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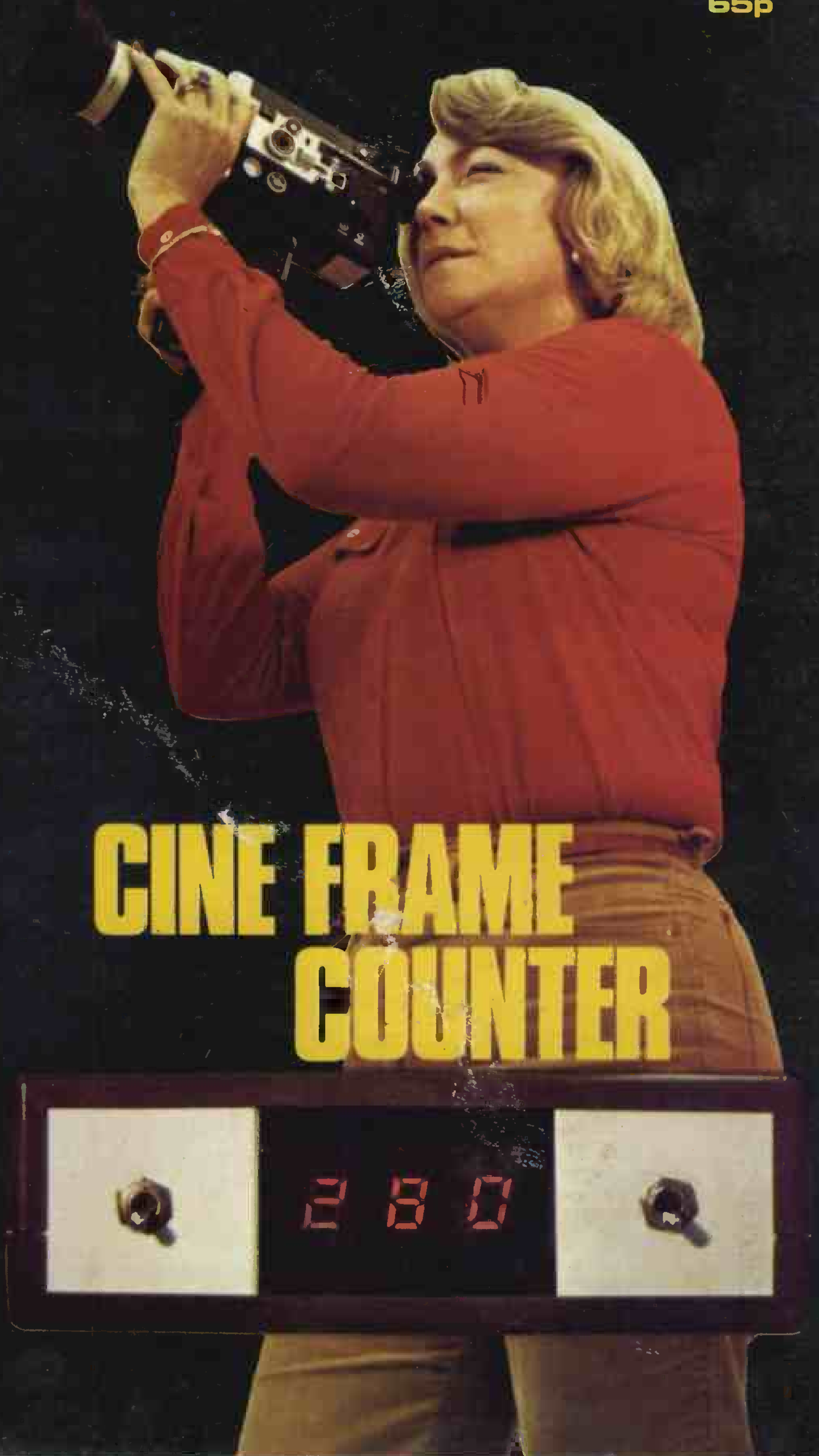

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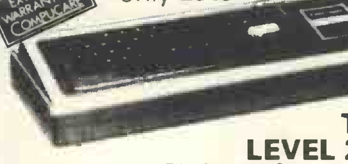

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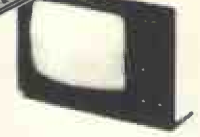

video 100

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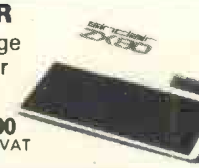

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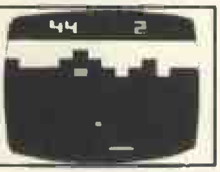

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PRACTICAL
ELECTRONICS

VOLUME 16 No. 10 OCTOBER 1980

CONSTRUCTIONAL PROJECTS

GENERAL FEATURES

NEWS & COMMENT

OUR NOVEMBER ISSUE WILL BE ON SALE FRIDAY, 10 OCTOBER 1980
(for details of contents see page 43)

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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 5p; 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 60p; 40V: 22, 33µF 8p; 100 12p; 2200, 3300 85p; 4700 115p; 35V: 10, 33 7p; 330, 470 32p; 25V: 10, 22, 47, 100 8p; 160, 220, 250 15p; 470 25p; 640, 1000 35p; 1500 40p; 2200 54p; 3300 74p; 4700 92p; 16V: 10, 40, 47 7p; 100, 125 8p; 220, 330 16p; 470 20p; 1000, 1500 30p; 2200 36p.
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 75p; 10V: 15µ, 22, 33 28p; 100 40p; 6V: 47µ, 68µ, 100 32p; 3V: 100 30p.

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:
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5KΩ 500KΩ Single gang	60p
10KΩ 500KΩ Dual gang	80p
Self-Stick graduated Alum. Bezels	33p

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

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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
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25-200pF 33p
100-500pF 45p
400-1250pF 58p

