonate
C3	4µ7 25V axial electrolytic
C4, 5, 6, 7	470n polyester C280AE series
C8, 9	100n polyester C280AE series
C10, 11	1µ 25V axial electrolytic
C12, 13	10µ 25V axial electrolytic
C14, 15	100µ 25V axial electrolytic
C16, 17	100µ 40V axial electrolytic
C18, 19—23	100n polyester C280AE series

Semiconductors

IC1—7	741C, 8 pin d.i.l. version
TR1, 2	BC107
TR3, 4	2N3819
D1	BZY88C9V1
D2	1N914
D3, 4	Panel l.e.d., green (RS type 586-541)

7 x 8 pin d.i.l. sockets
JK1—Standard jack socket, insulated
Spindle locks, set of 3 (RS type 509-816, one pack only required)



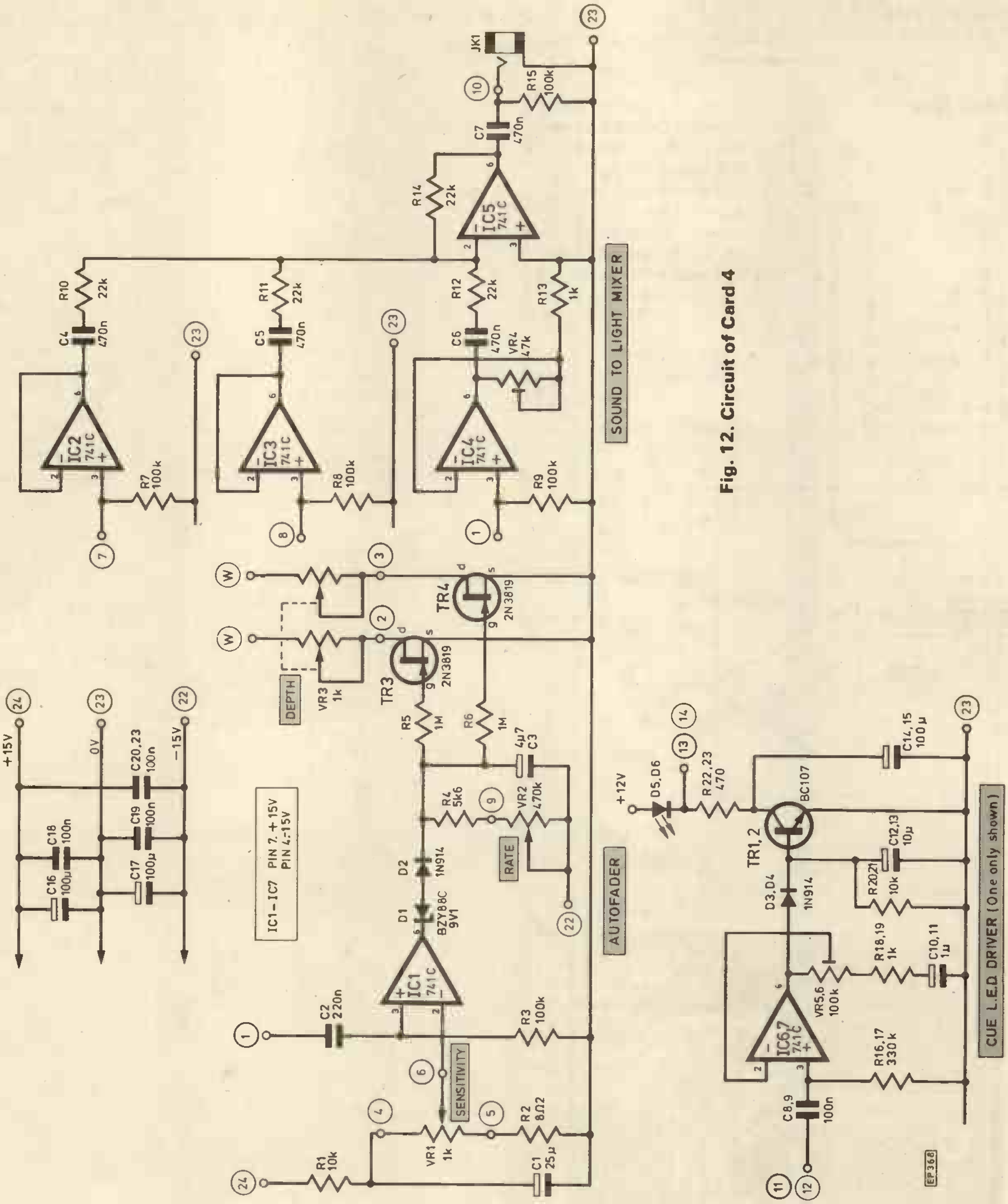


Fig. 12. Circuit of Card 4

CARD 4

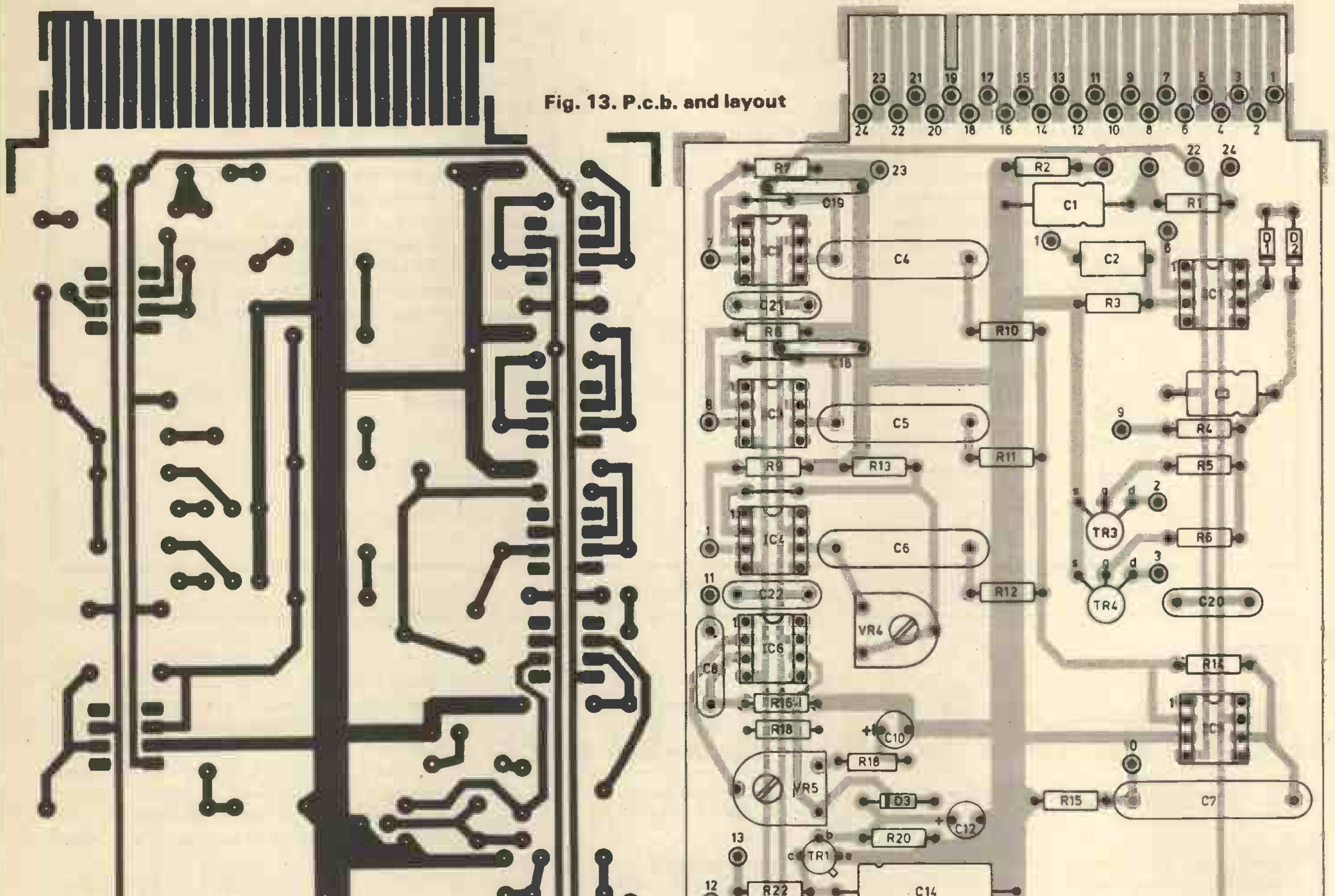


Fig. 13. P.c.b. and layout

Edge wiring

Card 3

Pin No.	Connection
1	Left input from music lines to peak indicator
2	Right input from music lines to peak indicator
3	Left output to VU meter
4	Right output to VU meter
5	Peak indicator output (Left) to indicator l.e.d. cathode
6	Peak indicator output (Right) to indicator l.e.d. cathode
7	Mono output to 3 pin male XLR socket
8	Left music input to Mono Mixer
9	Right music input to Mono Mixer
10	Microphone line into Mono Mixer
11	Microphone line, output to send-return switch
12	Input to Microphone Line Driver from VR3 (Slider)
13	Output of microphone equalisation stage to 'top' of VR3
14	T.CEN
15	B.CEN
16	B.MA
17	T.MA
18	T.MI
19	B.MI
20	Microphone input from transformer
21	Screen (OV) connection to transformer
22	−ve, 15V
23	OV, to central earth point
24	+ve, 15V

Card 4

Pin No.	Connection
1	Input to autofader and SLM mixer from 13 on Card 3
2	Left autofader output to depth pot } Then to point 'W'
3	Right autofader output to depth pot } Then to point 'W'
4	To 'top' of autofader sensitivity pot
5	To 'bottom' of autofader sensitivity pot
6	To slider of autofader sensitivity pot
7	Left music line into SLM mixer
8	Right music line into SLM mixer
9	To autofader rate control
10	SLM mixer output to jack socket
11	Input to cue l.e.d. driver 'A' from point 'X'
12	Input to cue l.e.d. driver 'B' from point 'Y'
13	Output from cue l.e.d. driver 'A' to l.e.d. cathode
14	Output from cue l.e.d. driver 'B' to l.e.d. cathode
15–21	No connection
22	−ve, 15V
23	OV, to central earth point
24	+ve, 15V

Next Month: Wiring details

Readout...

A selection from our Postbag

Readers requiring a reply to any letter must include a stamped addressed envelope.
Opinions expressed in Readout are not necessarily endorsed by the publishers of Practical Electronics.

Velikovsky

Sir—As one who has made an extensive study of Dr. Velikovsky's work, and that of the considerable number of scientists, historians, archaeologists, and others who have contributed towards further investigation of his theory, I would like to ask F. W. Hyde just exactly where and when did Velikovsky express a "conviction that the Earth came into being less than 4000 years ago", and just exactly when and where did he state that he "(did) not believe that there was a system before 1500 B.C. or thereabouts"?

Perhaps F. W. Hyde would care to consider rebutting his own mis-statements before tackling the statements Velikovsky actually made. Like the majority of Velikovsky-detractors, Hyde must prove his ability to read before I, for one, will be gullible enough to harken to *his* bizarre ideas.

I can find no reason to put Velikovsky's predictions within quotation marks. I find them to be perfectly logical and valid deductions from his main thesis, and, whilst I do not accept all that he claims, it is a fact that his record of success exceeds that of any other theorist. You may also care to note that my own further investigations of his theory were considered of sufficient scientific merit to be accepted for publication in the Journal of Physics, part A: Maths & Gen. (Oct 1978, vol. 11 no. 10 pp. 2107–2130), and that paper has been commented upon (without derision) in New Scientist, Physics Bulletin, Science Digest, Electrical Review, and elsewhere, and a voluminous correspondence from many parts of the world, including well-known centres of learning, has been most encouraging.

As for Mr. Birch, he may like to know that Dr. Velikovsky *was* a scientist. He was a longtime colleague and personal friend of A. Einstein. At the time of Einstein's death, he had open on his desk a copy of one of Velikovsky's books, which, unlike so many other scientists(?), he was reading and taking very seriously. And, Mr. Birch, it is high time *you* learnt to read, as well. Velikovsky did *not* put forward the idea that hydrocarbons in ordinary comet tails would burst into flames when passing through the Earth's atmosphere. You have obviously taken your information second-hand from your guru Asimov (or was it Sagan?), and not bothered to do what any good scientist should do, i.e. check the data. Asimov (or Sagan), incidentally, in his (or his) latest book, states that if the world's rotation were to be stopped suddenly, then all loose objects would go flying off. Think about it, Mr. Birch BSc, then tell me again who is talking nonsense. Velikovsky didn't make silly mistakes like that. Asimov (and Sagan) make far too many.

And, by the way, I am not a gullible member of the non-scientific public. I am a qualified physicist and mathematician with twenty years' worth of experience in scientific research.

P. Warlow,
Brentwood.

Sir—Mr. Hyde in his reply to Mr. Austin (Spacewatch June 1980) that 'there is no difficulty in dealing with Velikovsky's claims' but in fact there has been little critical analysis by the scientific fraternity. Mr Hyde admits that when Velikovsky came into the academic eye he was very badly treated but that since then he has been given a fair hearing reaching a peak in 1974 at the AAA symposium. Is Mr Hyde aware of the nature of this symposium, of the original proposal and its terms of reference and how after reading his paper Carl Sagan pleaded a prior appointment to dash away before his arguments could be discussed? The prior appointment was an appearance on the Johnny Carson t.v. show.

I too would like to see a reasoned argument from Hyde for the rejection of Velikovsky's theory especially since Mr. Hyde has already produced many thousands of words on the subject. Dr. Velikovsky in 'Worlds in Collision' made reference to plagues in Egypt in the wake of a cometry upheaval and now we have a new book by Prof. Fred Hoyle and N. C. Wickramasinghe titled 'Diseases from Space' wherein they propound the theory that epidemics on earth are due to this planet encountering a cloud of micrometeorites. No mention is made of Velikovsky in the

Bibliography or the Index of this book and no doubt the authors claim it to be original work despite the 30 years since the publication of 'Worlds in Collision'.

Reading Velikovsky's book 'Earth in Upheaval' it will be apparent that notable scientists over the past two hundred years have investigated geological and archeological evidence indicating cataclysmic upheaval of recent origin completely at variance with astronomers' claims of an orderly and unchanging solar system. Velikovsky produced a synopsis to explain a possible cause of these catastrophies. Established astronomers sensed a threat and attempted to suppress the publication of Velikovsky's books. The bizarre often attracts the attention of a very large number of people (as Mr. Hyde in Spacewatch April 1980 states) but then such publications do not arouse among the Scientific Establishment the furore that accompanied the publication of 'W in C'.

The ultimate (in the August issue) belongs to David Birch who quotes his B.Sc to show that he is not a member of the 'gullible non-scientific public'. Original thought is obviously not necessary in attaining such qualification and indeed could be a handicap. If Mr. Birch were a little less vitriolic in his condemnation of Velikovsky relying less on copying Dr. Asimov's 'fascinating essays' but rather forming his own opinion after reading Velikovsky's books then his letter might be taken seriously.

Sorry point not taken.

R. K. G. Williams,
Sutton Coldfield.

Sir—Many thanks for the opportunity to reply to the Letters published in your magazine in response to my communication on the theories of Velikovsky. I am sure that the tone of the letters, which both came from ardent pro-Velikovskians and spent more time niggling at me than defending against my criticisms, has served only to convince your readers that there is as little in Velikovsky's theories as they suspected. Both writers seem to think that my qualifications in Physics make me less able than them to talk on the subject and both infer that if I only read WinC I would be instantly converted to their way of thinking. Well, I have read it—I have also read most of the works of Von Daniken and the brothers Grimm. I enjoyed all but believed none.

Your readers may also wonder why one of the writers makes a sneering reference at an out of context quote from a book which he read so intently that he was unable to remember whether it was by Dr. Asimov or Carl Sagan (both of whom are distinguished scientists and writers). The quote concerns a sudden halt in the rotation of the Earth. Why? Well, another of Velikovsky's claims is that the comet Venus stopped the Earth rotating, hence accounting for the story of Joshua in the bible. Now, the Earth is rotating at several kilometres per second. Should this rotation suddenly cease, Joshua and his soldiers (and all other loose objects) would continue moving at this speed! Furthermore, the Earth's energy of rotation would be dissipated as heat melting the Earth's crust!

Nonsense? I think Velikovsky supplies enough for all of us.

David G. W. Birch,
Swindon.

Owing to a lack of space, Frank Hyde's reply will appear in the next issue. This correspondence is now closed.

Metal Detector

Sir—Following the publication of my metal detector circuit in Ingenuity Unlimited in the April 1980 issue of ***PE***, a number of would-be treasure hunters have contacted me with problems regarding the operation of the unit. It appears that many constructors have found that the metal detector produces a continuous tone which cannot be defeated by the adjustment of VR1.

This has been found to be due to large leakage currents in C8 when an aluminium electrolytic is used, producing a large offset voltage at the inputs of IC1, which is outside the offset null range of VR1. A tantalum capacitor therefore MUST be used for C8. If offset problems are still encountered, then R10 could be reduced to 560k to increase the range of VR1.

Additionally, using a tantalum capacitor for C7 would tend to improve the stability, but it should not be considered essential as the prototype units were quite satisfactory with aluminium types.

P.R. Williams
Stevenage

Beyond BASIC

Sir—We are running a part-time 1 year course on the FORTH computer language, for Micro Computer enthusiasts who want to know 'what lies beyond BASIC?'.

To answer this question we are extending the kit building approach to software. Participants are asked to provide their own hardware. An 8K UK101 or any micro with equivalent facilities is suitable.

By courtesy of the Forth Interest Group the college is able to provide a language model and assembly listings for the 8080 Z80 6800 6809 and 6502. The aim of the course is to help participants install and program in, this very interesting language.

The course runs for 1 year on Wednesday afternoons, fees will be around £35.

Bill Stoddart,
Department of Science,
Willesden College of Technology,
London NW10

Marvellous Magnum

Sir—I must send praise to Mr. Andy Flind on his design of his metal locator. We have built two locators so far, both working first go with no problems (except the p.c.b. in the final article is not full size), with the possibility of another being built. Indeed, you now have three more regular readers.

On completion of the locator we spent most of the Bank Holiday using it. We used it over various terrain and modes, from our back garden to pebbles, sand, wet sand, rocks and salt water, and it worked every time and was stable. The only point of interest was that on our sandy beach the ground control became more critical. However, we have built various designs from b.f.o. to l.b. and no other locator has worked on that beach.

We have not as yet found a fortune, but we have located nails down to 9 inches, part of a gold ring 6 inches down, fishing weights down to 12 inches. Believe it or not we have located iron plates on the beach down to 3 feet, but became wary of these and discarded them. We have also discovered that it will pick up meteorites and stones containing iron, so beware.

We hope to get quite a bit of pleasure from this locator and indeed to recover some of the cost of making it. For interest the batteries are going low on our locators after approximately 50hrs use. But it is still working with the batteries down to 6V. The audio one isn't yet affected. I hope to see more publications from Mr. Flind. Please can you forward our thanks to him for a super design which is stable and works well. Also the step by step guide was a great help in construction, as well as the coil set up procedure.

I. West,
Newhaven, Sussex.

BOOK REVIEWS

INTEGRATED CIRCUITS
by R.G. Hibberd
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112 pages 110 × 165 mm. Price £1·55

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79	2	1	3·93	1·10
3	4	2	6·35	1·10
20	6	3	7·39	1·31
21	8	4	8·79	1·31
51	10	5	10·86	1·52
117	12	6	12·29	1·67
88	16	8	16·45	1·89
89	20	10	18·89	1·89
90	24	12	21·09	2·24
91	30	15	24·18	2·39
92	40	20	32·40	O.A.

25/50 VOLT RANGE

Pri 220/240V Voltages available 5, 7, 8, 10, 13, 15, 17, 20, 33, 40 or 20V-0-20V or 25V-0-25V.

Ref.	Amps 25V	Amps 50V	Price	P & P
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103	2	1	4·57	1·10
104	4	2	7·88	1·31
105	6	3	9·42	1·52
106	8	4	12·82	1·73
107	12	6	16·37	1·89
118	16	8	22·29	2·39
119	20	10	27·48	O.A.
109	24	12	32·88	O.A.

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151	200	12·28	1·31
152	250	14·61	1·73
153	350	18·07	2·12
154	500	22·52	2·47
155	750	32·03	O.A.
156	1000	40·92	O.A.
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93	1500	25·61	O.A.
95	2000	38·31	O.A.
73	3000	65·13	O.A.
80S	4000	84·55	O.A.
57S	5000	98·45	O.A.

*0, 115, 220, 240.

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Pri 220-240 volts

Ref	Amps 12V	Amps 24V	Price	P&P
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71	2	1	3·86	0·90
18	4	2	4·46	1·10
85	5	2·5	6·16	1·10
70	6	3	6·99	1·10
108	8	4	8·16	1·31
72	10	5	8·93	1·31
116	12	6	9·69	1·52
17	16	8	11·79	1·80
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Pri 220/240V Voltages available 6, 8, 10, 12, 16, 18, 20, 24, 30, 36, 40, 48, 60 or 24-0-24V or 30V-0-30V.

Ref.	Amps *30V	Amps 60V	Price	P & P
124	1	·5	4·27	1·10
126	2	1	6·50	1·10
127	4	2	8·36	1·31
125	6	3	12·10	1·31
123	8	4	13·77	2·12
40	10	5	17·42	1·89
120	12	6	19·87	2·12
121	16	8	27·92	O.A.
122	20	10	32·51	O.A.
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2	432	13·35	1·31
3	433	16·17	1·40
4	434	20·65	2·11
5	435	29·30	2·47
6	436	36·69	O.A.
8	437	40·03	O.A.

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13	100	9-0-9	2·35	0·44
235	330, 330	0-9, 0-9	2·19	0·44
207	500, 500	0-8-9, 0-8-9	3·05	0·85
208	1A, 1A	0-8-9, 0-8-9	3·88	0·90
236	200, 200	0-15, 0-15	2·19	0·44
214	300, 300	0-20, 0-20	3·08	0·90
221	700(DC)	20-12-0-12-20	3·75	0·90
206	1A, 1A	0-15-20-0-15-27 x2	5·09	1·10
203	500, 500	0-15-27-0-15-20 x2	4·39	1·10
204	1A, 1A	0-15-27-0-15-27 x2	6·64	1·10
239	50	12-0-12	2·88	0·43
234	500	6	2·19	0·44

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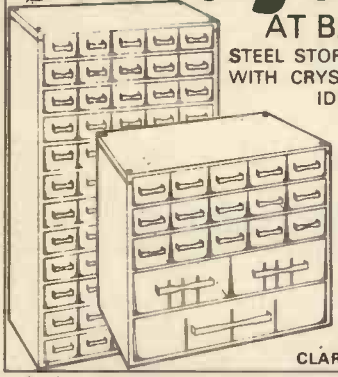

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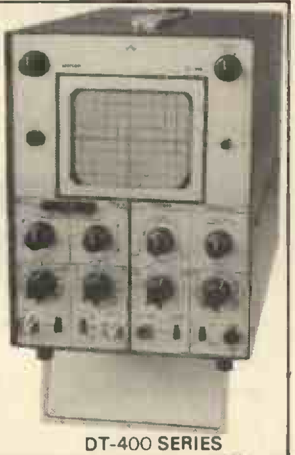

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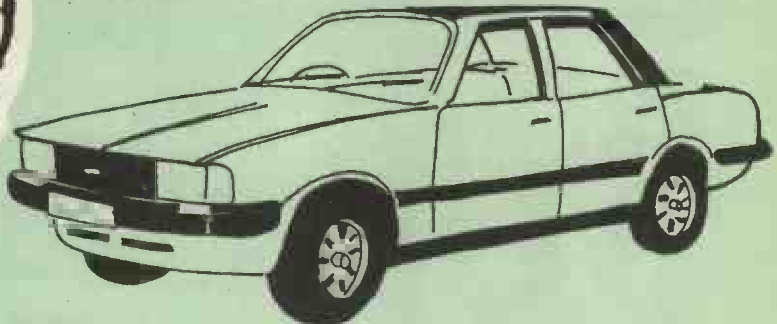

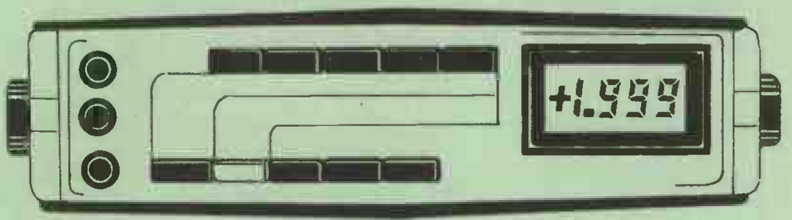

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INDEX...

Complete Volume 16 (1980) index with cross referencing for Constructional Projects, also lists all I.U.s, Points Arising, news, features, etc.

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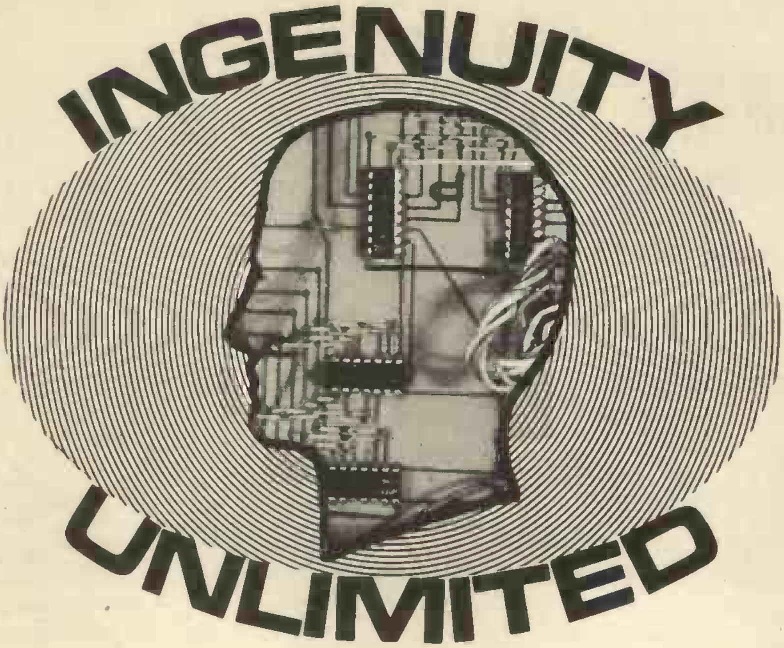


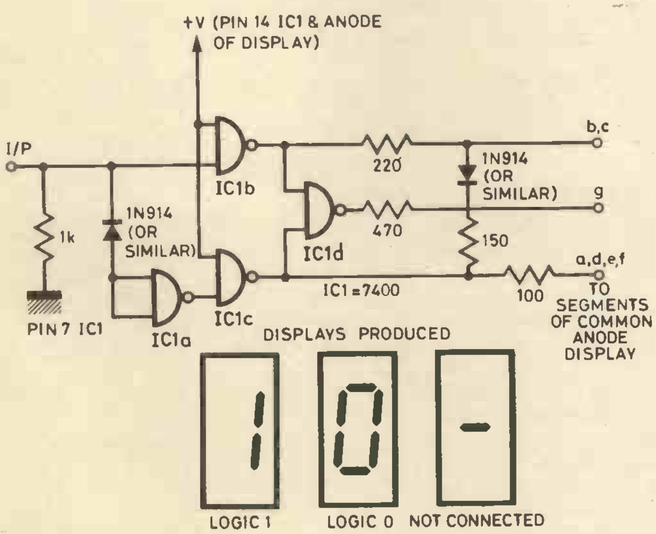
A selection of readers' original circuit ideas. It should be emphasised that these designs have not been proven by us. They will at any rate stimulate further thought.

Why not submit *your* idea? Any idea published will be awarded payment according to its merits.

Articles submitted for publication should conform to the usual practices of this journal, e.g. with regard to abbreviations and circuit symbols. Diagrams should be on separate sheets, not inserted in the text.

Each idea submitted must be accompanied by a declaration to the effect that it has been tried and tested, is the original work of the undersigned, and that it has not been offered or accepted for publication elsewhere.

TTL LOGIC TESTER



EA216

THIS circuit for yet another logic tester differs from others by instead of lighting one l.e.d. for logic 1 and another for logic 0, actually displaying a 1 or an 0 on a common anode seven-segment display.

When a pin is not connected or in tristate high impedence a dash is displayed. It utilises a single 7400 so if an "out-of-spec" display is obtained it can be built extremely cheaply. When the input is at 1 the output of IC1b goes low and segments b and c are lit. When the input is at 0 IC1c goes low and segments a, d, e, and f and b and c via the diode are lit. When the input is not connected and IC1b and c are high so IC1d goes low and segment g is lit. The prototype was constructed on a piece of Veroboard and put in a small plastic box with a window cut-out for the display. An old meter test lead was used for the probe. The +ve and ground must obviously be relatively low input impedance. The tester doesn't upset logic circuits unless they are on the very limit of fan-out. The circuit could probably be adapted for CMOS by using a 4011 (or 74C00) and increasing the 1k resistor accordingly.

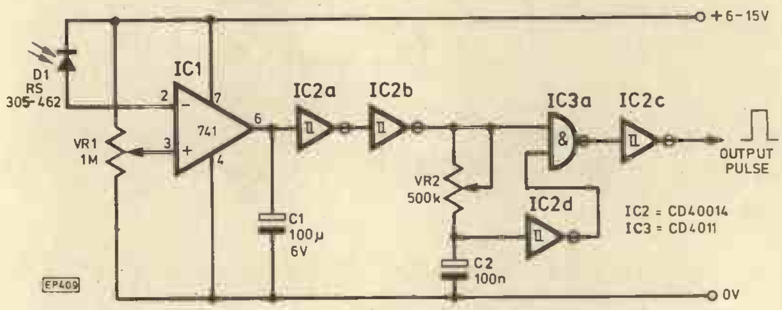
A. C. Twist,
Leicester.

LIGHT TRIGGERED VARIABLE PULSE

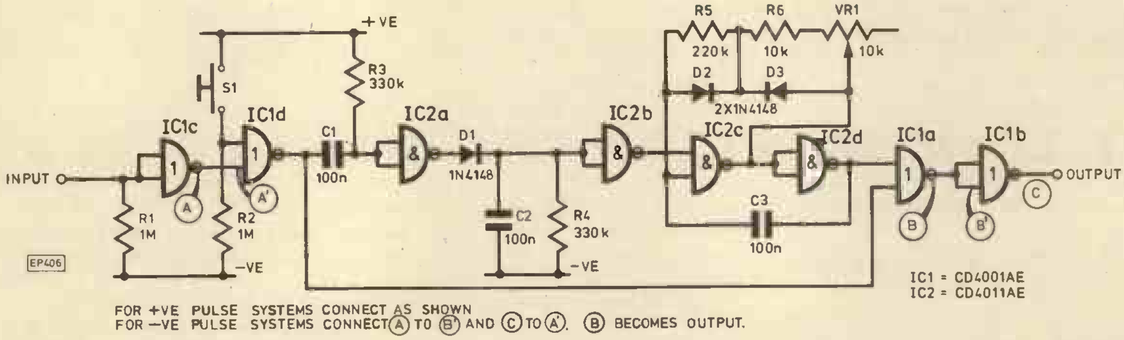
THIS relatively simple circuit, gives a standard pulse output, whose duration can be set by VR2 and C2. Every time the light falling on the photodiode is interrupted, the voltage on pin 2 of IC1 falls, this is compared to the potential on pin 3, which is set by VR1, causing the output on pin 6 to go high, this pulse is shaped and buffered by the two Schmitt triggers, IC2a and IC2b. The NAND gate inverts this pulse, which is changed back to a positive pulse by IC2c, the high pulse from IC2b, also charges up C2 via VR2. On reaching the threshold of Schmitt IC2d, the output of IC2d goes low, this switches off the NAND gate, consequently limiting the duration of the output pulse.

In the prototype a 15 watt bulb at 2 feet, was used for the light source.

M. Miller,
Reading,
Berks.



R/C FAILSAFE AND SERVO TESTER



PROPORTIONAL R/C servos are controlled by pulses of 1 to 2ms width which are repeated at approximately 20ms intervals. If through some malfunction of the transmitter or receiver these pulses are not present, this circuit, which is connected between the receiver and servo, detects this condition and activates its own pulse generator to drive the servo. The pulse generator is adjustable enabling the servo to be driven to any desired "fail safe" position e.g. throttle to low position. A push button is also provided to inhibit the normal pulse input so that the servo may be driven from the internal pulse generator for the purpose of testing. By a simple rearrangement of the input and output circuitry, versions suitable for positive or negative pulse R/C systems may be constructed.