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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	12	BFX88	28	TIP34C	88	2N1304	50
AC127	22	BC328	15	BFY50	21	TIP35A	160	2N1305	35
AC128	20	BC337	14	BFY51	21	TIP35C	185	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	TIP41B	60	2N2219A	22
ACY17	60	BC516	38	BRY39	39	TIP42A	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	28
ACY39	80	BC559	15	E421	290	TIP2955	60	2N2905A	26
AD149	75	BCY70	14	MD8001	179	TIP3055	60	2N2906	22
AD161	42	BCY71	18	MJ491	175	TIS43	30	2N2907A	22
AD162	42	BCY72	20	MJ2955	225	TIS44	45	2N2926G	10
AF114	75	BD121	78	MJE340	54	TIS45	45	2N3053	24
AF115	60	BD123	98	MJE370	70	TIS88A	50	2N3054	55
AF116	75	BD124	115	MJE371	70	TIS90	30	2N3055	48
AF117	95	BD131	42	MJE2955	99	TIS91	32	2N3442	140
AF118	95	BD132	42	MJE3055	70	UC734	68	2N3504	55
AF139	40	BD133	50	MPF102	66	ZTX107	11	2N3663	17
AF178	75	BD135	40	MPF103	36	ZTX108	11	2N3702	10
BC107	10	BD136	40	MPF104	36	ZTX109	11	2N3703	10
BC107B	12	BD137	40	MPF105	36	ZTX212	28	2N3704	10
BC108	10	BD138	40	MPF106	40	ZTX300	13	2N3705	10
BC108B	12	BD139	40	MPSA05	22	ZTX301	15	2N3706	12
BC108C	12	BD140	40	MPSA06	24	ZTX302	20	2N3707	12
BC109	10	BD144	198	MPSA12	29	ZTX303	25	2N3708	11
BC109B	12	BD145	175	MPSA55	29	ZTX304	17	2N3709	11
BC109C	12	BD205	110	MPSA56	29	ZTX314	24	2N3710	12
BC140	26	BD245	50	MPSU02	58	ZTX320	30	2N3711	12
BC142	26	BD378	70	MPSU05	50	ZTX326	45	2N3771	179
BC143	26	BD434	32	MPSU06	50	ZTX341	28	2N3772	195
BC147	9	BD517	70	MPSU52	65	ZTX500	15	2N3773	288
BC147B	10	BD695A	85	MPSU55	55	ZTX501	16	2N3819	20
BC148	8	BD696A	85	MPSU56	60	ZTX502	17	2N3820	45
BC148B	10	BDY56	170	OC23	170	ZTX503	15	2N3822	130
BC148C	10	BF115	26	OC26	170	ZTX504	25	2N3823	70
BC149	9	BF167	28	OC28	120	ZTX531	25	2N3866	90
BC149C	10	BF177	24	OC35	125	ZTX550	25	2N3903	18
BC153	20	BF178	25	OC36	130	40250	85	2N3904	18
BC154	13	BF179	38	OC41	125	40251	97	2N3905	18
BC157	10	BF180	38	OC42	48	40311	60	2N3906	17
BC158	10	BF194	11	OC43	55	40313	125	2N4037	58
BC159	11	BF195	12	OC44	55	40315	68	2N4058	15
BC160	28	BF196	12	OC45	40	40316	85	2N4061	17
BC167A	11	BF197	12	OC70	40	40317	65	2N4062	17
BC168C	11	BF198	16	OC71	35	40319	71	2N4069	45
BC169C	10	BF199	21	OC72	40	40320	70	2N4427	80
BC170	15	BF224	24	OC74	50	40361	50	2N4829	65
BC171	11	BF244A	28	OC76	45	40362	50	2N4859	65
BC172	11	BF244B	29	OC81	35	40406	65	2N4871	55
BC173	11	BF245	30	OC82	50	40407	52	2N4922	55
BC177	15	BF256	50	OC83	48	40408	95	2N5135	42
BC178	14	BF257	35	OC84	45	40411	280	2N5136	42
BC179	15	BF258	35	OC140	110	40412	65	2N5138	28
BC181	10	BF259	35	OC170	85	40467	95	2N5172	25
BC182	10	BF274	42	OC171	45	40468	60	2N5179	60
BC183	10	BF336	35	OC200	48	40594	95	2N5180	80
BC184	10	BF451	35	TIP29	31	40595	98	2N5191	75
BC182L	10	BF594	40	TIP29A	36	40603	90	2N5305	40
BC183L	10	BF595	40	TIP29B	56	40636	125	2N5457	35
BC184L	10	BF910	95	TIP29C	60	40673	95	2N5458	35
BC187	25	BFR39	25	TIP30	40	2N697	25	2N5459	35
BC212	9	BFR40	25	TIP30A	48	2N698	40	2N5485	40
BC212L	9	BFR41	24	TIP30B	50	2N699	35	2N5642	750
BC213	9	BFR79	24	TIP30C	58	2N706A	19	2N5777	45
BC213L	9	BFR80	24	TIP31A	45	2N708	22	2N6027	44
BC214	10	BFR81	24	TIP31C	55	2N914	32	2N6109	50
BC214L	10	BFR98	105	TIP32A	48	2N916	37	2SD234	70
BC237	14	BFX29	28	TIP32C	60	2N918	33	3N128	112
BC238	15	BFX84	26	TIP33A	65	2N1131	26	3N140	112
		BFX85	28						

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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

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AY-1-5051	160	LM380	80	SN76013N	170
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AY-3-1270	840	LM382	125	SN76023N	170
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AY-5-1230	450	LM733	125	SN76227N	95
AY-5-1315	595	LM384	110	SN76477	175
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CA3014	157	LM3915	240	TAA960	320
CA3018	68	LM13600	135	TAD100	159
CA3019	70	M252AA	625	TBA120S	70
CA3020	186	M253AA	1150	TBA540	220
CA3023	191	MC1204	250	TBA550Q	330
CA3028A	80	MC1301	79	TBA641-A12/ BX1 or BX11	250
CA3035	235	MC1303	88	TBA651	190
CA3036	115	MC1304P	260	TBA800	90
CA3043	275	MC1310P	150	TBA810S	95
CA3045	365	MC1312PQ	195	TBA820	70
CA3046	70	MC1458	45	TBA920Q	260
CA3048	214	MC1494	595	TBA990Q	270
CA3059	175	MC1495	350	TCA965	120
CA3075	213	MC1496L	92	TDA1004	290
CA3080E	65	MC1596	225	TDA1008	310
CA3081	190	MC1710	79	TDA1022	575
CA3089E	215	MC3302	150	TDA1024	105
CA3090AQ	375	MC3340P	120	TDA2020	320
CA3123	150	MC3360P	120	TDA2030	300
CA3130	90	MC3401	52	TL061C	54
CA3140	48	MC3403	135	TL064CN	159
CA3160	95	MC3405	150	TL071	45
ICL7106	795	MFC6040	97	TL072CP	90
ICL7107	975	MK50398	635	TL074CN	140
ICL8211	150	MM5303	635	TL081CP	42
ICL8038CC	340	MM5307	1275	TL082CP	70
ICM7205	1150	MM57160	620	TL083CP	95
ICM7207A	550	MSM5626	820	TL084CP	120
ICM7215	1050	NE518	210	UAA170	150
ICM7216A	1950	NE543	210	UAA180	150
ICM7216B	1950	NE544	185	XR2206	350
ICM7217A	790	NE555	22	XR2266	750
ICM7224	785	NE556DB	55	ZN414	95
ICM7555	89	NE560	325	ZN423	195
LD130	452	NE561	395	ZN424E	130
		NE562B	410	ZN423	195
		NE564	435	ZN425E	415
				ZN1034	200
				ZN1040E	685