The circuit shown, consists essentially of a monostable (IC2 a/b) driving a gated oscillator (IC2 c/d). An OR gate (IC1 a/b) driven by the oscillator and input signal via the input inhibitor (IC1 c/d) ensures that the output to the servo is provided from either the input signal or the gated oscillator. The monostable period is greater than 20ms, therefore, the normal pulse input keeps it in its triggered state (output low). This inhibits the operation of the oscillator, whose output also remains low, thus allowing the input pulses to pass through the OR gate to the output. Should the input pulses cease, the monostable output goes high and the oscillator is enabled. Diodes in the oscillator circuit give an asymmetrical output consisting of an adjustable 1 to 2ms pulse with a fixed 20ms interval, similar to the original input pulses.

The circuit shown above is suitable for positive pulse R/C systems which are by far the most commonly used. For negative pulse R/C systems (e,g, Horizon) the pulse input is inverted before and after the circuit.

J. R. Shield,
Blaydon,
Tyne and Wear.

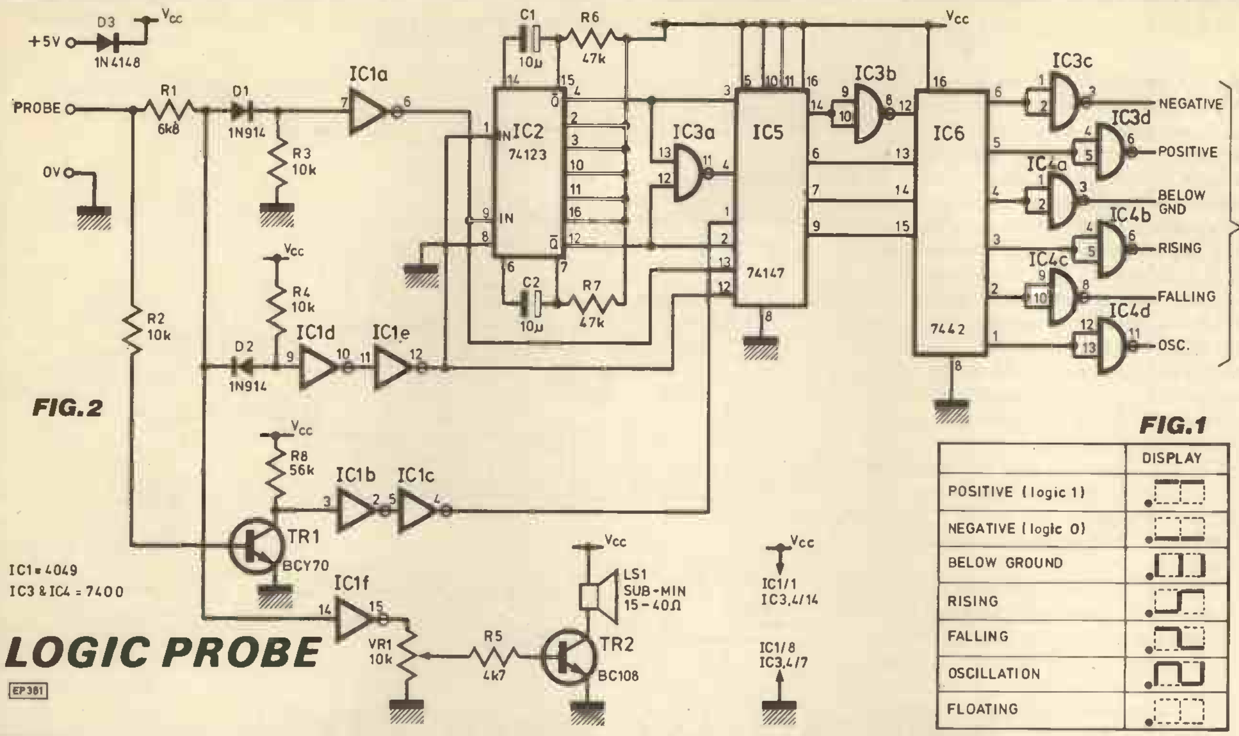


FIG.2

FIG.1

	DISPLAY
POSITIVE (logic 1)	
NEGATIVE (logic 0)	
BELOW GROUND	
RISING	
FALLING	
OSCILLATION	
FLOATING	

LOGIC PROBE

EP381

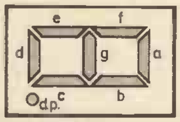
THIS logic probe uses a seven segment display on its side to indicate, in an easy to understand way, the state of the probe (Fig. 1). The symbols were designed to look like the trace on an oscilloscope. The decimal point is used to indicate that the probe is on, the other segments are used as in Fig. 1, and the loudspeaker (LS1) is used to indicate the frequency of an oscillation (if it is audible). IC1f buffers the input to VR1 which acts as a volume control, TR2 amplifies the signal to LS1 which may need a series resistor if the speaker has a low resistance. The symbols were chosen as the probe was designed for fault finding on a microprocessor system with logic levels of +5V, 0V, and −12V. The circuit consists of three basic sections—detection, priority encoding (Fig.2) and display encoding (Fig. 3).

The detection stage consists of several circuits each detecting a different thing—below ground detection is achieved by TR1 which is turned on by an input which is below 0V. If a different type of transistor is used R2 and R8 may need altering. When TR1 switches on, the output of IC1b goes high and the output of IC1c goes low. When the input is positive (logic 1) D1 conducts and the output of IC1a goes low. When the input is negative (logic 0), D2 conducts and the output of IC1e goes low. Transitions are detected by a 74123—IC2a, b wired up to detect falling edges and give an output pulse of approximately ½ a second. When the output of IC1a goes low (as the input rises to logic 1), IC2b is triggered, and its Q output (pin 12) goes low for ½ a second—indicating a rising edge. A similar thing happens when the input goes negative and the output of IC1e goes low triggering IC2b, indicating a falling edge. The time for which these symbols are displayed can be varied by altering R1, R2 or C1 and C2.

If the input goes low and high (rises and falls) within the ½ second for which the monostables are triggered, both Q outputs will be low and the output of IC3a will also go low indicating an oscillation. These signals cannot be fed straight to a display as several occur at the same time, e.g. for an oscillation to occur rising and falling must also be present. If these were fed straight to a display all three symbols would appear on top of each other. The priority encoding stage ensures that only one symbol is displayed at once. The operation of this stage is shown tabled. IC5 a 74147 decimal to BCD converter and priority encoder—converts decimal inputs into BCD but only the highest decimal input is converted into BCD. From the table (below)—the signal with the highest priority is oscillation with a decimal value of 7. The 74147 has inverted outputs, so 7 in inverted BCD is 1,000 (on pins 9, 7, 6 and 14 of IC5). As IC6 does not have inverted inputs the signals are swapped over—oscillation decimal 7 on IC5 becomes decimal 0 to IC6. The outputs of IC6 are inverse so they need inverting by IC4a, b, c, d and IC3c, d.

These signals are fed to the diode matrix (D4–D18) which generates the required symbol (Fig. 1). The display is a common cathode type used on its side. The decimal point is connected to V_{cc} through a 330 resistor. The i.c.s are protected against reversed supply connection by D3. The complete probe was built into a small box with three sockets on the top for +5V, ground and probe.

I. Mercer,
Loughborough,
Leicestershire.



ARRANGEMENT OF SEGMENTS

Detection Signal	IC5 pin	IC5 dec. i/p	IC5 BCD DCBA	After IC3b DCBA	IC6 pin	IC6 dec. o/p
Oscillation	4	7	1000	0000	1	0
Falling edge	3	6	1001	0001	2	1
Rising edge	2	5	1010	0010	3	2
Below ground	1	4	1011	0011	4	3
Positive	13	3	1100	0100	5	4
Negative	12	2	1101	0101	6	5

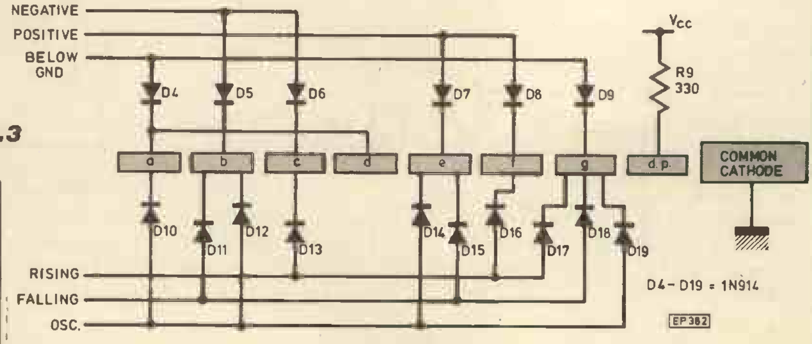


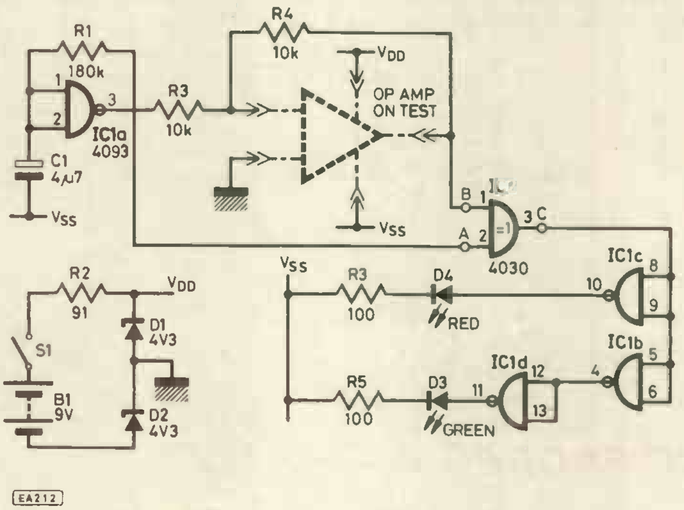
FIG.3

OP-AMP TESTER

A 1Hz oscillator feeds an EX-OR gate directly, and via the op-amp under test, connected as an inverter. The gate output will be high only if the two inputs disagree (i.e. antiphase). A green l.e.d. indicates the condition while the red l.e.d. shows up agreement. The tester is powered by a single 9V battery with two Zeners giving a split supply. The c.m.o.s. gates use 4·3 volts for V_{DD} and −4·3 volts for V_{SS}. A 4093 quad NAND Schmitt is used as the 1Hz oscillator and l.e.d. drivers. A 4030 quad EX-OR is used as the phase detector. The op-amp is plugged into a test socket, which may be patched if desired for non-standard pinouts.

a) Op-amp functioning: A and B are antiphase, C is high, green on, red off.
b) Op-amp open circuit: A and B are in phase, C is low, green l.e.d. off, red l.e.d. on.
c) Op-amp stuck at fixed level: A and B alternately agree and disagree, C oscillates at 1Hz, l.e.d.s flash alternately. On switch on the red l.e.d. will light first if the op-amp is stuck above ground and conversly if below ground.

S. Callaghan,
Gt. Baddow,
Essex.



SHOOT GAME

THIS circuit is similar to the *PE* version a couple of years ago.

Fig. 1 is basically an electronic game, using l.e.d.s and a decade counter divider i.c., the clock frequency of which is obtained from a two NAND gates (IC2) oscillator. The l.e.d.s should be arranged in sequence, so that when l.e.d. 5 (pin 1, IC2) is logic 1 and S1 is pressed, the clock is stopped or inhibited by the gate output of IC2 (c).

Cheats who press the button before l.e.d. 5 illuminates, find the sequence resetting at 3 until SW1 is released.

An alternative "Fire" button arrangement using one single throw push switch and an extra i.c. is shown in Fig. 2.

Completely disconnect R5 and replace this circuit in between xx and yy.

The speed of the oscillator can be changed by varying the values of C1 and R2.

L. Privett,
Barking,
Essex.

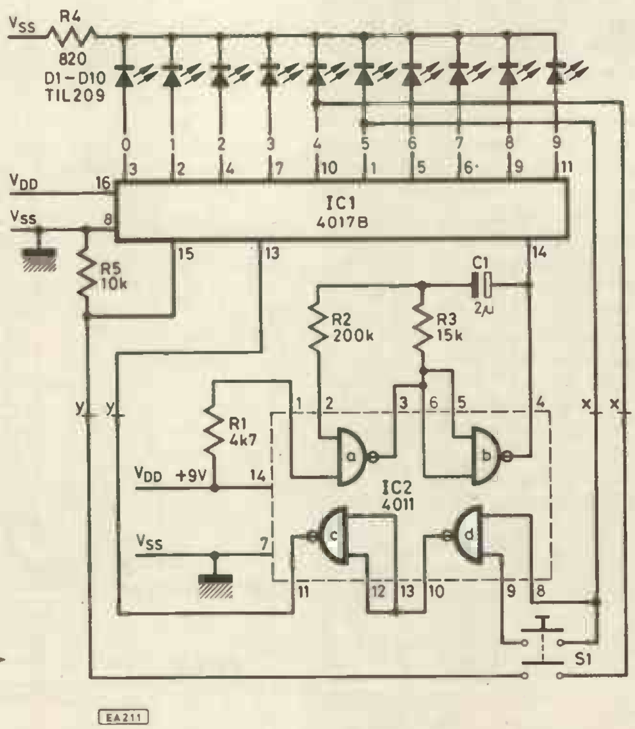


Fig. 1

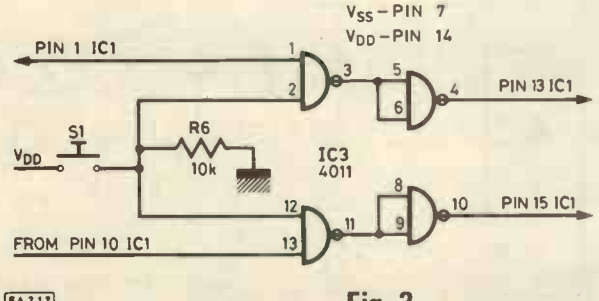


Fig. 2

BI-PAK SEMICONDUCTORS

TRANSISTORS

Type	Price
AC107	£0.25
AC113	£0.23
AC115	£0.23
AC117	£0.35
AC117K	£0.39
AC121	£0.23
AC122	£0.16
AC125	£0.23
AC126	£0.23
AC127	£0.23
AC128	£0.22
AC128K	£0.30
AC132	£0.23
AC134	£0.23
AC137	£0.23
AC141	£0.25
AC141K	£0.35
AC142	£0.42
AC142K	£0.35
AC151	£0.23
AC153	£0.25
AC153K	£0.35
AC154	£0.23
AC155	£0.23
AC156	£0.23
AC157	£0.29
AC165	£0.23
AC166	£0.23
AC167	£0.23
AC168	£0.29
AC169	£0.23
AC171	£0.29
AC176	£0.21
AC176K	£0.30
AC178	£0.29
AC179	£0.29
AC180	£0.23
AC180K	£0.32
AC181	£0.23
AC181K	£0.32
AC187	£0.21
AC187K	£0.32
AC188	£0.21
AC188K	£0.32
ACY17	£0.40
ACY18	£0.40
ACY19	£0.40
ACY20	£0.40
ACY21	£0.40
ACY22	£0.40
ACY27	£0.40
ACY28	£0.37
ACY29	£0.56
ACY30	£0.40
ACY31	£0.40
AD130	£0.81
AD140	£0.69
AD142	£0.98
AD143	£0.86
AD149	£0.69
AD161	£0.40
AD162	£0.40
AD161/2	£0.81
AF124	£0.35
AF125	£0.35
AF126	£0.35
AF127	£0.37
AF139	£0.40
AF178	£0.69
AF179	£0.69
AF180	£0.69
AF181	£0.67
AF186	£0.58
AF239	£0.44
AL102	£1.38
AL103	£1.36
ASY26	£0.44
ASY27	£0.46
ASY28	£0.44
ASY29	£0.44
ASY50	£0.35
ASY51	£0.35
ASY52	£0.35
ASY54	£0.35
ASY55	£0.35
ASY56	£0.35
ASY57	£0.35
ASY58	£0.35
ASY73	£0.35
AU104	£1.61
AU110	£1.61
AU113	£1.61
BC107	£0.09
BC107A	£0.09
BC107B	£0.10
BC107C	£0.12
BC108	£0.09
BC108A	£0.09
BC108B	£0.10
BC108C	£0.12
BC109	£0.09
BC109A	£0.09
BC109B	£0.10
BC109C	£0.12
BC113	£0.18
BC114	£0.18
BC115	£0.22
BC116	£0.22
BC116A	£0.22
BC117	£0.23
BC118	£0.16
BC119	£0.29
BC120	£0.46
BC125	£0.20
BC126	£0.25
BC132	£0.21