COMPUTER IC's

2102	125	MC1489	
2112-2N	250	MC14411	
2114-450N	250	MC14412	1520
2114-300N	325	MK4027-2	470
2708	445	MK4027-4	350
4116 16K	299	MM1702	299
6502	995	RO-3-2513	650
6503	850	SFF96364E	1050
6504	785	SFC71301	820
6505	850	SFS80102	205
6520	525	TMS2516	750
6522	825	TMS2716	1250
6532	1050	TMS 4035	250
6551	1150	TMS 4039	250
6800	800	TMS 4047	775
6810	360	TMS 6011	355
6821	500	Z80 CPU2.5	990
6850	485	Z80 A4M	1099
6852	485	Z80 P10	660
74L00	66	Z80 CTC	595
74S00	60	Z80A P10	750
74S04	73	Z80A CTC	720
74S132	360		
74S138	250		
74S158	524		
74S188	210		
74S189	158		
74S194	750		
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	695		
8085A	1220		
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	150
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	28	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	135		
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	238		
		74145	90	74298	185		
		74147	180	74365	95		
		74148	145	74366	95		
		74150	150	74367	95		
		74151	75	74368	95		
				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
4001	18	4013	45
4002	24	4014	85
4006	92	4015	85
4007	22	4016	42
4008	82	4017	82
4009	40	4018	88
4010	48	4019	48
4011	24	4020	99
		4021	105
		4022	95
		4023	25
		4024	75
		4025	25
		4026	180
		4027	48
		4028	82
		4029	105
		4030	60
		4031	225
		4032	125
		4033	175
		4034	210
		4035	125
		4036	365
		4037	115
		4038	118
		4039	360
		4040	105
		4041	80
		4042	80
		4043	95
		4044	95
		4045	175
		4046	130
		4047	98
		4048	65
		4049	45
		4050	48
		4051	80
		4052	80
		4053	80
		4054	130
		4055	135
		4056	135
		4057	2850
		4059	575
		4060	130
		4061	1225
		4062	995
		4063	120
		4066	58
		4067	430
		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
4490V	750
4501	28
4502	125
4503	75
4506	75
4507	60
4508	325
4510	99
4511	150
4512	98
4513	225
4514	265
4515	299
4516	120
4517	450
4518	105
4519	70
4520	115
4521	250
4522	150
4526	150
4527	160
4528	120
4529	175
4530	89
4531	165
4532	140
4534	575
4536	395
4538	160
4539	135
4541	150
4543	175
4549	296
4553	440
4554	175
4555	85
4556	75
4557	425
4558	130
4559	290
4560	235
4561	95
4562	595
4566	190
4568	299
4569	250
4572	48
4580	595
4581	350
4582	150
4583	125
4584	65
4585	140

WATFORD ELECTRONICS

(Continued from opposite side)

DIODES

AA129	25
AAZ15	15
BY100	24
BY127	12
CRO33	158
OA9	45
OA47	18
OA70	12
OA79	12
OA81	15
OA85	15
OA90	8
OA91	8
OA95	8
OA200	9
OA202	9
IN914	4
IN916	6
IN400/2	5
IN4003	6
IN4004/5	6
IN4006/7	7
IN4148	4
IS44	20
3A/100V	18
3A/400V	20
3A/600V	27
3A/1000V	30

SCR's Thyristors

0.8A30V	28
0.8A100V	30
0.8A200V	35
1A/100V	42
1A/200V	47
1A600V	70
3A/400V	75
5A300V	35
5A600V	43
8A300V	48
8A600V	85
12A300V	59
12A500V	92
12A800V	150
15A700V	195
BT106	150
BT116	150
C106D	38
MCR101	32
TIC44	22
TIC45	28
2N4444	140

BRIDGE RECTIFIERS
(plastic case)

1A/50V	20
1A/100V	22
1A/200V	25
1A/400V	29
1A/600V	34
2A/50V	35
2A/100V	44
2A/200V	46
2A/400V	53
2A/600V	65
4A/100V	72
6A/100V	73
6A/200V	78
6A/400V	85
BY164	56
VM18 DIL	50

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

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

VARICAPS

MVAM2	165
MVAM115	140
BA102	25
BB105B	40
BB106	40

Noise Diode

Z5J	180

TRIACS

3A/100V	48
3A/400V	50
8A/100V	54
8A/400V	64
8A/500V	85
8A/800V	108
12A/100V	60
12A/400V	70
12A/800V	130
16A/100V	95
16A/400V	105
16A/500V	120
16A/800V	195
25A/400V	160
30A/400V	525
25A/800V	295
T2800D	120

DIAC

ST2	25

SPEAKERS

8Ω 0.3W	
2"; 2½"	75
2.5; 3"	75
40Ω 2.5"	88
64Ω 2.5"	80
80Ω 2.5"	80
8Ω 5W	
7"×4"	250
8Ω 3W	
6"×4"	160

ALUM.BOXES

3×2×1"	55
2¾×5×1½"	75
4×4×1½"	75
4×2¼×1½"	75
4×5¼×1½	100
4×2½×2"	75
5×4×2"	98
6×4×2"	110
7×5×2½"	185
8×6×3"	185
10×7×3"	210
10×4½×3"	198
12×5×3"	215
12×8×3"	265

VEROBOARD

	Pitch 0.1 (copper clad)	0.15 (copper clad)	0.1 (plain)	0.15 (plain)
2½×3¾"	66p	59p	47p	34p
2½×5"	75p	69p	—	39p
3¾×3¾"	75p	—	—	—
3¾×5"	86p	92p	72p	63p
3¾×17"	298p	260p	210p	178p
4¾×17"	387p	—	—	280p

Pkt of 36 pins	20p	VQ board	144p
Spot face cutter	107p	DIP board	326p
Pin insertion tool	147p	Veroblock	324p

VERO WIRING PEN and Spool 325p
Spare Wire (Spool) 80p; Combs 7p ea.

FERRIC CHLORIDE
1 lb bag Anhydrous
225p + 40p p&p

EURO BREADBOARD
£5.20

DALO ETCH RESIST
Pen + Spare tip 90p

BIMBOARDS
£8.25

COPPER CLAD BOARDS

Fibre Glass	Single-sided	Double-sided	SRBP 9.5"×8.5"
6"×6"	90p	110p	95p
6"×12"	150p	195p	

SOLDERCON PINS
100 pins 60p 500 pins 275p

OPTO ELECTRONICS
LEDS Plus. Clip

TIL209 Red 125"	13
TIL211 Grn 125"	18
TIL212 Yellow	22
TIL220 .2" Red	15
0.2" Yel, Grn, Amber	18
Rectangular LEDS. Red, Green and Yellow	30
2N5777 45; OCP71	120
ORP12	63
LD271 Infra Red (emit)	40
TIL32 Infra Red (emit)	58
SFH205 (detector)	70
TIL78 (detector)	70
OPTO isolators	
IL74	48
TIL 111/2 or 117	100
7 Segment Displays	
TIL 312 & 313 0.3"	105
TIL321 5" C.An	115
TIL322 5" C.th	115
DL704 3" C.Cth	99
DL707 3" C.Anod	99
DL747 6" An	180
.8" Orange C.A.	250
FND357 or 500	120
.3" Green C.A.	150
±1.3" Red or Green	150
Bargraph 10 seg. Red	225

Liquid Crystal Display
3½ digit 875p; 4 digit 975p
6 Digit LCD 950p

VOLTAGE REGULATORS

1A	TO3 + ve		— ve	
5V	7805	145p	7905	220p
12V	7812	145p	7912	220p
15V	7815	145p		—
18V	7818	145p		—
1A	TO220 Plastic Casing			
5V	7805	60p	7905	65p
12V	7812	60p	7912	65p
15V	7815	60p	7915	65p
18V	7818	60p	7918	65p
24V	7824	60p		
100mA	TO92 Plastic Casing			
5V	78L05	30p	79L05	65p
6V	78L62	30p		—
8V	78L82	30p		—
12V	78L12	30p	79L12	65p
15V	78L15	30p	79L15	65p

CA3085	95	LM323K	625
LM300H	170	LM325N	240
LM305H	140	LM326N	240
LM309K	135	LM327N	270
LM317K	350	LM723	39
78H05 5V/5A	595p	TBA625B	85
UA78HG +5 to +24V 5A	650	TDA1412	120

SWITCHES
SLIDE 250V

1A DPDT	14
1A DPDT C/OFF	15
½A DPDT	13
4 pole 2-way	24

PUSH BUTTON
Spring loaded red button. Latching

SPST on off	65
SPDT C/over	75
DPDT 6 Tag	95

TOGGLE 2A 250V

SPST	32
DPDT	44
4 pole on off	54

SUB-MIN TOGGLE

SP changeover	59
SPST on off	54
SPDT c/off	70
SPDT Biased	85
DPDT 6 tags	70
DPDT C/OFF	79
DPDT Biased	115
3 pole c/over	150

MINIATURE Non Locking
Push to make 15p Push Break 25

ROCKER: 5A, 250V, SPST 30p

ROCKER: (white) 5A 250V SP change-over centre off 52p

ROCKER: Lights red when on. 3A 250V. DPST 85p

ROCKER: (White) 10A/250V DPDT 85p

ROTARY: "Make-A-Switch" Make your own multiway Switch as required. Shafting assembly has adjustable stop.
Accommodates up to 6 Wafers 90p
Break before make Wafers. Silver contacts.
1 pole/12 way; 2 pole/6 way; 3 pole/4 way; 4 pole/3 way; 6 pole/2 way 59p
Mains DPST Switch to fit 40p
Screen & Spacers 6p

ROTARY: (Adjustable Stop Type)
1 pole/2 to 12 way, 2p/2 to 6 way, 3 pole/2 to 4 way, 4 pole/2 to 3 way 43p

ROTARY: Mains 250V AC, 4 Amp 52p

CRYSTALS

100kHz	323p
455kHz	385p
1.28MHz	392p
1MHz	323p
1.6MHz	395p
1.008MHz	383p
1.80MHz	385p
1.8432MHz	362p
2.4576MHz	362p
3.2768MHz	323p
3.57954M	195p
4MHz	290p
4.032MHz	323p
4.433619M	135p
5.0MHz	355p
5.24288	425p
6.0MHz	392p
6.5536MHZ	200p
7.680MHz	323p
8.0833N	362p
8 867MHz	323p
9.375MHz	323p
10MHz	323p
10.7MHz	323p
12MHz	392p
14.318118M	300p
18MHz	323p
18.432M	392p
20MHz	362p
26.69MHz	390p
27.648MHz	350p
38.6667M	250p
48MHz	323p
100MHz	323p

COMPUTER CORNER

- **SUPERBOARD II** Ready-built & tested (requires PSU) **Only: £150**
- **PSU** 5V/3A for above incl. UHF Mod. £24
  610 Expansion Board (8K) £150
- **UK101** Complete Kit incl. instructions £179
- **Challenger 1P** Cased £188
- **Plastic Case for Superboard**, fits UK101, NASCOM etc. £24
- **Space Invaders for Superboard (4K)** £5
- **PRINTER 800.** Ideal for PET, Apple, TRS80, Superboard etc. **Only: £345**
- **VIDEO GENIE** based on TRS80 16K RAM **Only: £325**
- **STRINGY FLOPPY** (economy of Cassette, speed of Disc) **Only: £169**
- **SOFTY.** Intelligent EPROM Programmer Kit £99
  Ready-Built & Tested £120
  PSU for above (Built) £20
- **TEX UV EPROM** Eraser. Erases up to 32 ICs in 15-30 min. £33
- **UHF MODULATORS** 6MHz 280p
  UHF MODULATORS 8MHz 450p
- **KEYPADS** 4 × 4 matrix 350p
- **Model 756 ASCII** Keyboard £40
- **10 × C12 Cassettes** in stockable racks 660p

DIL PLUGS (Headers)
14 pin 35p; 24 pin 85p
16 pin 39p; 40 pin 295p
(DIL Sockets on opp. page)

'D' CONNECTORS (Cannon type)

	Plugs	Sockets	Covers plastic
9 way	85p	110p	—
15 way	112p	160p	125p
25 way	168p	250p	145p
37 way	250p	360p	150p

DIL switches (SPST)

4 way	85p
6 way	98p
8 way	115p

EDGE CONNECTORS double type

	.1	.156
2×10 way	—	85p
2×15 way	—	99p
2×18 way	115p	120p
2×22 way	130p	135p
2×25 way	149p	160p
2×30 way	170p	—
2×36 way	194p	—
2×40 way	210p	—
2×43 way	232p	—

TRANSFORMERS (mains Prim. 220-240V)
6-0-6V 100mA; 9-0-9V 75mA; 12-0-12V 75mA 98p
8VA type: 6V-.5A 6V-.5A; 9V-.4A 9V-.4A; 12V-.3A 12V-.3A; 15V-.25A 15V-.25A 215p.
12VA: 4.5-1.3A 4.5V-1.3A; 6V-1.2, 6V-1.2A 12V-.5A 12V-.5A 235p (30p p&p)
24VA: 6V-1.5A 6V-1.5A; 9V-1.2A 9V-1.2A; 12V-1A 12V-1A; 15-.8A 15-.8A; 20V-.6A 20V-.6A 320p (55p p&P)
50VA: 6V-4A 6V-4A; 9V-2.5A 9V-2.5A; 12V-2A 12V-2A; 15V-1.5A 15V-1.5A; 20V-1.2A 20V-1.2A; 25V-1A 25V-1A; 30V-.8A 30V-.8A 365p (60p p&p)
100VA: 12V-4A 12V-4A; 15V-3A 15V-3A; 20V-2.5A 20V-2.5A; 30V-1.5A 30V-1.5A; 40V-1.25A 40V-1.25A; 50V-1A 50V-1A 695p (74p p&p)

AUTO (Step Down) TRANSFORMERS:
Prim: 240V Sec. 115V 50/60Hz
50VA: £5.95 (60p); 100VA: £7.40 (70p)
100VA: £9.95 (70p); 250V: £14.75 (85p)
(N.B. P&P charge to be added above our normal postal charge.)