Type	Price
BC134	£0.21
BC135	£0.17
BC136	£0.21
BC137	£0.21
BC139	£0.37
BC140	£0.35
BC141	£0.32
BC142	£0.25
BC143	£0.25
BC145	£0.53
BC147	£0.08
BC148	£0.08
BC149	£0.08
BC150	£0.23
BC151	£0.25
BC152	£0.25
BC153	£0.29
BC154	£0.22
BC157	£0.12
BC158	£0.12
BC159	£0.12
BC160	£0.30
BC161	£0.44
BC167	£0.14
BC168	£0.10
BC169	£0.10
BC169C	£0.10
BC170	£0.10
BC171	£0.10
BC172	£0.10
BC173	£0.10
BC174	£0.17
BC175	£0.40
BC177	£0.53
BC178	£0.18
BC179	£0.18
BC180	£0.29
BC181	£0.10
BC182	£1.25
BC182L	£0.10
BC183	£0.10
BC183L	£0.10
BC184	£0.10
BC184L	£0.10
BC186	£0.25
BC187	£0.25
BC207	£0.13
BC208	£0.13
BC209	£0.14
BC212	£0.10
BC212L	£0.10
BC213	£0.10
BC213L	£0.10
BC214	£0.10
BC214K	£0.10
BC225	£0.30
BC226	£0.41
BC227	£0.18
BC238	£0.18
BC251	£0.17
BC251A	£0.18
BC301	£0.32
BC302	£0.33
BC303	£0.32
BC304	£0.44
BC327	£0.17
BC328	£0.17
BC337	£0.17
BC338	£0.17
BC440	£0.35
BC441	£0.44
BC460	£0.44
BC461	£0.44
BC477	£0.23
BC478	£0.23
BC479	£0.23
BC546	£0.12
BC547	£0.12
BC548	£0.12
BC549	£0.12
BC550	£0.16
BC556	£0.16
BC557	£0.15
BC558	£0.16
BCY30	£0.63
BCY31	£0.63
BCY32	£0.69
BCY33	£0.63
BCY34	£0.69
BCY70	£0.17
BCY71	£0.17
BCY72	£0.17
BCZ10	£0.69
BCZ11	£0.69
BCZ12	£0.69
BD115	£0.58
BD116	£0.92
BD121	£0.75
BD123	£0.75
BD124	£0.81
BD131	£0.40
BD132	£0.40
BD131/132mp	£0.92
BD133	£0.46
BD135	£0.44
BD136	£0.40
BD137	£0.40
BD138	£0.41
BD139	£0.41
BD140	£0.41
BD139/140mp	£0.92
BD155	£0.92
BD175	£0.69
BD176	£0.69
BD177	£0.78

Type	Price
BD178	£0.78
BD179	£0.86
BD180	£0.86
BD181	£0.98
BD182	£1.04
BD183	£1.09
BD184	£1.27
BD185	£0.78
BD186	£0.78
BD187	£0.86
BD188	£0.86
BD189	£0.90
BD190	£0.90
BD195	£1.04
BD196	£1.04
BD197	£1.09
BD198	£1.09
BD199	£1.14
BD200	£1.14
BD201	£0.92
BD202	£0.92
BD201/202mp	£1.95
BD203	£0.92
BD204	£0.92
BD203/204mp	£1.95
BD205	£0.92
BD206	£0.92
BD207	£0.92
BD208	£0.00
BD222	£0.00
BD225	£0.54
BD232	£0.53
BD233	£0.55
BD234	£0.63
BD235	£0.63
BD236	£0.67
BD237	£0.63
BD238	£0.69
BD239A	£0.58
BD240A	£0.58
BDX32	£2.53
BDY11	£1.50
BDY17	£2.07
BDY20	£0.92
BDX77	£1.04
BF115	£0.25
BF117	£0.58
BF118	£0.66
BF119	£0.86
BF121	£0.58
BF123	£0.69
BF125	£0.58
BF127	£0.68
BF152	£0.29
BF153	£0.29
BF154	£0.25
BF155	£0.40
BF156	£0.32
BF157	£0.32
BF158	£0.32
BF159	£0.32
BF160	£0.35
BF162	£0.35
BF163	£0.35
BF164	£0.55
BF165	£0.55
BF167	£0.28
BF173	£0.23
BF176	£0.44
BF177	£0.30
BF178	£0.35
BF179	£0.35
BF180	£0.35
BF181	£0.35
BF182	£0.35
BF183	£0.35
BF184	£0.23
BF185	£0.23
BF186	£0.30
BF187	£0.30
BF188	£0.46
BF194	£0.12
BF195	£0.12
BF196	£0.12
BF197	£0.14
BF198	£0.16
BF199	£0.16
BF200	£0.35
BF218	£1.04
BF222	£1.04
BF240	£0.20
BF241	£0.20
BF244	£0.35
BF257	£0.29
BF258	£0.29
BF259	£0.40
BF262	£0.69
BF263	£0.69
BF270	£0.41
BF271	£0.36
BF272	£0.92
BF272	£0.41
BF273	£0.41
BF274	£0.44
BF324	£0.40
BF336	£0.35
BF337	£0.35
BF338	£0.44
BF457	£0.43
BF458	£0.43
BF459	£0.44
BF596	£0.32
BFR39	£0.28
BFR40	£0.29

Type	Price
BFR79	£0.32
BFR80	£0.32
BFX29	£0.25
BFX30	£0.35
BFX84	£0.25
BFX85	£0.28
BFX86	£0.29
BFX87	£0.25
BFX88	£0.25
BFX90	£0.43
BFY50	£0.20
BFY51	£0.20
BFY52	£0.20
BFY53	£0.18
BFY90	£0.95
BIP19	£0.44
BIP20	£0.44
BIP19/20	£0.92
BSX25	£1.67
BSX19	£0.21
BSX20	£0.21
BSY25	£0.18
BSY26	£0.18
BSY27	£0.18
BSY28	£0.18
BSY29	£0.18
BSY38	£0.22
BSY39	£0.22
BSY40	£0.33
BSY41	£0.33
BSY51	£0.29
BSY95	£0.15
BSY95A	£0.15
BRY39	£0.52
BU105	£1.84
BU105/02	£2.24
BU204	£1.81
BU205	£1.81
BU208	£2.19
BU208/02	£2.59
MJE2955	£1.04
MJE3055	£0.69
MJE3440	£0.60
MPB113	£0.60
MPF102	£0.32
MPF104	£0.40
BPF105	£0.40
MPSA05	£0.23
MPSA06	£0.23
MPSA55	£0.23
MPSA56	£0.23
ND120	£0.21
OC20	£2.13
OC22	£1.73
OC23	£1.73
OC24	£1.55
OC25	£1.15
OC26	£1.15
OC28	£0.92
OC29	£1.09
OC35	£1.04
OC36	£1.04
OC41	£0.23
OC42	£0.25
OC44	£0.28
OC45	£0.23
OC70	£0.28
OC71	£0.17
OC72	£0.28
OC74	£0.30
OC75	£0.35
OC76	£0.40
OC77	£0.58
OC81	£0.25
OC81DD	£0.28
OC82	£0.28
OC82D	£0.35
OC83	£0.30
OC84	£0.44
OC139	£0.92
OC140	£0.92
OC169	£0.40
OC170	£0.40
OC171	£0.40
OC200	£0.44
OC201	£1.09
OC202	£1.38
OC203	£0.98
OC204	£1.04
OC205	£1.32
TIC44	£0.33
TIC45	£0.40
TIP29A	£0.46
TIP29B	£0.48
TIP29C	£0.51
TIP30A	£0.46
TIP30B	£0.48
TIP30C	£0.48
TIP31A	£0.46
TIP31B	£0.48
TIP31C	£0.51
TIP32A	£0.46
TIP32B	£0.48
TIP32C	£0.51
TIP41A	£0.51
TIP41B	£0.53
TIP41C	£0.55
TIP42A	£0.51
TIP42B	£0.53
TIP42C	£0.55
TIP2955	£0.69
TIP3055	£0.53
TIS43	£0.26
TIS90	£0.21
UT46	£0.23
ZTX107	£0.12
ZTX108	£0.12

Type	Price
ZTX109	£0.12
ZTX300	£0.14
ZTX301	£0.14
ZTX302	£0.18
ZTX303	£0.18
ZTX304	£0.23
ZTX330	£0.17
ZTX500	£0.15
ZTX501	£0.14
ZTX502	£0.18
ZTX503	£0.14
ZTX504	£0.29
ZTX531	£0.29
ZTX550	£0.18
2N388	£0.41
2N388A	£0.64
2N404	£0.23
2N524	£0.46
2N527	£0.58
2N598	£0.46
2N599	£0.53
2N696	£0.15
2N697	£0.14
2N698	£0.14
2N699	£0.37
2N708	£0.12
2N706A	£0.14
2N707	£0.55
2N706	£0.16
2N711	£0.35
2N717	£0.35
2N718	£0.29
2N718A	£0.58
2N726	£0.33
2N727	£0.33
2N743	£0.23
2N744	£0.23
2N914	£0.17
2N918	£0.35
2N929	£0.23
2N930	£0.21
2N946	£0.46
2N1131	£0.21
2N1132	£0.21
2N1302	£0.17
2N1303	£0.21
2N1304	£0.21
2N1305	£0.21
2N1306	£0.29
2N1307	£0.29
2N1308	£0.35
2N1309	£0.40
2N1613	£0.23
2N1711	£0.23
2N1889	£0.52
2N1890	£0.52
2N1893	£0.35
2N2147	£0.86
2N2148	£0.81
2N2160	£0.00
2N2192	£0.44
2N2193	£0.44
2N2194	£0.44
2N2217	£0.25
2N2218	£0.26
2N2218A	£0.23
2N2219	£0.23
2N2219A	£0.28
2N2220	£0.23
2N2221	£0.23
2N2221A	£0.25
2N2222	£0.23
2N2222A	£0.23
2N2368	£0.21
2N2369	£0.16
2N2369A	£0.18
2N2411	£0.29
2N2412	£0.29
2N2646	£0.54
2N2711	£0.25
2N2712	£0.25
2N2714	£0.25
2N2904	£0.21
2N2904A	£0.24
2N2905	£0.21
2N2905A	£0.23
2N2906	£0.18
2N2906A	£0.22
2N2907	£0.23
2N2907A	£0.25
2N2923	£0.17
2N2924	£0.17
2N2925	£0.17
2N2926G	£0.10
2N2926Y	£0.09
2N2926O	£0.09
2N2926R	£0.09
2N2926B	£0.09
2N3010	£0.75
2N3011	£0.17
2N3053	£0.20
2N3054	£0.46
2N3055	£0.46
2N3391	£0.23
2N3391A	£0.25
2N3392	£0.23
2N3393	£0.23
2N3394	£0.23
2N3395	£0.25
2N3402	£0.24
2N3403	£0.24
2N3404	£0.33
2N3405	£0.48
2N3414	£0.18
2N3415	£0.18

Type	Price
2N3416	£0.33
2N3417	£0.33
2N3614	£1.15
2N3615	£1.21
2N3616	£1.21
2N3646	£0.10
2N3702	£0.09
2N3703	£0.09
2N3704	£0.08
2N3705	£0.08
2N3706	£0.09
2N3707	£0.09
2N3708	£0.08
2N3708A	£0.08
2N3709	£0.08
2N3710	£0.08
2N3711	£0.08
2N3772	£1.84
2N3773	£2.53
2N3819	£0.21
2N3820	£0.40
2N3821	£0.69
2N3823	£0.69
2N3903	£0.12
2N3904	£0.12
2N3905	£0.12
2N3906	£0.12
2N4058	£0.14
2N4059	£0.16
2N4060	£0.16
2N4061	£0.14
2N4062	£0.14
2N4921	£0.63
2N4923	£0.75
2N5135	£0.12
2N5136	£0.12
2N5138	£0.12
2N5172	£0.16
2N5194	£0.64
2N5245	£0.46
2N5294	£0.39
2N5296	£0.41
2N5457	£0.37
2N5458	£0.37
2N5459	£0.40
2N5551	£0.41
2N6027	£0.39
2N6121	£0.81
2N6122	£0.81
2S301	£0.58
2S302	£0.49
2S302A	£0.49
2S303	£0.64
2S403	£0.82
2S305	£0.92
2S306	£0.92
2S307	£0.92
2S321	£0.66
2S322	£0.49
2S322A	£0.49
2S323	£0.66
2S324	£0.82
2S325	£0.00
2S326	£0.82
2S327	£0.82
40311	£0.42
40313	£1.09
40316	£1.09
40316	£1.09
40317	£0.46
40326	£0.46
40327	£0.52
40346	£0.52
40347	£0.75
40348	£0.92
40360	£0.41
40362	£0.44
40406	£0.52
40407	£0.40
40408	£0.60
40409	£0.88
40410	£0.88
40411	£0.00
40430	£1.09
40476	£1.84
40494	£0.81
40495	£0.92
40512	£1.55
40594	£1.04
40636	£1.27

VOLTAGE REGULATORS

UA7805	£0.81
UA7812	£0.81
UA7815	£0.81
UA7818	£0.81
UA7824	£0.81
UA7905	£0.92
UA7912	£0.92
UA7915	£0.92
UA7918	£0.92
UA7924	£0.92
72723	£0.52
UA723	£0.52
LM309K	£1.72

74 SERIES TTL ICs

Type	Price
7400	£0.10
7401	£0.13
7402	£0.13
7403	£0.13
7404	£0.13
7405	£0.13
7406	£0.25
7407	£0.25
7408	£0.23
7409	£0.15
7410	£0.13
7411	£0.20
7412	£0.17
7413	£0.28
7414	£0.58
7416	£0.26
7417	£0.26
7420	£0.13
7421	£0.23
7422	£0.18
7423	£0.24
7425	£0.22
7426	£0.26

Type	Price
7427	£0.28
7428	£0.30
7430	£0.13
7432	£0.25
7433	£0.35
7437	£0.24
7438	£0.24
7440	£0.14
7441	£0.58
7442	£0.46
7443	£0.81
7444	£0.81
7445	£0.75
7446	£0.69
7447	£0.55
7448	£0.64
7450	£0.13
7451	£0.13
7453	£0.13
7454	£0.13
7460	£0.13
7470	£0.29
7472	£0.23

Type	Price
7473	£0.29
7474	£0.29
7475	£0.33
7476	£0.29
7480	£0.51
7481	£0.98
7482	£0.78
7483	£0.67
7484	£1.01
7485	£0.78
7486	£0.35
7489	£1.96
7490	£0.37
7491	£0.74
7492	£0.40
7493	£0.35
7494	£0.88
7495	£0.58
7496	£0.58
74100	£0.98
74104	£0.45
74105	£0.44
74107	£0.28

Type	Price
74110	£0.41
74111	£0.67
74118	£0.92
74119	£1.38
74121	£0.28
74122	£0.45
74123	£0.46
74136	£0.60
74141	£0.63
74145	£0.63
74150	£0.78
74151	£0.65
74153	£0.55
74154	£0.94
74155	£0.58
74156	£0.58
74157	£0.58
74160	£0.67
74161	£0.71
74162	£0.71
74163	£0.71
74164	£0.78
74165	£0.78

Type	Price
74166	£0.90
74174	£0.75
74175	£0.71
74176	£0.67
74177	£0.67
74180	£1.73
74181	£0.67
74182	£0.81
74184	£0.81
74190	£0.78
74191	£0.71
74192	£0.69
74193	£0.67
74194	£0.71
74195	£0.69
74196	£1.21
74197	£1.21
74198	£2.13
74199	£2.13

CMOS ICs

Type	Price
CD4000	£0.16
CD4001	£0.23
CD4002	£0.18
CD4006	£1.06
CD4007	£0.20
CD4008	£1.06
CD4009	£0.52
CD4010	£0.55
CD4011	£0.23
CD4012	£0.22
CD4013	£0.46