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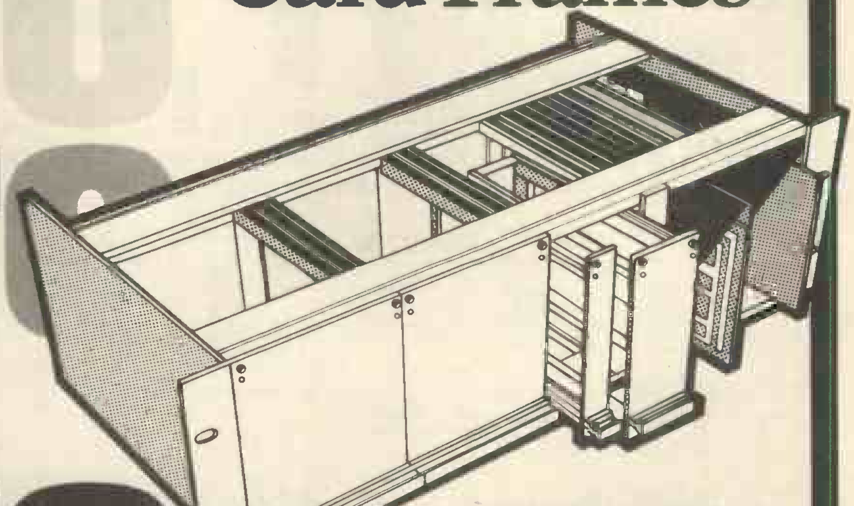
Card Frames



Our 19" Card frame will house your projects in a 'professional' manner. It is designed to take Eurocards or Modules and offers facilities for interconnection through 2 - part DIN 41612 or direct edge connectors.
A full range of compatible items are available — all selected from the established range of industrial products — boards, accessories, cases etc.
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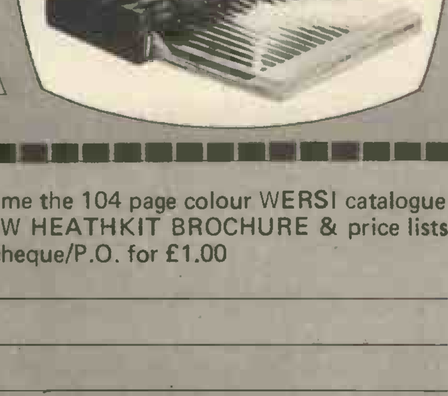
Aura Sounds *are the first company to successfully market Wersi Organs and Kits in the United Kingdom. Operating from modern Showrooms, we offer a complete, unique evening and weekend telephone support advice. We pride ourselves on our friendly and individual service. We market Wersi products because we feel they are simply the best, both in terms of quality and reliability. These factors, together with a fresh approach, are what have made Wersi one of the leading organ manufacturers in the world today. AURA SOUNDS AND WERSI – THE WINNING COMBINATION. Illustrated below are just a few of the wide range of organs in stock.*

The SATURN W3T.
The ultimate transportable organ, featuring sophisticated rhythm unit and built-in WERSI Voice. 30 or 61 note Keyboards and 30 pedals.

The COSMOS W5S
The baby of the range, a great instrument at a great price. There are many optional extras and Cosmos can be easily assembled at home by the average handyman.

The HELIOS. *For home or professional use. Available as a transportable model with various options including 25–pedal clavier.*



The GALAXY.
The top model of the range with 3 full manuals and a 30 note pedalboard. For looks and sound, the effects are first class.

IMPORTANT
AURA SOUNDS have just been appointed marketing agents for the range of Heath Electronic Kits in the U.K. This exciting range of 'up-market' Kits makes AURA SOUNDS, more than ever before, the company to come to for advice and product choice.

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PE 10

D.I.Y. KITS FOR SYNTHESISERS, SOUND EFFECTS

BASIC COMPONENTS SETS include all necessary resistors, capacitors, semiconductors, potentiometers and transformers. Hardware such as cases, sockets, knobs, keyboards, etc. are not included but most of these may be bought separately. Fuller details of kits PCBs and parts are shown in our lists.

LAYOUT DIAGRAMS are supplied free with all PCBs unless "as published".

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MAIL ORDER SUPPLIERS OF QUALITY PRINTED CIRCUIT BOARDS, KITS AND COMPONENTS TO A WORLD-WIDE MARKET

P.E. MINISONIC MK2 SYNTHESISER

A portable mains operated miniature sound synthesiser with keyboard circuits. Although having slightly fewer facilities than the large Formant and P.E. synthesisers the functions offered by this design give it great scope and versatility.

Set of basic component kits (excl. KBD R's & tuning pots – see list for options available) and PCBs (incl. layout charts) KIT 38-25 £80.12
"Sound Design" booklet £1.00

P.E. 128-NOTE SEQUENCER

Enables a voltage controlled synthesiser to automatically play pre-programmed tunes of up to 32 pitches and 128 notes long. Programs are keyboard initiated and note length and rhythmic pattern are externally variable.

Set of basic comps, PCBs and charts KIT 76-7 £35.56
Set of text photocopies £1.36

P.E. 16-NOTE SEQUENCER

Sequences of up to 16 notes may be programmed by the use of external panel controls and fed into most voltage controlled synthesisers.

Set of basic comps, PCBs and charts KIT 86-5 £33.60
Set text photocopies £1.84

P.E. STRING ENSEMBLE

A multivoiced polyphonic string instrument synthesiser.

Set of basic comps, PCBs & charts KIT 77-8 £107.86

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A touch-sensitive multiple-voicing piano using the latest integrated circuit techniques for the keying and envelope shaping, and virtually eliminating "bee-hive" noise hitherto inherent in previous electronic pianos.

5-octave set of basic comps and PCBs (as publ.) KIT 80-9 £146.66
Additional 3-octave extension and basic parts and PCBs (as published) KIT 80-10 £56.36
Set of text photocopies £1.81

ELEKTOR FORMANT SYNTHESISER

A very sophisticatged synthesiser for the advanced constructor who puts performance before price.

Set of basic comps, PCBs (as publ.) KIT 66-14 £255.45
Set of text photocopies £7.83

ELEKTOR DIGITAL REVERB UNIT

A very advanced unit using sophisticated i.c. techniques instead of mechanical spring lines. The basic delay range of 24 to 90mS can be extended up to 450mS using the extension unit. Further delays can be obtained using more extensions.

Main unit basic comps and PCB (as publ.) KIT 78-3 £55.40
Extension unit basic comps and PCB (as publ.) KIT 78-4 £52.77
Text photocopy 86p

ELEKTOR ANALOGUE REVERB

Using i.c.s instead of spring-lines the main unit has a maximum delay of up to 100mS, and the additional set extends this up to 200mS. May be used in either mono or stereo mode.

Main unit basic component set KIT 83-1 £29.49
Additional Delay basic components KIT 83-2 £20.07
PCB (as publ.) to hold both kits PCB9973 £4.52
Text photocopy 67p

ELEKTOR RING MODULATOR

Compatible with the Formant & most other synthesisers.

Set of basic comps & PCB (as publ.) KIT 87-2 £6.84
Text photocopy 38p

NEW KITS

ELEKTOR CHOROSYNTH

A 2½-octave Chorus synthesiser with an amazing variety of sounds ranging from violin to cello and flute to clarinet amongst many others. Experienced constructors can readily extend the octave coverage.

Basic comps, PCBs and charts but excl. sw's KIT 100-8 £44.39
Text photocopy 70p

ELEKTOR SEWAR

For use with Elektor Analague Reverb to give greater flexibility to the reverb effects.

Basic comps, PCB (as publ.) KIT 101-1 £22.53
Text photocopy 60p

ELEKTOR FUNNY TALKER

Incorporates a ring modulator, chopper & frequency modulator to produce fascinating sounds when used with speech & music signals.

Basic comps, PCB (as publ.) KIT 99-1 £9.60
Text photocopy 40p

ELEKTOR FREQUENCY DOUBLER

For use with guitars & other electronic instruments to produce an output one octave higher than the input. Inputs and outputs may be mixed to give greater depth.

Basic comps, PCB (as publ.) KIT 98-1 £5.48
Text photocopy 20p

P.E. SPLIT-PHASE TREMOLO

A simple but effective substitute for a rotary cabinet. The output of an internal generator is phase-split and modulated by an input signal from an electronic guitar or other instrument. Output amplitudes, depth & rate are variable. May be fed to one or two amplifiers.

Basic comps, PCB & chart KIT 102-3 £17.58
Text photocopy 65p

P.E. MINISONIC WAVEFORM CONVERTER

A simple converter that modifies the Minisonic sawtooth waveform to produce triangle and sine outputs. Ideally one should be used with each Minisonic VCO.

Basic comps, PCB & chart KIT 96-1 £3.98

DISCO-CROSS FADER

The cross-fade between 2 decks is switch-initiated and can be preset on the panel for a cross fade rate of between about ½ sec & 24 secs. Basically a stereo unit but may be used in mono.

Basic comps, PCB & chart KIT 94-1 £11.83

P.E. GUITAR MULTIPROCESSOR

An extremely versatile sound processing unit capable of producing, for example, flanging, vibrato, reverb, fuzz and tremolo as well as other fascinating sounds. May be used with most electronic instruments.

Set of basic comps, PCBs & charts (excl. SWs) KIT 85-5 £54.56
Set of text photocopies £2.52

P.E. PHASER

An automatically controlled 6-stage phasing unit with integral oscillator.

Basic components, PCB & chart KIT 88-1 £10.69
2-Notch extension, PCB & chart KIT 88-2 £6.36
Text photocopy 68p

ELEKTOR PHASING & VIBRATO

Includes manual and automatic control over the rate of phasing & vibrato, and has been slightly modified to also include a 2-input mixer stage.

Set of basic comps, PCB & chart KIT 70-2 £21.67
Text photocopy 67p

ELEKTOR RESONANCE FILTER

Allows a synthesiser to produce a more realistic simulation of natural musical instruments.

Set of basic comps, & PCB (as publ.) KIT 82-2 £22.45
Text photocopy 57p

P.E. GUITAR EFFECTS UNIT

Modulates the attack, decay and filter characteristics of a signal from most audio sources, producing 8 different switchable effects that can be further modified by manual controls.

Basic comps, PCB & chart KIT 42-3 £10.37
Text photocopy 28p

P.E. GUITAR OVERDRIVE

Sophisticated versatile fuzz unit incl. variable controls affecting the fuzz quality whilst retaining attack and decay, and also providing filtering. Usable with most electronic instruments.

Basic components, PCB & chart KIT 56-3 £11.22
Text photocopy 68p

P.E. SMOOTH FUZZ

Basic components, PCB & chart KIT 91-1 £6.40
Text photocopy 55p

TREMOLO UNIT

A slightly modified version of the simple P.E. unit.

Basic components, PCB & chart KIT 54-1 £3.74

GUITAR FREQUENCY DOUBLER

A slightly modified and extended version of the P.E. unit.

Basic components, PCB & chart KIT 74-1 £5.19
Text photocopy 39p

P.E. GUITAR SUSTAIN

Maintains the natural attack whilst extending note duration.

Basic components, PCB & chart KIT 75-1 £6.73
Text photocopy 38p

P.E. WAH-WAH UNIT

Can be controlled manually or by integral automatic control.

Basic components, PCB & chart KIT 51-1 £4.93

P.E. AUTO-WAH UNIT

Automatically gives Wah or Swell sounds with each note played

Basic components, PCB & chart KIT 58-1 £9.68
Text photocopy 58p

ELEKTOR WAVEFORM CONVERTER

Converts a saw-tooth waveform into sinewave, mark-space sawtooth, regular triangle, or square-wave with variable mark-space.

Basic comps, PCB & chart, but excl. sw's KIT 67-1 £9.24

P.E. SWITCHED TONE TREBLE BOOST

Provides switched selection of 4 preset tonal responses.

Basic components, PCB & chart KIT 89-1 £4.34
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P.E. TREBLE BOOST UNIT

A simple treble boost unit with manual control depth.

Basic components, PCB & chart KIT 53-1 £2.92

P.E. SYNTHESISER

The well acclaimed and highly versatile large scale mains operated synthesiser. Other circuits in our lists may be used with it to good advantage.

Basic comps, PCBs & charts KIT 23-33 £167.57
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AND OTHER PROJECTS

PHOTOGRAPHS in this advertisement show two of our units containing some of the P.E. projects built from our kits and PCBs. The cases were built by ourselves and are not for sale, though a small selection of other cases is available.

LIST—Send stamped addressed envelope with all U.K. requests for free list giving fuller details of PCBs, kits and other components.

OVERSEAS enquiries for list Europe—send 35p: other countries—send 75p.

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KIMBER-ALLEN KEYBOARDS as required for many published projects. The manufacturers claim that these are the finest moulded plastic keyboards available. All octaves are C to C, the keys are plastic, spring-loaded, fitted with actuators, and mounted on a robust aluminium frame.

3 Octave (37 notes) **£25.50** 4 Octave (49 notes) **£32.25** 5 Octave (61 notes) **£39.75**

CONTACT ASSEMBLIES (gold-clad wire) – 1 required for each KBD note:
Type GJ – SPCO **33p** ea. Type GB – 2 pr N/O **37½p** ea.