Type	Price
CD4015	£0.94
CD4016	£0.49
CD4017	£0.94
CD4018	£0.98
CD4019	£0.48
CD4020	£1.04
CD4021	£0.94
CD4022	£0.94
CD4023	£0.22
CD4024	£0.75
CD4025	£0.22

Type	Price
CD4026	£1.70
CD4027	£0.58
CD4028	£0.78
CD4029	£0.98
CD4030	£0.55
CD4031	£2.30
CD4035	£1.38
CD4037	£1.09
CD4040	£1.01
CD4041	£0.87
CD4042	£0.83

Type	Price
CD4043	£1.01
CD4044	£0.94
CD4045	£1.61
CD4046	£1.50
CD4047	£1.00
CD4049	£0.55
CD4050	£0.55
CD4054	£1.27
CD4055	£1.15
CD4056	£1.55
CD4069	£0.20

Type	Price
CD4070	£0.20
CD4071	£0.20
CD4072	£0.20
CD4081	£0.20
CD4082	£0.25
CD4510	£1.27
CD4511	£1.44
CD4516	£1.15
CD4518	£1.15

LINEAR ICs

Type	Price
CA3011	£1.12
CA3014	£1.55
CA3018	£0.75
CA3020	£1.96
CA3028	£0.92
CA3035	£1.61
CA3036	£1.15
CA3042	£1.63
CA3043	£2.13
CA3046	£0.81
CA3052	£1.84
CA3054	£1.27
CA3075	£1.73
CA3081	£1.73
CA3089	£2.30
CA3090	£4.14
CA3123	£2.19
CA3130	£0.97
CA3140	£0.81

Type	Price
LM301	£0.33
LM304	£1.94
LM308	£1.15
LM309	£1.73
LM380	£0.98
LM381	£1.67
LM3900	£0.67
LM3914	£2.45
LM3915	£2.46
MC1303L	£0.98
MC1304	£1.19
MC1310	£1.09
TBA120	£0.60
MC1312	£2.19
MC1350	£1.38
MC1352	£1.61
MC1469	£3.39
MC1496	£1.04
NE536	£3.06

Type	Price
NE550	£1.09
NE555	£0.28
NE556	£0.69
NE565	£1.38
NE566	£1.73
NE567	£1.96
UA702C	£0.53
72702	£0.53
UA703	£0.28
UA709	£0.29
72709	£0.53
UA710C	£0.46
72710	£0.35
UA711C	£0.37
72711	£0.37
UA723C	£0.52
72723	£0.52
UA741C	£0.28
72741	£0.28

Type	Price
741P	£0.23
UA747C	£0.69
72747	£0.69
UA748	£0.40
748P	£0.40
SN76013N	£2.01
SN76023	£2.01
SN76110	£1.73
SN76115	£2.19
SN76660	£0.86
TAA550B	£0.49
TAA621A	£2.30
TAA621B	£2.88
TAA661	£1.73
TAD100	£1.50
TBA540	£2.42
TBA810S	£0.86

Type	Price
TBA810	£1.13
TBA820	£0.81
TBA9200	£2.88
TCA270S	£2.30
TBA800	£0.92
ZN414	£1.15
TBA120	£0.60
TBA641A	£1.84
TBA6413	£2.53

DIODES

Type	Price
AA110	£0.09
AA120	£0..09
AA129	£0.09
AAY30	£0.10
AAZ13	£0.17
BA100	£0.12
BA102	£0.37
BA148	£0.17
BA154	£0.17
BA155	£0.16
BA173	£0.17
BB104	£0.46

Type	Price
BAX13	£0.08
BAX16	£0.09
BY100	£0.25
BY101	£0.25
BY105	£0.25
BY114	£0.25
BY124	£0.25
BY126	£0.17
BY127	£0.18
BY128	£0.18
BY130	£0.20
BY133	£0.24

Type	Price
BY164	£0.58
BY176	£0.86
BY206	£0.34
BYZ10	£0.52
BYZ11	£0.52
BYZ12	£0.46
BYZ13	£0.46
BYZ16	£0.47
BYZ17	£0.41
BYZ18	£0.41
BYZ19	£0.41
OA5	£0.69

Type	Price
OA10	£0.40
OA47	£0.09
OA70	£0.09
OA79	£0.12
OA81	£0.12
OA85	£0.12
OA90	£0.12
OA91	£0.12
OA95	£0.12
OA182	£0.15
OA200	£0.09
OA202	£0.09

Type	Price
SD10	£0.07
SD19	£0.07
IN34	£0.08
IN34A	£0.08
IN914	£0.07
IN916	£0.07
IN4148	£0.07
IS44	£0.06
IS920	£0.07

TRIACS

2 amp Volts	T05 Case No.	Price
100	TR12a/100	£0.36
200	TR12a/200	£0.59
400	TR12a/400	£0.82

6 amp Volts		
100	TR16a/100	£0.59
200	TR16a/200	£0.70
400	TR16a/400	£0.89

10 amp Volts		Price
100	TR110a/100	£0.89
200	TR110a/200	£1.06
400	TR110a/400	£1.29

10 amp Volts		
400	TR110a/400p	£1.21

Diacs

BR100	£0.23	D32	£0.23

BRIDGE RECTIFIERS

SILICON 1 amp

Type	No.	Price
50v RMS	BR1 50	£0.23
100v RMS	BR1 100	£0.25
200v RMS	BR1 400	£0.29
400v RMS	BR1 400	£0.41

SILICON 2 amp

Type	No.	Price
50v RMS	BR2 50	£0.52
100v RMS	BR2 100	£0.55
200v RMS	BR2 200	£0.60
400v RMS	BR2 400	£0.67
1000v RMS	BR2 1000	£0.78

SILICON 10 amp

Type	No.	Price
50v RMS	BR10 50	£1.73
200v RMS	BR10 200	£1.95

SILICON 25 amp

Type	No.	Price
50v RMS	BR25 50	£2.19
200v RMS	BR25 200	£2.53

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BP26	Radio Antenna Book Long Distance Reception & Transmission	1.00
BP27	Giant Chart of Radio Electronic Semi-conductor & Logic Symbols	0.60
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BRACKETS

Right-angle mounting brackets. Ideal for mounting, PCB, panels et cetera into boxes and cases.
18SWG — Mild steel — short face has slotted hole 6.5cm x 3.7cm long face has 3.7cm diam. hole

O/NO:1726	Height 15cm, length 15cm, width 10cm	£0.06
O/NO:1727	Height 25cm, length 15cm, width 10cm	£0.07

SWITCHES

Description	No.	Price
DPDT miniature slide	1973	£0.16
DPDT standard slide	1974	£0.17
Toggle switch SPST 1½ amp 250V ac	1975	£0.38
Toggle switch DPDT 1 amp 250V ac	1976	£0.48
Rotary on-off mains switch	1977	£0.58
Push switch — Push to make	1978	£0.16
Push switch — Push to break	1979	£0.21

ROCKER SWITCH

	Colour	No.	Price
A range of rocker	RED	1980	£0.35
switches SPST — moulded	BLACK	1981	£0.35
in high insulation	WHITE	1982	£0.35
material available in a	BLUE	1983	£0.35
choice of colours ideal	YELLOW	1984	£0.35
for small apparatus	LUMINOUS	1985	£0.35

Description	No.	Price
Miniature SPST toggle 2 amp 250V ac	1958	£0.81
Miniature SPST toggle 2 amp 250V ac	1959	£0.86
Miniature DPDT toggle 2 amp 250V ac	1960	£0.92
Miniature DPDT toggle centre off 2 amp 250V ac	1961	£1.09
Push-button SPST 2 amp 250V ac	1962	£1.04
Push-button SPST 2 amp 250V ac	1963	£1.09
Push-button DPDT 2 amp 250V ac	1964	£1.38

MIDGET WAFER SWITCHES
Single bank wafer type — suitable for switching at 250V ac 100mA or 150V dc in non-reactive loads make-before-break contacts. These switches have a spindle 0.25 in dia and 30 indexing

Description		No.	Price
1 pole	12 way	1965	£0.55
2 pole	6 way	1966	£0.55
3 pole	4 way	1967	£0.55
4 pole	3 way	1968	£0.55

MICRO SWITCHES

	No.	Price
Plastic button gives simple 1 pole change over action Rating 10 amp 250V ac	1970	£0.29

OPTOELECTRONICS

NEW INCREASED RANGE—ALL 1ST QUALITY LEDS (diffused)

O/No.	Type	Size	Colour	Price
1501	ARL209 (TIL209)	3mm (·125)	RED	£0·12
1502	MIL3232 (TIL211)	3mm (·125)	GREEN	£0·22
1503	MIL3331 (OPL212A)	3mm (·125)	YELLOW	£0·22
1504	ARL4850 (FLV117)	5mm (·2)	RED	£0·12
1505	MIL5251 (TIL222)	5mm (·2)	GREEN	£0·22
1506	MIL5351 (MV5353)	5mm (·2)	YELLOW	£0·22
1509	FLV111	5mm (·2)	CLEAR (ill. Red)	£0·13

SUPER 'HI BRITE' TYPE

1521	MIL32	3mm (·125)	RED	£0·12
1522	MIL52	5mm (·2)	RED	£0·12
1514	ORP12	Light dependent resistor		£0·63
1520	OCP71	Photo transistor		£0·40

LED CLIPS

1508/125	pack of 5	125 clips	£0·17
1508/2	pack of 5	2 clips	£0·21

DISPLAYS

DL703 7 segment D P left (30" height) RED Single Digit	Common Anode O/NO. 1523	£0·85
DL707 7 segment D P left (30" height) RED Single Digit	Common Anode O/NO. 1510	£0·92
DL527 7 segment D P left (50" height) RED Two-Digit Reflector	Common Anode O/NO. 1524	£2·08
DL727 7 segment D P right (·510" height) RED Two-Digit Light Pipe	Common Anode O/NO. 1512	£2·07
DL747 7 segment D P left (630" height) RED Single Digit Light Pipe	Common Anode O/NO. 1511	£1·73

OPTO-ISOLATORS
Isolation Breakdown–Voltage 1500—continuous fwd. current 100 mA
CIL74 Single Channel 6 pin DIP standard type–optically coupled pair with infra-red LED Emitter and NPN Silicon Photo Transistor O/NO. 1497 £0·61
CILQ74 Multi-Channel 8 pin DIP Two Isolated Channels O/NO. 1498 £1·22
CILQ74 Multi-Channel 16 pin DIP Four Isolated Channels O/NO. 1499 £2·69

MELL II (TIL81) NPN LIGHT DETECTOR
Silicon Photo Darlington Amplifier–VCBO 30V VECO 10V 1c 100mA Ptot 300mW IL Min. 0·5 Typ 2mA 1D 100mA nA O/NO. 1495 £0·29

WIRE CONNECTORS

Entirely new range of connectors for Discrete wire. Uniquely designed Wirepost is soldered to the P.C. Board. A pre-stripped wire is inserted into the connector and easily locked by pressing the housing down. The wire is alternatively removed by lifting the housing. Tin alloy plated contacts ensure good as gold performance.
Housing consists of Thermo plastic polyster.

1728	Single connector in red/black or white	£0.12 inc. VAT
1729	Threeway connector black ONLY	£0.23 inc VAT
1730	Fourway connector black ONLY	£0.28 inc. VAT

FUSE HOLDERS AND FUSES

Description	No.	Price
20mm X 5mm chassis mounting	506	£0.18
1¼in X ¼in chassis mounting	507	£0.14
1¼in car inline type	508	£0.18
Panel mounting 20mm	509	£0.23
Panel mounting 1¼in	510	£0.37

QUICK BLOW 20mm

Type	No.		Type	No.		Type	No.	
150mA	611	7p	1A	615	6p	3A	619	6p
250mA	612	6p	1.5A	616	7p	4A	620	10p
550mA	613	6p	2A	617	6p	5A	621	6p
800mA	614	8p	2.5A	618	7p			

ANTI-SURGE 20mm

Type	No.	Type	No.	Type	No.
100mA	622	1A	625	2.5A	628
250mA	623	2A	626	3.15A	629
500mA	624	1.6A	627	5A	630

All 8p each

QUICK-BLOW 1¼in

Type	No.	Type	No.	Type	No.
250mA	631	500mA	632	800mA	634

All 8p each

Type	No.	Type	No.	Type	No.
1A	635	2.5A	638	4A	641
2A	637	3A	639	5A	642

All 7p each

NUTS AND BOLTS

BA BOLTS — packs of BA threaded cadmium plated screws slotted cheese head. Supplied in multiples of 50

Type	No.	Price	Type	No.	Price
1in 0BA	839	£1.38	½in 4BA	846	£0.37
½in 0BA	840	£0.86	¼in 4BA	847	£0.29
1in 2BA	842	£0.75	1in 6BA	848	£0.46
½in 2BA	843	£0.52	½in 6BA	849	£0.24
¼in 2BA	844	£0.60	¼in 6BA	850	£0.29
1in 4BA	845	£0.51			

BA NUTS — packs of cadmium plated full nuts in multiples of 50

Type	No.	Price	Type	No.	Price
0BA	855	£0.83	4BA	857	£0.35
2BA	856	£0.55	6BA	858	£0.28

BA WASHERS — flat cadmium plated plain stamped washers supplied in multiples of 50

Type	No.	Price	Type	No.	Price
0BA	859	£0.16	4BA	861	£0.14
2BA	860	£0.14	6BA	862	£0.14

SOLDER TAGS — Hot tinned supplied in multiples of 50

Type	No.	Price	Type	No.	Price
0BA	851	£0.46	4BA	853	£0.25
2BA	852	£0.32	6BA	854	£0.25

AUDIO LEADS

No.	Type	Price
107	FM indoor Ribbon Aerial	£0.69
113	3.5mm Jack plug to 3.5mm Jack plug Length 1.5m	£0.86
114	5 pin DIN plug to 3.5mm Jack connected to pins 3 & 5 Length 1.5m	£0.98
115	5 pin DIN plug to 3.5mm Jack connected to pins 1 & 4 Length 1.5m	£0.98
116	Car aerial extension Screened insulated lead Fitted plug and socket	£1.44
117	AC mains connecting lead for cassette recorders and radios 2 metres	£0.78
118	5 pin DIN phono plug to stereo headphone Jack socket	£1.21
119	2+2 pin DIN plugs to stereo Jack socket with attenuation network for stereo headphones Length 0.2m	£1.04
120	Car stereo connector Variable geometry plug to fit most car cassettes 8-track cartridge and combination units Supplied with inlined fuse power lead and instructions	£0.69
123	6.6m Coded Guitar Lead Mono Jack plug to Mono Jack plug. Black	£1.73
124	3 pin DIN plug to 3 pin DIN plug Length 1.5m	£0.86
125	5 pin DIN plug to 5 pin DIN plug Length 1.5m	£0.86
126	5 pin DIN plug to Tinned open end Length 1.5m	£0.86
127	5 pin DIN plug to 4 Phono Plugs All colour coded Length 1.5m	£1.50
128	5 pin DIN plug to 5 pin DIN socket Length 1.5m	£0.92
129	5 pin DIN plug to 5 pin DIN plug mirror image Length 1.5m	£1.21
130	2 pin DIN plug to 2 pin DIN inline socket Length 5m	£0.78
131	5 pin DIN plug to 3 pin DIN plug 1 & 4 and 3 & 5 Length 1.5m	£0.95
132	2 pin DIN plug to 2 pin DIN socket Length 10m	£1.13
133	5 pin DIN plug to 2 Phono plugs Connected pins 3 & 5 Length 1.5m	£0.86
134	5 pin DIN plug to 2 Phono sockets Connected pins 3 & 5 Length 23cm	£0.78
135	5 pin DIN socket to 2 Phono plugs Connected pins 3 & 5 Length 23cm	£0.78
136	Coded stereo headphone extension lead Black Length 6m	£2.01
178	AC mains lead for calculators, etc	£0.52

TRANSFORMERS

MINIATURE MAINS Primary 240V

No.	Secondary	Price
2021	6V-0-6V 100mA	£1.04
2022	9v-0-9v 75mA	£1.04
2023	12V-0-12V 100mA	£1.29

MINIATURE MAINS Primary 240V
with two independent secondary windings

No.	Type	Price
2024	MT280 0.6V 0.6V RMS	£1.84
2025	MT150 0-12V 0-12V RMS	£1.84

1 AMP MAINS Primary 240V

No.	Secondary	Price	
2026	6V-0-6V 1 amp	£2.88	P &P 45p
2027	9V-0-9V 1 amp	£2.30	P &P 45p
2028	12V-0-12V 1 amp	£2.99	P &P 55p
2029	15V-0-15V 1 amp	£3.16	P &P 66p
2030	30V-0-30V 1 amp	£3.97	P &P 86p

STANDARD MAINS Primary 240V
Multi tapped secondary mains transformers available in ½ amp, 1 amp and 2 amp current rating. Secondary taps are 0-19-25-33-40-50V. Voltages available by use of taps. 7, 8, 10, 14, 15, 17, 19, 25, 31, 33, 40, 25-0-25V

No.	Rating	Price	
2031	½ amp	£3.91	P &P 86p
2032	1 amp	£5.06	P &P 86p
2033	2 amp	£6.27	P &P £1
2035	240V Primary 0-55V @ 2A Secondary	£7.30	P &P £1

CASES AND BOXES

INSTRUMENT CASES. In two sections vinyl covered top and sides aluminium bottom front and back

No.	Length	Width	Height	Price
155	8in	5½in	2in	£1.73
156	11in	6in	3in	£2.92
157	6in	4¾in	1¾in	£1.79
158	9in	5¼in	2½in	£2.43

ALUMINIUM BOXES. Made from bright alu folded construction each box complete with half-inch deep lid and screws

No.	Length	Width	Height	Price
159	5¼in	2¼in	1½in	£0.85
160	4in	4in	1½in	£0.85
161	4in	2¼in	1½in	£0.85
162	5¼in	4in	1½in	£0.97
163	4in	2½in	2in	£0.87
164	3in	2in	1in	£0.60
165	7in	5in	2½in	£1.43
166	8in	6in	3in	£1.83
167	6in	4in	2in	£1.18

SLOPE front aluminium boxes with black vinyl base and sides & aluminium back top & front — strong construction easily accessible

169	2⅞in	5⅝in	2¾in	12in	3½in	8in	£5.45
168	1⅝in	7¼in	4in	16in	4½	11in	£8.21

Terms cash with order. Cheques/Postal Orders made payable to Bi-Pak at above address

BARCLAYCARD VISA

KEELMOOR Quality...

Keelmoor Ltd is a company which has been established for a long time – we supply the products you have often bought from other companies. Our precision watches and electrical goods are renowned for their superb quality and reliability.
We differ from other companies in that we import direct world-wide – that difference is passed on to you at unbeatable prices. You receive the goods faster and we provide a service and no catch guarantee of which we are justly proud.
We employ experts world-wide whose job it is to seek out products of the highest quality at the lowest possible prices. Illustrated here is just a tiny selection of our comprehensive range. Just compare these items with those seen elsewhere – we are confident the prices will amaze you. You can save ££££'s.

GENTS 5 FUNCTION LCD

A

This is the foundation of our range and is ideal for the man requiring the basic functions of hours, minutes and seconds, with month and date. A backlight is included and the stainless steel strap provided is fully adjusted to suit any size of wrist. Guaranteed for one year, this watch represents fantastic value at only

£4.95p

ILLUSTRATED BELOW IS THE LADIES 5 FUNCTION LCD.
This watch has the same time and auto calendar functions as the basic gents model described above, together with backlight and adjustable strap to suit the daintiest of wrists. It's compact, pleasing appearance makes it a very practical day watch and it is also often used for boys and girls. Available in black or white face.

These are just a few of our fantastic offers remember. A free colour catalogue is posted with every order. Or just send large S.A.E. and we'll send you one.

B

£5.95p

C

GENTS LCD ALARM WATCH

This model represents fantastic, incredible value for money. The 6 digit display continuously shows hours, minutes and seconds, or may be changed at will to hours, minutes and date. Its effective alarm is extremely useful and may be set to any time within a 24 hr. period. In addition, there is an alarm indicator, 4 year calendar and snooze repeater.

£8.95p

FULLY GUARANTEED
We must emphasize all these items are fully guaranteed for one year. All electronic goods come complete with demonstration batteries which cannot be guaranteed. New batteries are available for only 60p.

BARCLAYCARD AND ACCESS CARD WELCOME. SEE COUPON.

HERE IS THE AMAZING 12/24 HOUR ALARM/CHRONOGRAPH

D

Along with the usual time and date displays, this multi-functional timepiece has a 24 hour alarm and a 1/10 second stopwatch. The time may be set to operate in 12 or 24 hour mode and the date can be in English or American format. The day of the week is continuously indicated and the stopwatch display may, on command, be frozen to show split/laptime while the stopwatch continues to run. Stopwatch operation does not effect normal time keeping. £12.95 only for this model. Also available with solar energy panel to conserve energy during daylight hours for £14.95

FROM **£12.95p**

From Watches to Clocks, from Calculators to Radios, from Binoculars to Tool Kits – KEELMOOR is the name for the right quality at the right price. Your personal catalogue will tell you more – free with every order.

E

LADIES QUARTZ LCD DRESS WATCH

This attractive ladies model with the standard 5 functions of hours, minutes, seconds, month and date has literally sold in tens of thousands. Available in gold or silver colours with 'sugar coated' finish. Please state first and second choice of square, round or oval design.

£8.95p

THE ULTIMATE GENTS LCD CALCULATOR/ALARM WATCH

F

If you want a watch from the top end of the market this is the one for you. Full calculator functions plus memory and percentage are combined with time and alarm functions to make this item an outstanding buy. Manufactured in Japan at the same factory that produces models for probably the most famous name in the watch business, this device represents sheer quality at an unbelievable price. Comes complete with backlight and button operating tool carried in the strap clasp. We advise you to order quickly whilst stocks last.

£39.95p

at Keener Prices

FREE
With every order.
Big colourful
Keelmoor catalogue
featuring hundreds of
products at bargain
prices.

We don't think you'll find items of this quality anywhere else at the price we offer. Order now, Christmas is round the corner and this is the way to make gift buying easier – and cheaper too.

WE ARE PROUD TO INTRODUCE THE AMAZING MELODY ALARM CHRONOGRAPH

ACTUALLY PLAYS
THE YELLOW ROSE OF TEXAS
BUT AS YOU CAN SEE FROM THE DETAILS BELOW THIS CHRONOGRAPH IS NO MERE NOVELTY

Today's technology has produced this fine watch which incorporates a musical alarm which plays a complete verse of 'The Yellow Rose of Texas.' Other functions included are as for model number 1.

G

£14.95p

NEW TO OUR RANGE, WE COMBINE PRECISION AND STYLE IN THIS – THE SUPER SLIM GENTS 5 FUNCTION CHRONOGRAPH

JUST TO GIVE YOU AN IDEA OF THE ULTRA SLIMNESS OF THESE WATCHES WE HAVE ILLUSTRATED A SIDE VIEW OF THE SUPERSLIM DIGITAL. BELOW, WE HAVE ELABORATED ON SOME OF THE TECHNICALITIES:—

These watches need no special functions to make them stand out in a crowd – their slimness serves that purpose. If you've been put off digital quartz watches in the past because you require an ultra-slim design, now is the time to change. Is equipped with standard 5 functions and backlight.

£9.95p

Keelmoor Ltd, 78 Castle Street, Melbourne, Derbyshire, DE7 1DY.

MAINS DIGITAL ALARM CLOCK

I

A very practically sized mains operated digital alarm clock – this item is extremely well finished and looks equally at home by the bedside or in the living room. With snooze/repeater alarm you could not even buy the components to build your own for this price. Available at the amazingly low price of only

£8.95p

AND FINALLY, WHAT MUST BE THE ULTIMATE IN SQUEEZING A QUART INTO A HALF PINT POT! THE INCREDIBLE MINIATURE LCD TRAVEL/ALARM CLOCK

As you can see from the photograph above this device is tiny and yet it continuously displays hours and minutes with auto calendar and night light. Invaluable for the busy traveller or simply for use in the modern home, it comes complete with its own travelling case and can easily be carried in top pocket or the smallest of handbags. It has even got a stand for upright position on table, shelf or sleeping compartment. An unusual gift to yourself or others at only £10.95. **J**

Every order dispatched by return, and is sent by recorded delivery. That is **Keelmoor's Promise** To You.

THE KEELMOOR PROMISE
Keelmoor have a tremendous reputation to uphold, both in the retail and wholesale trades and so, with every product sold, we automatically give the Keelmoor Promise
This includes—
- **NO RISK GUARANTEE.** Try any of these items for 15 days and if you are not completely satisfied with the quality and value simply return it for a complete refund.
- **ONE YEAR'S FULL GUARANTEE** on all products
- **BACK UP SERVICE** second to none

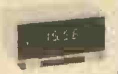
15 DAY TRIAL COUPON.
To Keelmoor Ltd, 78 Castle Street, Melbourne, Derby DE7 1DY
Please send me the items indicated in the boxes below. I understand that if I am not completely satisfied, I may return the goods undamaged within 15 days and my money will be refunded in full.

A	B	C	D	E	F	G	H	I	J	Just indicate with a ✓ tick, item required, if more then one required tick plus number – i.e ✓3

TOTAL AMOUNT = £

NAME Mrs. Miss. Ms. Mr. ______________
ADDRESS ______________
______________ POSTCODE ______________
I enclose a cheque/PO to **KEELMOOR LTD**
Or charge my **Access** [ ] or **BARCLAYCARD** [ ] (tick as applicable).
No. ______________
TOTAL – £ Please add 50p per item P&P.
The advertisements to watch for quality precision at the right price.
All goods dispatched by return. PE 5

24 HOUR CLOCK/APPLIANCE TIMER KIT



Switches any appliance up to 1KW on and off at preset times once per day. Kit contains: AY-5-1230 IC, 0.5" LED display, mains supply, display drivers, switches, LEDs, triac, PCBs & full instructions.

CT1000K Basic Kit	£14.90
CT1000KB with white box (56/131×71mm)	£17.40
Ready Built	£22.50

MINI KITS

These Kits form useful subsystems which may be incorporated into larger designs or used alone. Kits include PCB, short instructions and all components.

MK1 TEMPERATURE CONTROLLER/ THERMOSTAT
Uses LM3911 IC to sense temperature (80°C max). and triac to switch heater. 1KW **£4.00**

MK2 SOLID STATE RELAY
Ideal for switching motors, lights, heaters, etc. from logic. Opto-isolated with zero voltage switching. Supplied without triac. Select the required triac from our range. **£2.60**

MK3 BAR/DOT DISPLAY
Displays an analogue voltage on a linear 10-element LED display as a bar or single dot. Ideal for thermometers, level indicators etc. May be stacked to obtain 20 to 100 element displays. Requires 5-20V supply. **£4.75**

MK4 PROPORTIONAL TEMPERATURE CONTROLLER
Based on the TDA1024 Zero voltage switch, this kit may be wired to form a "burst fire" power controller or a "proportional temperature" controller enabling the temperature of an enclosure to be maintained to within 0.5°C. 3KW **£6.55**

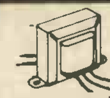
MK5 MAINS TIMER
Based on the ZN1034E Timer IC this kit will switch a mains load on (or off) for a preset time from 20 minutes to 35 hours. Longer or shorter periods may be realised by minor component changes. Maximum load 1KW **£4.50**

TRIACS

400V Plastic Case (Texas)

3A	49p		
8A	58p	16A	95p
12A	85p	25A	190p
6A with trigger			80p
8A isolated tab			65p
Diac			18p

MINI TRANSFORMERS



Standard mains primaries 240V a.c. 100mA secondaries

6-0-6V	80p
9-0-9V	85p
12-0-12V	90p

TRADE ENQUIRIES WELCOME

CMOS

4000	.17	4019	.42	4069	.19
4001	.18	4023	.22	4070	.19
4002	.18	4025	.21	4071	.18
4007	.17	4026	1.30	4077	.26
4011	.19	4027	.40	4081	.20
4012	.17	4028	.50	4093	.54
4013	.38	4040	.80	4501	.24
4015	.75	4049	.38	4511	.90
4016	.35	4050	.40	4514	1.80
4017	.70	4060	1.08	4516	1.80

SPECIAL OFFERS

Orders must be received by 30/11/80.

3½ digit Liquid Crystal Display. 0·5" digits, d.i.l. package. Can be backlit for viewing in the dark **£5.95**

2N3442 Power Transistor 2 for **£1.80**

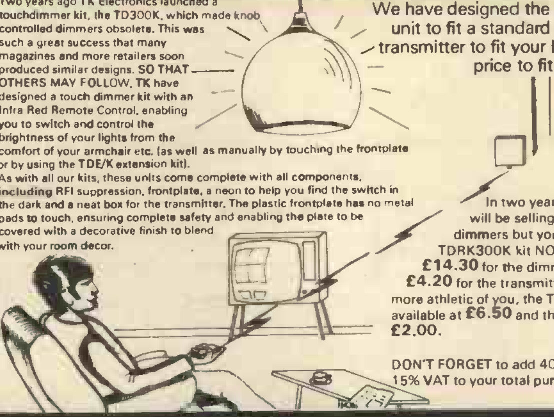
INTEGRATED CIRCUITS

555 Timer	21p
741 Op. Amp.	19p
AY-5-1224 Clock	£2.60
AY-5-1230/2 Clock/Timer	£4.50
AY-3-1270 Thermometer	£8.20
ICL7106 DVM (LCD drive)	£7.00
LM377 Dual 2W Amp.	£1.45
LM379S Dual 6W Amp.	£3.50
LM380 2W Audio Amp.	80p
LM382 Dual low noise Preamp	£1.00
LM386 250mW low voltage Amp.	75p
LM1830 Fluid Level Detector	£1.50
LM2907 f-v Converter (8 pin)	£1.40
LM2917 f-v Converter (14 pin)	£1.60
LM3909 LED Flasher/Oscillator	60p
LM3911 Thermometer	£1.20
LM3914 Dot/Bar Driver	£2.10
MM74C911 4 digit display controller	£6.50
MM74C915 7 segment-BCD converter	96p
MM74C926 4 digit counter with 7 seg. o/p	£4.50
S566B Touchdimmer	£2.50
S9263 Touchswitch 16-way	£4.85
SN76477 Complex Sound Generator	£2.52
TBA800 5W Audio Amp.	68p
TBA810AS 7W Audio Amp.	
TDA1024 Zero Voltage Switch	£1.20
TDA2020 20W Audio Amp.	£2.85
ZN1034E Timer	£1.80

All ICs supplied with data sheets.
Data Sheets only. 10p each device.

AND NOW A DIMMER THAT MAKES TOUCH DIMMERS OBSOLETE

Two years ago TK Electronics launched a touchdimmer kit, the TD300K, which made knob controlled dimmers obsolete. This was such a great success that many magazines and more retailers soon produced similar designs. SO THAT OTHERS MAY FOLLOW, TK have designed a touch dimmer kit with an Infra Red Remote Control, enabling you to switch and control the brightness of your lights from the comfort of your armchair etc. (as well as manually by touching the frontplate or by using the TDE/K extension kit).
As with all our kits, these units come complete with all components, including RFI suppression, frontplate, a neon to help you find the switch in the dark and a neat box for the transmitter. The plastic frontplate has no metal pads to touch, ensuring complete safety and enabling the plate to be covered with a decorative finish to blend with your room decor.



We have designed the light dimmer unit to fit a standard wall box, the transmitter to fit your hand and the price to fit your pocket.

In two years' time everyone will be selling remote control dimmers but you can have your TDRK300K kit NOW for only **£14.30** for the dimmer unit and **£4.20** for the transmitter. For the more athletic of you, the TD300K is still available at **£6.50** and the TDE/K at **£2.00.**

DON'T FORGET to add 40p P&P and 15% VAT to your total purchase.

REMOTE CONTROL COMPONENTS

LD271 IR Emitting Diode	36p
SFH205 Photodiode Detector	95p
SL480 IC Pulse Amp.	£1.70
SL490 32 command encoder/transmitter	£2.40
ML922 10 channel receiver + 3 analogue outputs	£4.20
ML926 16 channel receiver 4 momentary binary o/p	£1.40
ML928 16 channel receiver 4 latched binary o/p	£1.40
ML929 16 channel receiver 4 latched binary o/p	£1.40
Data sheets per device	10p

These ICs can be used with infra red, ultrasonic or radio links, depending on range, cost and speed of operation.