P.E. V.C.F.
A voltage controlled filter extracted from P.E. Minisonic project.
Basic comps, PCB & chart KIT 65-1 **£8.45**

P.E. RING MODULATOR
Extracted from P.E. Minisonic project.
Basic comps, PCB & chart KIT 59-1 **£6.35**

WIND & RAIN EFFECTS UNIT
A slightly modified version of the original P.E. unit.
Basic comps, PCB & chart KIT 28-1 **£4.84**
Text photocopy **28p**

P.E. ENVELOPE SHAPER WITHOUT VCA
Provides full manual control over attack, decay, sustain and release functions, and is for use with an existing VCA.
Basic comps, PCB & chart KIT 44-1 **£5.73**
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P.E. ENVELOPE SHAPER WITH VCA
Has an integral Voltage Controlled Amplifier, and has full manual control over the A.D.S.R. functions.
Basic comps, PCB & chart KIT 50-1 **£8.03**
Text photocopy **58p**

P.E. TRANSIENT GENERATOR
An ADSR envelope shaper without VCA, and additionally providing Repeat-triggering enabling a synthesiser to be programmed for mandolin or banjo effects.
Basic comps, PCB & chart KIT 63-2 **£7.62**
Text photocopy **58p**

P.E. EXTERNAL-INPUT SYNTHESISER-INTERFACE
Allows external inputs such as guitars, microphone etc., to be processed by synthesiser circuits.
Basic comps, PCB & chart KIT 81-1 **£3.90**

P.E. TUNING FORK
Produces 84 switch-selected frequency-accurate tones with an LED monitor clearly displaying beat-note adjustments.
Set of basic components, incl. power supply, PCBs & charts KIT 46-3 **£23.32**
Text photocopy **97p**

P.E. TUNING INDICATOR
A simple 4-octave frequency comparitor for use with synthesisers and other instruments where the full versatility of KIT 46 is not required.
Basic components, PCB & chart, but excl. sw. KIT 69-1 **£8.19**
Text photocopy **58p**

P.E. DYNAMIC RANGE LIMITER
Preset to automatically control sound output levels.
Basic comps, PCB & chart KIT 62-1 **£5.31**

P.E. CONSTANT DISPLAY FREQUENCY COUNTER
A 4-digit counter for 1Hz to 99kHz with 1Hz sampling rate. Readout does not count visibly or flicker due to blanking.
Basic components, PCB & chart KIT 79-4 **£31.35**
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P.E. 6-CHANNEL MIXER
A high specification stereo mixer with variable input impedances.
Basic components (excl. sw's.) and set of PCBs and charts. KIT 90-8 **£61.25**
Extra 2-channel set with PCB KIT 90-9 **£11.62**
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STEREO HEADPHONE AMPLIFIER
Extracted from P.E. 6-channel mixer.
Basic components, PCB & chart KIT 92-1 **£5.68**

DIGITAL EXPOSURE UNIT
Controls up to 750 watts in ½ second steps up to 10 minutes, with built-in audio alarm.
Basic components, PCBs & charts KIT 93-3 **£23.27**
Text photocopy **£1.20**

P.E. DISCOSTROBE
A 4-channel light show controller giving a choice of sequential, random, or full strobe mode of operation, and with extra audio input.
Basic components, PCB & chart KIT 57-2 **£25.12**
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RHYTHM GENERATORS
Several available, including programmable 16 beat 64000 pattern, 128 beat almost infinite pattern, and pre-programmed 15 pattern using either M252 or M253 rhythm chips. A selection of effects instrument circuits is also available.

P.E VOICE OPERATED FADER
For automatically reducing music volume during talkover – particularly useful for discos.
Basic components, PCB & chart KIT 30-1 **£4.37**
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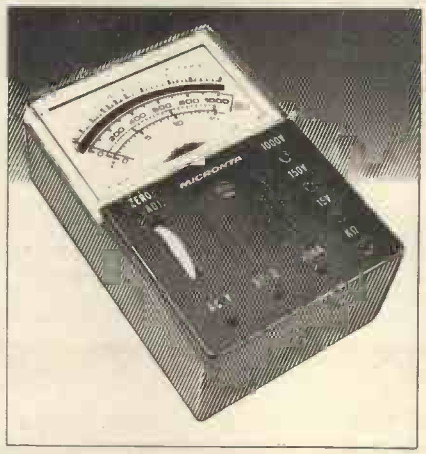

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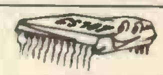

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74LS75	39p
74LS86	39p
74LS90	40p
74LS107	40p
74LS123	69p
74LS125	50p
74LS132	79p
74LS138	69p
74LS151	75p
74LS153	75p
74LS155	65p
74LS161	78p
74LS163	90p
74LS164	90p
74LS174	190p
74LS174	99p
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4031	195p
4033	145p
4035	104p
4036	290p
4037	105p
4038	110p
4039	290p
4040	99p
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4042	73p
4043	86p
4044	88p
4045	160p
4047	99p
4048	56p
4049	38p
4050	40p
4051	69p
4052	75p
4053	73p
4054	111p
4055	121p
4056	121p
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4067	422p
4068	19p
4069	19p
4070	28p
4071	25p
4072	25p
4075	20p
4076	88p
4077	23p
4078	29p
4081	23p
4082	25p
4085	86p
4086	68p
4089	130p
4093	68p
4094	225p
4095	99p
4096	325p
4098	110p
4099	180p
4501	25p
4502	112p
4503	68p
4507	52p
4508	288p
4510	76p
4511	125p
4512	75p
4514	250p
4515	290p
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4K CMOS RAM (1K × 4) 450 NS ONLY £6.95 (8 for £45).

The TC 5514P from Toshiba, CMOS equivalent of the 2114!

- Low Power Dissipation
  10pW/BIT (TYP.) *3.0V (STAND BY)
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- Full Static Operation
- Three State Output
- Input/Output TTI Compatible
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Toshiba's TC5514P (industry type 6514) is a full static read write memory organised as 1024 words by 4 bits using CMOS technology. Ultra low power dissipation means it can be used as battery-operated portable memory system and also as a non-volatile memory with battery back-up. Operates from a single 5V power supply with static operation, hence no refresh periods and a much simplified power supply circuit design. Three state outputs simplify memory expansion for minimum data retention voltage is 2V, the battery back-up system needs only simple circuit. Toshiba's original C²MOS technology also means wide operating and noise margins. The TC 5514P is moulded in a dual-in-line 18 pin plastic package 0·3 inch in width.

STEREO! S100 SOUND COMPUTER BOARD!

At last, an S-100 Board that unleashes the full power of two unbelievable General instrumentsd AY-3-8910 NMOS Computer sound IC's. Allows you under total computer control to generate an infinite number of special sound effects for games or any other program. Sounds can be called in BASIC, ASSEMBLY LANGUAGE etc.

KIT FEATURES

- Two GI Sound computer IC's (AY-3-8910)
- Four parallel I/O ports on Board.
- Uses on Board audio Amps or your STERO.
- On Board proto typing area.
- All sockets, parts and hardware are included.
- PC Board is soldermasked, silk screened with gold contacts.
- Easy, quick and fun to build, with full instructions.
- Uses Programmed I/O for maximum system flexibility.
- Both BASIC and ASSEMBLY language programming examples are included.

COMPLETE KIT . . . Only £59.96 includes 60 page data manual.
BARE BOARD . . . Only £25.00 includes 60 page data manual.
AY-3-8910 chip special price with purchase of BARE BOARD (2 chips) £15.