RC500K KIT

If you do not require a sophisticated multi-channel remote control, we have developed a simple single-channel on/off infra red transmitter and receiver kit. The transmitter unit comes complete with a hand held box and requires a PP3 (9V) battery. The receiver includes a triac capable of switching up to 500W at 240V a.c. and comprises a pre-amplifier bistable latch and a mains power supply, making the unit completely self-contained. The small size of the receiver enables the unit to be "built into" all kinds of equipment from lamps to tape recorders. Range: approximately 20 ft.

£12.50.

ALL COMPONENTS ARE BRAND NEW AND TO SPECIFICATION. ADD VAT AT CURRENT RATE TO ABOVE PRICES. 40p P&P MAIL ORDER – CALLERS WELCOME BY APPOINTMENT

TK Electronics
(P.E.), 11 Boston Road, London
W7 3SJ. TEL. 01-579 9794

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(SWIFT OF WILMSLOW) FOR HI-FI & COMPLETE SPEAKERS

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Special purchase of factory clearance capacitors enables us to offer: **C280 Polyesters** (Liquorice Allsorts) at **£2** for 100 mixed. And **Miniature Electrolytics** at £1.50 for 100 mixed. **Pack of each** only £3.
These consist of spillages, floor sweepings, cosmetic imperfects etc. As we have no time to sort them they are magnificent value for the constructor.

HUMIDISTATS
Don't Let Your Environment Dehydrate You!
Buy our Honeywell **Humidity Controller.**
Membrane actuated, very sensitive. ¼" shaft. 250V, 3.75A Contacts. Ideal for greenhouses, centrally heated homes, offices etc. Build your own humidifiers or alarms. Fraction of original cost 90p ea. 3 for £2.

20 ASSORTED ZENER DIODES
1 watt and 400MW. £1.50

100 MIXED DIODES
Includes: Zener, power, bridge, germanium, silicon etc. All full spec £4.95

.2" LED's
0·2" LEDS with 2 piece clips.

ULTRASONIC TRANSDUCERS
Transmitter and receiver 40 kHz 14 mm dia. £3·25 pair.

MINIATURE REED SWITCHES
We are the cheapest! 12 for £1.00 100 for £4.20

G.E.C. UHF TRANSISTOR TV TUNERS
Rotary type with slow motion drive, leads and aerial socket £1.50 3 for £3.50 "for G.E.C. "2010" series etc."

DE LUXE FIBRE GLASS PRINTED CIRCUIT ETCHING KITS
Includes 150 sq. ins. copper clad F/G. board 1 lb ferric chloride 1 dalo etch resist pen. Abrasive cleaner. Etch tray plus instructions. **Special Price £4.95**
1 lb FE. C1. To mil. spec. £1.25
5 lb FE. C1. To mil spec £5.00
150 sq. in. **Single sided** board £2.00
150 sq. in. **Double sided** board £3.00

MINIATURE MAINS TRANSFORMERS
Top quality. Split bobbin construction will give 4·5V-0-4·5V at 250 MA. 1½"×1¼"×1¼", all sorts of uses **ONLY 90p.** 3 for £2.20.
2,200 µf 40V **Radial.** 1½"×2" 60p. 3 for £1·50.
1,000 µf 100V **Radial.** 1½"×2" **ONLY 70p.** 3 for £1·50.

BD181 78 Watt T.O.3 Power Transistors. 50p ea. 3 for £1.
4AF1 Alternator Diodes. Ideal for making **Battery Chargers** etc. 4 make 50 amp bridge. **50p ea.** –Ve or +Ve case 2 of ea. £1.50.

TRANSISTOR PACKS
100. Full spec, new and marked. Includes BC148, BC184L, ME0412, BF274, BC154 etc. etc. **£4.95**
200 as above and includes AC128, 2N3055, BFY50, BD131, BF200 etc. **£8.95**
Buy bulk and save money, these packs are worth at least double.

P/B SWITCH BANKS
These cost a fortune! Were made for various music centres. Includes independent and interdependent latching types multi pole c/o etc. Can be modified. Can't be **repeated. 3 Banks for £1**

Knobs for P/B Switches. Fit 3½ mm sq. shaft 10 for £1. Chrome or Spun Aluminium Finish.

BULK BARGAINS. STOCK UP FOR SUMMER
300 mixed ¼ & ½ watt resistors £1.50
150 mixed 1 & 2 watt resistors £1.50
300 mixed capacitors, modern, most types £3.75
100 mixed ceramic and plate caps £1.20
400 mixed film resistors £2.95
100 mixed polystyrene caps £2.20
25 pots and presets £1.50
25 presets, skeleton etc. £1.20
20 VDRs and thermistors £1.20
100 Hi wattage resistors wirewound at £2.75
100 electrolytics, nice values £2.20
300 printed circuit resistors £1
300 printed circuit components £1.50

100K MINIATURE THUMBWHEEL SLIDER POTS
Very neat, can be banked side by side. Ideal for v. cap tuning, graphic equalisers etc. 10 for £1

MINIATURE LEVEL/BATT. METERS 200µA
F.S.D. as fitted to many cassette recorders 60p

50p P & P on all above items. Cheque or P.O. with order to:

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TELEPHONE 01-883 3705 01-883 2289

YOUR SOUNDEST CONNECTION IN THE WORLD OF COMPONENTS

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8N (8K RAM)
£399

16N (16K RAM) **£499**
32N (32K RAM) **£599**

ALL WITH NEW KEYBOARD AND GREEN SCREEN.

PERIPHERALS

Service & Assistance available.
Interfaces available are:
X-Y plotters, analogue to digital converter, 16 channel interfaces, bi-directional interfaces, etc.

EXTERNAL CASSETTE DECK SUITABLE FOR ALL PETS **£55**

NEW LOW PRICE

UK101

£179 in kit form
£229 ready built & tested
£249 complete in case

INVADER TAPE £5.00

ASSEMBLER EDITOR TAPE £14.95

NO EXTRAS REQUIRED
* FREE SAMPLER TAPE
* FULL QWERTY KEYBOARD
* 8K BASIC
* RAM EXPANDABLE TO 8K ON BOARD (4K INC)
* KANSAS CITY TAPE INTERFACE

* New monitor allows full editing & cursor control.
£22

LATEST STOP PRESS AND PRICE LIST

SEND SAE OR PHONE FOR UP TO DATE **PRICES** OF ALL OUR RANGE OF ITEMS STOCKED

CASES

Available for UK101, Superboard, NASCOM.
Approx. dim. 17″x15″
435mmx384mm
Price £24.50
Post and packing £1.50

TAPES

Unique stackable tape storage unit. Interlocking drawers. Drawers each containing 2 x C12 tapes.
10 drawers **£9.50**
5 drawers **£5.25**
Single drawer **£1.10**

MEMORY EXPANSION KIT

Suitable for UK101, Superboard expansion using 2114's. Each board has 16K RAM capacity.

Kit contains:

* On board power supply
* 4K EPROM expansion
* Fully buffered for easy expansion via 40 pin socket

* **8K KIT £99.95**
* **16K KIT £139.90**

PRINTERS

TX-80 £375
EPSON TX-80 £375

Dot-matrix printer with Pet graphics Interface: Centronics parallel, options: PET, Apple and serial.

MEMORY

D. RAMS	£ p.
4027	2.75
4050 (350NS)	2.35
4060 (300NS)	2.39
4116	4.35
S. RAMS	
2102A	1.09
2102A-2	1.09
2112A	2.25
21L02	98
2114-4045	2.95
4035	1.07
4044-5257	6.93
BULK PURCHASE	
8 x 2114	22.50
8 x 4116	29.95
8 x 21L02	7.00
BULK PURCHASE	
16 x 2114	39.95
16 x 21L02	13.00
32 x 21L02	25.00
64 x 21L02	45.00

EPROM'S

2708	4.95
2716 (5v)	13.95
2532	39.95

ROM'S

2513(UC)	5.95
2513(LC)	5.95

CPU'S

6502	9.50
8080	4.75
9900	25.95
6800	5.90
Z80	8.95

BUFFERS

81LS95	1.25
81LS96	1.25
81LS97	1.25
81LS98	1.25
SN74365	52
SN74366	52
SN74367	52
SN74368	52
8T26	1.75
8T28	1.75
8T95	1.57
8T96	1.57
8T97	1.50
8T98	1.57

BAUD RATE GENS

MC14411	8.75
MM5307	8.75

UARTS

AY-5-1013	3.45
AY-5-1015	3.98
MM5503	4.75
TMS 6011	3.55

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New Profile Amplifiers - Two New Series

MOSFET

CHOOSE AN I.L.P MOSFET POWER AMP when it is advantageous to have a faster slew rate, lower distortion at higher frequencies, enhanced thermal stability, the ability to work with complex loads without difficulty and complete absence of cross-over distortion. I.L.P's exclusive encapsulation technique within fully adequate heatsinks has been taken a stage further with specially developed computer-verified 'New Profile' extrusions. These ensure optimum operating efficiency from our new MOSFETS, and are easier to mount. Connection is via five pins on the underside. **I.L.P MOSFETS ARE IDENTICAL IN PERFORMANCE TO THE COSTLIEST AMPLIFIERS IN THIS EXCITING NEW CATEGORY BUT ARE ONLY A FRACTION OF PRICES CHARGED ELSEWHERE.**

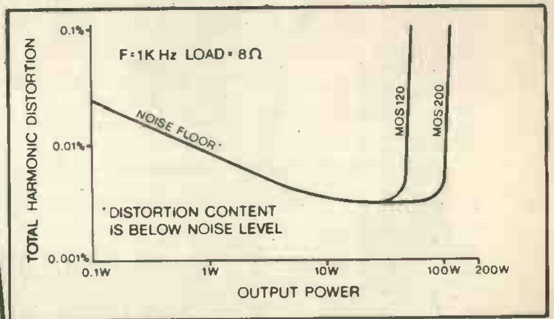
Model	Output Power RMS	Distortion Typical at 1KHz	Slew Rate	Rise Time	Signal/Noise Ratio DIN AUDIO	Price & VAT
MOS120	60W into 4-8Ω	0.005%	20V/μs	3μs	100dB	£25.88 + £3.88
MOS200	120W into 4-8Ω	0.005%	20V/μs	3μs	100dB	£33.46 + £5.02

BIPOLAR

CHOOSE AN I.L.P BIPOLAR POWER AMP where power and price are first consideration while maintaining optimum performance with hi-fi quality and wide choice of models. From domestic hi-fi to disco and P.A., for instrument amplification, there is an I.L.P Bipolar to fill the bill, and as with our new Mosfets, we have encapsulated Bipolars within our New Profile extrusions with their computer-verified thermal efficiency and improved mounting lugs. Connections are simple, via five pins on the underside and with our newest pre-amps and power supply units, it becomes easier than ever to have a system layout housed the way you want it.

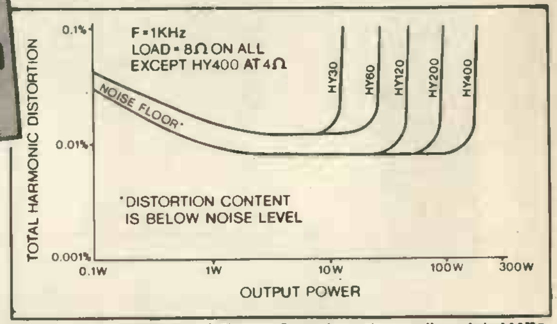
Model	Output Power RMS	Distortion Typical at 1KHz	Slew Rate	Rise Time	Signal/Noise Ratio DIN AUDIO	Price & VAT
HY30	15W into 4-8Ω	0.015%	15V/μs	5μs	100dB	£6.34 + 95p
HY60	30W into 4-8Ω	0.015%	15V/μs	5μs	100dB	£7.24 + £1.09
HY120	60W into 4-8Ω	0.01%	15V/μs	5μs	100dB	£15.20 + £2.28
HY200	120W into 4-8Ω	0.01%	15V/μs	5μs	100dB	£18.44 + £2.77
HY400	240W into 4Ω	0.01%	15V/μs	5μs	100dB	£27.68 + £4.15

ILP POWER AMPS ARE ENCAPSULATED FOR THERMAL STABILITY AND LONGER LIFE



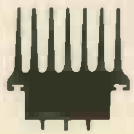
Load impedance both models 4Ω-∞ Input sensitivity both models 500mV

Input impedance both models 100KΩ Frequency response both models 15Hz-100KHz - 3dB



Load impedance all models 4Ω-∞ Input sensitivity all models 500mV

Input impedance all models 100KΩ Frequency response all models 15Hz-50KHz - 3dB



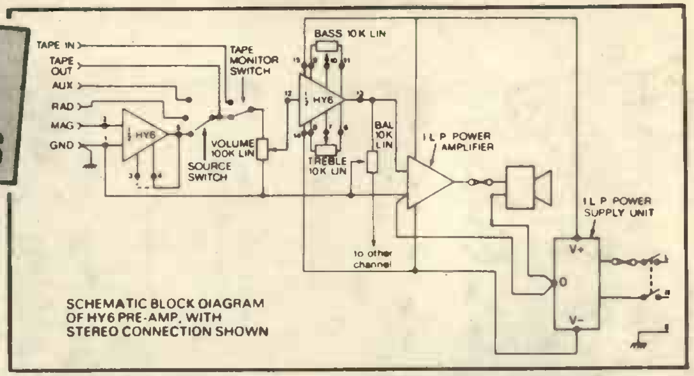
THE NEW PROFILE EXTRUSIONS
The introduction of standard heatsink extrusion for all I.L.P power amplifiers achieves many advantages: – Research shows they provide optimum thermal dissipation and stability. Slotted shoulders allow easy mounting; standardisation enables us to keep our prices competitive. Surfaces are matt black, anodised for lower thermal conductivity. Extrusions vary in size according to module number.

NEW PRE-AMPS

HY6 (mono) and **HY66** (stereo) are new to I.L.P's range of advanced audio modules. Their improved characteristics and styling ensure their being compatible with all I.L.P power-amps both MOSFET and BIPOLAR, giving you chance to get the best possible reproduction from your equipment. HY6 and HY66 pre-amps are protected against short circuit and wrong polarity. Full assembly instructions are provided. Mounting boards are available as below.
Sizes – **HY6** – 45 x 20 x 40 mm. **HY66** – 90 x 20 x 40 mm.
Active Tone Control circuits provide ±12dB cut and boost.
Inputs Sensitivity – Mag. PU. –3mV: Mic – selectable 1-12mV: All others 100mV. **Tape O/P** – 100mV: **Main O/P** – 500mV: **Frequency response** – D.C. to 100KHz – 3dB.

HY6 mono £5.60 + 84p VAT Connectors included
HY66 stereo £10.60 + £1.59 VAT Connectors included
B6 Mounting Board for one HY6 78p + 12p VAT
B66 Mounting Board for one HY66 99p + 15p VAT

COMPATIBLE WITH ALL ILP MODULES



SCHEMATIC BLOCK DIAGRAM OF HY6 PRE-AMP, WITH STEREO CONNECTION SHOWN

- **DISTORTION TYPICALLY 0.005%**
- **S/N RATIO – 90dB (Mag. P.U. – 68 dB)**
- **38 dB overload margin on Mag. P.U.**
- **LATEST HIGH QUALITY CONNECTORS**
- **ONLY POTS, SWITCHES AND PLUGS/SOCKETS NEED ADDING**
- **NEEDS ONLY UNREGULATED POWER SUPPLY ± 15 to ± 60v**

NEW POWER SUPPLY UNITS

IN A RANGE OF 11 MODELS USING LATEST TOROIDAL TRANSFORMERS

Of the eleven power supply units which comprise our current range, nine have toroidal transformers made in our own factory. Thus these I.L.P power supply units are space-saving, more efficient and their better overall design helps enormously when assembly building. All models in the range are compatible with all I.L.P amps and pre-amps with types to match whatever I.L.P power amps you choose.

PSU30 ±15V at 100mA to drive up to 12 x HY6 or 6 x HY66	**£4.50** + 0.68p VAT
THE FOLLOWING WILL ALSO DRIVE I.L.P PRE-AMPS	
PSU36 for 1 or 2 HY30's	**£8.10 + £1.22 VAT**
PSU50 with toroidal transformer for 1 or 2 HY60's	**£9.75 + £1.46 VAT**
PSU60 with toroidal transformer for 1 HY120	**£9.75 + £1.46 VAT**
PSU65 with toroidal transformer for 1 MOS120	**£9.75 + £1.46 VAT**
PSU70 with toroidal transformer for 1 or 2 HY120's	**£13.61 + £2.04 VAT**
PSU75 with toroidal transformer for 1 or 2 **MOS120**	**£13.61 + £2.04 VAT**
PSU90 with toroidal transformer for 1 HY200	**£13.61 + £2.04 VAT**
PSU95 with toroidal transformer for 1 **MOS200**	**£14.75 + £2.21 VAT**
PSU180 with toroidal transformer for 1 HY400 or 2 HY200	**£23.02 + £3.45 VAT**
PSU185 with toroidal transformer for 1 or 2 **MOS200**	**£24.20 + £3.63 VAT**

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When, as a young man in 1971, Ian L. Potts founded his now world-famous company, he realised the need for a different and more rational approach to exploiting to the maximum, the potential of modular construction. New thinking was badly needed. The result was a range of modules completely revolutionary in concept. The rightness of Ian Potts' thinking is shown in the size of the company today, its new factory, its vast exports, its acceptance by constructors as *the* modules to build with. The range grows bigger and better. New lines (in no way replacing existing ones) are well past drawing board stage. This is why I.L.P are simply ahead and staying there – we don't rest on our laurels.

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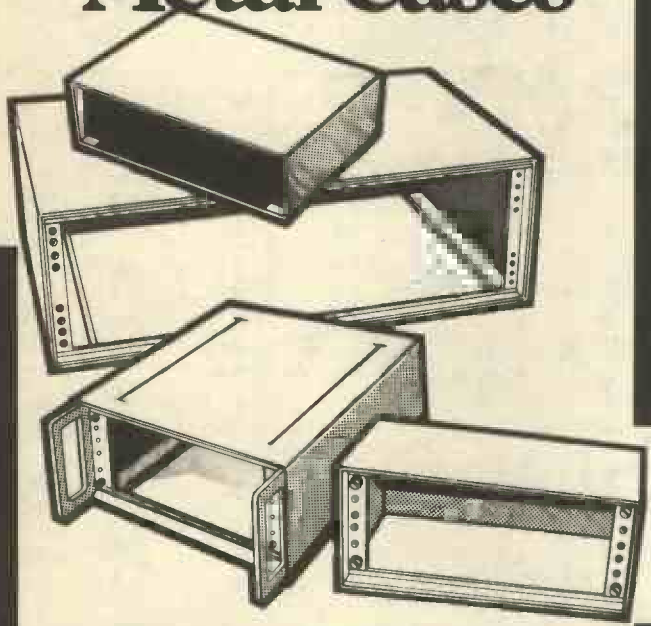

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20FE06	6+6	1·6A EACH	3·36	75p
50FE06	6+6	3A EACH	4·02	90p
60FE06	6+6	4A EACH	5·03	125p
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12FE09	9+9	0·7A EACH	2·66	75p
20FE09	9+9	1A EACH	3·36	75p
50FE09	9+9	2·5A EACH	4·02	90p
60FE09	9+9	3A EACH	5·03	125p
06FE12	12+12	0·2A EACH	1·99	60p
08FE12	12+12	0·3A EACH	2·40	60p
20FE12	12+12	0·8A EACH	3·36	75p
50FE12	12+12	1·8A EACH	4·02	90p
60FE12	12+12	2·5A EACH	5·03	125p
80FE12	12+12	3A EACH	6·20	125p
06FE15	15+15	0·2A EACH	1·99	60p
08FE15	15+15	0·25A EACH	2·40	60p
12FE15	15+15	0·4A EACH	2·66	75p
20FE15	15+15	0·6A EACH	3·36	75p
50FE15	15+15	1·5A EACH	4·02	90p
60FE15	15+15	2A EACH	5·03	125p
80FE15	15+15	3A EACH	6·20	125p
06FE20	20+20	0·15A EACH	1·99	60p
12FE20	20+20	0·25A EACH	2·66	75p
20FE20	20+20	0·5A EACH	3·36	75p
50FE20	20+20	1·2A EACH	4·02	90p
60FE20	20+20	1·5A EACH	5·03	125p
80FE20	20+20	2A EACH	6·20	125p
BATTERY CHARGER TRANSFORMERS				
48FE12	0-6-12	4A	5·00	125p
66FE12	0-6-12	5A	5·80	125p
70FE12	0-6-12	6A	6·15	150p
90FE12	0-6-12	8A	7·40	150p
06FE30	6-0-6	1·5A	1·95	60p
06FE40	9-0-9	0·5A	1·95	60p
06FE50	12-0-12	0·5A	1·95	60p

Type	Voltage	Current	£	p/p
06FE60	15-0-15	0·4A	1·95	60p
08FE40	9-0-9	1A	2·35	60p
08FE60	15-0-15	0·5A	2·35	60p
12FE40	9-0-9	1·5A	2·60	75p
12FE50	12-0-12	1A	2·60	75p
12FE60	15-0-15	0·8A	2·60	75p
20FE50	9-0-9	2A	3·30	75p
20FE60	12-0-12	1·6A	3·30	75p
20FE70	15-0-15	1·2A	3·30	75p
20FE80	20-0-20	1A	3·30	75p
20FE100	30-0-30	0·6A	3·30	75p
50FE50	9-0-9	5A	4·00	90p
50FE70	15-0-15	3A	4·00	90p
50FE80	20-0-20	2A	4·00	90p
50FE110	30-0-30	1·4A	4·00	90p
60FE70	15-0-15	4A	5·00	125p
60FE80	20-0-20	3A	5·00	125p
60FE100	28-0-28	2·2A	5·00	125p
60FE110	30-0-30	3A	5·00	125p
80FE40	12-0-12	6A	6·15	125p
80FE50	15-0-15	5A	6·15	125p
80FE60	20-0-20	4A	6·15	125p
80FE80	28-0-28	2·5A	6·15	125p
80FE70	24-0-24	3A	6·15	125p
80FE90	30-0-30	2·3A	6·15	125p
90FE50	15-0-15	5A	6·30	150p
90FE80	28-0-28	3A	6·30	150p
90FE90	30-0-30	3A	6·30	150p
100FE50	15-0-15	4A	6·60	150p
100FE26	26-0-26	3·5A	6·60	150p
100FE28	28-0-28	3A	6·60	150p
100FE30	30-0-30	3A	6·60	150p
100FE36	36-0-36	3A	6·60	150p
150FE15	15-0-15	6A	8·20	160p
150FE26	26-0-26	5A	8·20	160p
150FE30	30-0-30	4A	8·20	160p
150FE36	36-0-36	4A	8·20	160p
150FE42	42-0-42	3A	8·20	160p
250FE28	28-0-28	8A	9·02	200p
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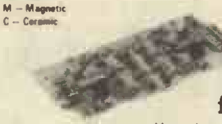
M – Magnetic
C – Ceramic



£30.70

Magnetic or ceramic deck versions – please state

NEW ADVANCED MODEL AVAILABLE

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LBPA3PS – Regulated supply – £10.50.

Full set of pots — **£8.63** Sliders — **£11.21**

3 CHANNEL SOUND/LIGHT

LB31000SL

£21.40

All the advantages of the SLC without chase. Controls: bass/mid/treble/master sensitivity.

LPBA2

£17.20

A four channel mixer and tone stage for mics, guitars, etc. Can be used with any LB amps. Set of pots £2.74, sliders £5.23.

LBPA1

£19.50

A stereo hi-fi preamp and tone stage for mag. p.u./tape/tuner, etc. Set of pots £3.27, sliders £4.49.

3-WAY ACTIVE CROSSOVER

LBAC01

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LBPSU1

£6.20

Bass/mid/treble active crossover with stage booster! Available with crossover points of 200 or 300Hz, and 2K or 3KHz (please specify) LBPSU1 supply for LBACO1.

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An all logic chaser system for use with up to 8 channels at 1,000 watts each. Facilities include footswitch trigger and module cascading (16, 24, 32 channel, etc.), chase speed and re-cycle delay.

POWER AMPLIFIERS

Tough dealing power amps for use in sound systems. Open/short circuit protection and fused. Heavy gauge heatsinks and rugged o/p devices (all operate down to 4 ohms).

25W R.M.S	100W R.M.S	150W R.M.S	250W R.M.S
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0.07% THD	0.1% THD	0.1% THD	0.1% THD
96DB S/N	110DB S/N	110DB S/N	110DB S/N
LB25	LB100	LB150	LB250
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Note all models are available with either 500mV or 775mV sensitivity. Please state when ordering.

4 CHANNEL SEQUENCER

LB41000LS

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A 4 channel sequence generator for banks of lamps up to 1,000W per channel. Two speed controls, cross effect to provide settings between seconds and rapid burst.

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A de-thump unit for use with any LB power amps.

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LB31000LD

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Single channel version

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P/P £1.20	P/P £1.40	P/P £1.40	P/P £1.70

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24 feet ropes
Red/Yellow
Blue/Green

ROPE LIGHTS

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A four channel chaser up to 1,000W per channel, with a sound trigger facility. The music input signal modulates the speed of the chase giving an excellent sound/light effect. The unit will control up to 10 ropes with chase speed and trigger level control

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(8 ohms)

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LBMM3 Bass/boost/cut for either LBMM1/2/3/4/5
LBMM4 Mid-boost/cut for either LBMM1/2/3/4/5
LBMM5 Treble boost/cut for either LBMM1/2/3/4/5
LBPSU1 ± 15V supply for up to 8 modules
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50HZ BLACK AND WHITE SUPERBOARD II £159.95 + 15% VAT POST FREE.
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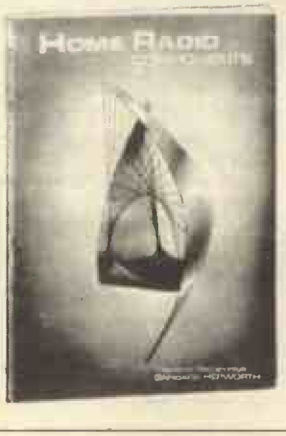

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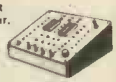

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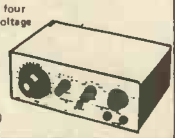

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Advertisements in this publication are required to conform to the British Code of Advertising Practice. In respect of mail order advertisements where money is paid in advance, the code requires advertisers to fulfill orders within 28 days, unless a longer delivery period is stated. Where goods are returned undamaged within seven days, the purchaser's money must be refunded. Please retain proof of postage/despatch, as this may be needed.

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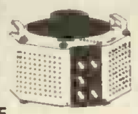

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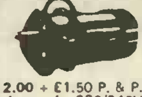

200 rpm. 35 lbs in. 115V. 50Hz.
Price: £16·00 + £1·50 P. & P.(£20·13 inclus. VAT). N.M.S.
Suitable Transformer for 230/240V. a.c.
Price: £8·00 + £1·00 P. & P. (£10·35 inclus. VAT). N.M.S.

1 rpm 230/240V. a.c. Synchronous geared Motor, mf. **HAYDON. 2 rpm** 230/240V. a.c. Synchronous geared Motor. mf. **CROUZET.** Either type £3.90 + 30p. P. & P. (£4.83 inc. VAT).

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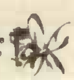
Powerful continuously rated a.c. motor complete with 5 blade 6½in. or 4 blade 3in. aluminium fan. Price £3.50. P. & P. 65p (£4.77 incl. VAT & P.).



24V. D.C. GEARED MOTOR
24V. D.C. 200 rpm 10lbs/ins. continuously rated geared Motor mfg. by either Parvalux or Carter. Easily removable from heavy all. chassis containing 9×24V. D.C. Solenoids, microswitches, friction clutch, precision gearing etc. etc. Ex-equipment London Transport Ticket Printer. Price: £11.00 + £2.00 p. & p. (total incl. VAT £14.95).

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Direct coupled to 1/3 h.p. 110/115V. A.C. Motor 4.2 amp. 1380 rpm. Motor manuf. by A.E.I. or G.E.C. Pump by Williams. Max. Vac. 25" H.G. Max. pressure cont. 10 p.s.i. Int. 15 p.s.i. Max. airflow 3 c.f.m. at "0" H.G. Price: £30.00 + £3.00 P. & P. (£37.95 incl. VAT). N.M.S.
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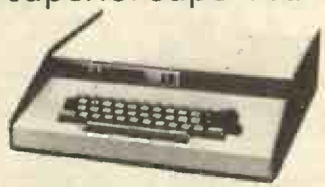

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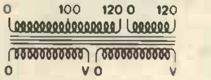

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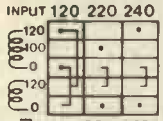

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TTP 451	4·18 • 2	4·57	120
TTP 452	8·33 • 2	5·68	120

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REF	AMPS	PRICE	P/P
TTP 460	0·30 • 2	1·79	50
TTP 461	0·50 • 2	2·14	60
TTP 463	0·60 • 2	2·36	70
TTP 464	1·38 • 2	2·99	85
TTP 465	2·77 • 2	4·57	120
TTP 466	5·55 • 2	5·68	120

0v·12v 0v·12v

REF	AMPS	PRICE	P/P
TTP 467	0·25 • 2	1·79	50
TTP 468	0·38 • 2	2·14	60
TTP 470	0·50 • 2	2·36	70
TTP 471	1·04 • 2	2·99	85
TTP 472	2·08 • 2	4·57	120
TTP 473	4·16 • 2	5·68	120

0·15v 0·15v

REF	AMPS	PRICE	P/P
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TTP 475	0·30 • 2	2·14	60
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TTP 478	0·83 • 2	2·99	85
TTP 479	1·66 • 2	4·57	120
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TTP 498	0·25 • 2	2·36	70
TTP 499	0·52 • 2	2·99	85
TTP 500	1·04 • 2	4·57	120
TTP 501	2·08 • 2	5·68	120

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TTC 450	2·08 • 2	3·10	85
TTC 451	4·18 • 2	4·70	120
TTF 452	8·33 • 2	5·85	120

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REF	AMPS	PRICE	P/P
TTC 460	0·30 • 2	1·85	50
TTC 461	0·50 • 2	2·20	60
TTC 463	0·60 • 2	2·45	70
TTC 464	1·38 • 2	3·10	85
TTC 465	2·77 • 2	4·70	120
TTF 466	5·55 • 2	5·85	120

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REF	AMPS	PRICE	P/P
TTC 467	0·25 • 2	1·65	50
TTC 468	0·38 • 2	2·20	60
TTC 470	0·50 • 2	2·45	70
TTC 471	1·04 • 2	3·10	85
TTC 472	2·08 • 2	4·70	120
TTF 473	4·16 • 2	5·85	120

0v·15v 0v·15v

REF	AMPS	PRICE	P/P
TTC 474	0·20 • 2	1·85	50
TTC 475	0·30 • 2	2·20	60
TTC 477	0·40 • 2	2·45	70
TTC 478	0·83 • 2	3·10	85
TTC 479	1·66 • 2	4·70	120
TTF 480	3·33 • 2	5·85	120

0v·24v 0v·24v

REF	AMPS	PRICE	P/P
TTC 495	0·13 • 2	1·85	50
TTC 496	0·19 • 2	2·20	60
TTC 498	0·25 • 2	2·45	70
TTC 499	0·52 • 2	3·10	85
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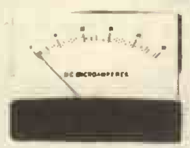

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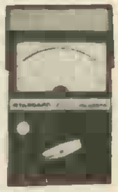

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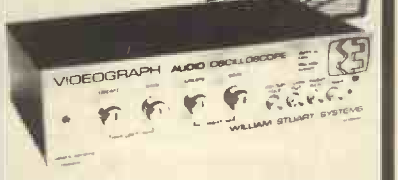

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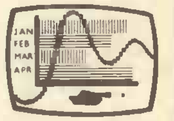

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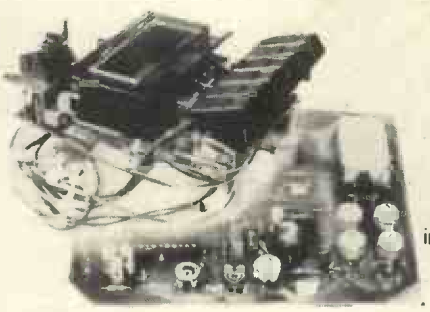

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