SOFTWARE

SCL is now available! Our Sound Command language makes writing Sound Effects programs a SNAP! SCL also includes routines for Register-Examine-Modify, Memory-Examine-Modify and Play-Memory. SCL is available on CP/M compatible diskette or 2708/2716. Diskette – £19.95, 2708 – £14.95, 2716 – £24.95. Diskette includes the source. EPROM'S are ORG at E000H.

TUNES SYNTHESIZER

The AY3-1350 is a MOS microcomputer synthesizer of preprogrammed tunes for applications in toys, music boxes and door chimes. The standard device has a set of 25 different popular and classical tunes. In addition there are 3 chimes making a total of 25 tunes.

FEATURES

- Minimal external components.
- Automatic switch-off signal at end of tune for power saving.
- Envelope control to give organ or piano quality.
- Sequential tune mode.
- 4 door capability when used as door chime.
- Operation with tunes in external PROM if required (2708).
- Single supply (+5V) operation.
- Tunes include: STAR WARS, BEETHOVEN'S 9TH AND 5TH, JINGLE BELLS, YANKEE DOODLE, STAR SPANGLED BANNER, CLEMENTINE, GOD SAVE THE QUEEN, O SOLE MIO, WESTMINSTER CHIMES, and DESCENDING OCTAVE CHIME plus many more! with detailed specs and instructions.

SE 01 Sound Effects Kit — NEW

The SE-01 is a complete kit that contains all the parts to build a programmable effects generator. Designed around the new Texas Instruments SN 76477 Sound Chip, the board provides banks of MINI DIP switches and pots to program the various combinations of the SLF Oscillator, VCO, Noises, One Shot, and Envelope Controls. A Quad Op Amp IC is used to implement an Adjustable Pulse Generator, Level Comparator and Multiplex Oscillator for even more versatility. The 3½"×3" PC Board features a prototype area to allow for user added circuitry. Easily programmed to duplicate Explosion, Phaser Guns, Steam Trains, or almost, an infinite number of other sounds. The unit has a multiple of applications. The low price includes all arts, assembly manual, programming charts, and detailed 76477 chip specifications. It runs on a 9V battery (not included). On board 100MV amp will drive a small speaker directly, or the unit can be connected to your stereo with incredible results! (Speaker not included.)

COMPLETE KIT ONLY £14.99
P&P 67p + VAT

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AY-3-8910 THE NEW GI COMPUTER SOUND CHIP

The amazing AY-3-8910 is a fantastically powerful sound and music generator, perfect for use with any 8-bit micro processor. Contains 3 tone channels, noise generator, 3 channels of amplitude controls, 16-bit envelope period control, 2 parallel I/O, 3D/A converters plus much more. All in 40 pin DIP. Super easy to interface to the S-100 or other Busses.

ONLY £8.50 + VAT, including FREE reprint of BYTE '79 article! Also, add £2.25 for 60-page data manual.

"Perhaps the next famous composer will not direct a 150-piece orchestra but, rather, a trio of microcomputers controlling a bank of AY-3-8910s." BYTE July '79.

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- ULTRA low Power Consumption LCD 106

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LED BAR GRAPH AND ANALOG METER DRIVER

New from National LM3914. Drives 10 LED directly for making bar graphs, audio power meters, analog meters, LED Oscillators, etc. Units can be stacked for more LEDs. A super versatile and truly remarkable IC.

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The most SOPHISTICATED MOTION DETECTOR available!

NEW FROM SPRAGUE

- Long Range Operation
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- Automatic Timed Reset
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MUSIC FOR YOUR EARS

Bullet's Electronic Music Maker TM Kit has a single 28 Pin Microprocessor Chip with ROM that has been programmed to play the first 6 to 10 notes of the 25 popular tunes listed below. Each tune can easily be addressed individually or played sequentially at the push of a button. The 3 chime sequences are activated at any time by separate switch closures, so when used as a doorbell, one door can play songs while two others wil play different chimes. The unit has a 5 watt audio Amp anid will run on either 12 VAC or 12 VDC. Construction is very simple, works with any 8 or 16 ohm speaker, or horn speaker (not included). Tunes can be remotely programmed using a single rotary switch (not included), if desired.

Complete Kit £9.95. 240V Transformer optional.

Tunes: Toreador ★ William Tell ★ Hallelujah Chorus ★ Star Spangled Banner ★ Yankee Doodle ★ America America ★ Deutschland Leid ★ Wedding March ★ Beethoven's 5th and 9th ★ Hell's Bells ★ La Vien en Rose ★ Stars Wars Theme ★ Clementine ★ Marseillaise ★ O Sole Mio ★ Santa Lucia ★ The End ★ Blue Danube ★ Brahms Lullaby ★ Westminster Chime ★ Simple Chime ★ Descending Octave Chime ★ Augustine ★ Jingle Bells ★ God Save the Queen ★ Colonel Bogie.

Ordering information. Unless otherwise stated, for orders under £50 add 50p p&p. Add 15% VAT to total (no VAT on books). All devices are brand new, factory prime and full spec and subject to prior sales and availability. Prices subject to change without notice. Minimum telephone order using ACCESS is £10. If ordering by post with ACCESS, include name, address and card no. written clearly. Please allow 4/6 weeks delivery on books.

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BP70	Transistor Radio Fault-Finding Chart	0.50
BP160	Coil Design & Construction Manual	0.75
BP202	Handbook of Integrated Circuits Equivs & Substitutes	1.00
BP211	First Book of Diode Characteristics & Equivalents & Substitutes	1.25
BP213	Electronic Circuits for Model Railways	1.00
BP215	Shortwave Circuits & Gear for Experimenters & Radio Hams	0.85
BP221	28 Tested Transistor Projects	1.25
BP224	50 CMOS IC Projects	0.95
BP226	Build Advanced Short wave receivers	1.20
BP227	Beginners Guide to Building Electronic Projects	1.25
RCC	Resistor Colour Code Disc	0.20

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

ANTEX IRONS

1943	15 watt iron element ceramic fitted with 3/32" bit	£5.12
1947	Replacement element for 1943 iron	£2.33
1944	Iron coated bit 3/32" for 1943 iron	£0.58
1945	Iron coated bit ⅛" for 1943 iron	£0.58
1946	Iron coated bit 3/16" for 1943 iron	£0.58
1948	General purpose 18 watt iron fitted with iron coated bit	£5.12
1952	Replacement element for 1948 iron	£2.22
1949	Iron coated bit 3/32" for 1948 iron	£0.58
1958	Iron coated bit ⅛" for 1948 iron	£0.58
1951	Iron coated bit 3/16" for 1948 iron	£0.58
1931	Highly popular X 25 25 watt quality iron ceramic shafts to provide near perfect insulation breakdown voltage of 1500 volts AC and a leakage current of only 3.5uA and another shaft of stainless steel to ensure strength	£5.12
1935	Replacement element for 1931 iron	£2.00
1932	Iron coated bit ⅛" for 1931 iron	£0.58
1933	Iron coated bit ⅛" for 1931 iron	£0.58
1934	Iron coated bit 3/32" for 1931 iron	£0.58
1953	SK1 kit contains 15 watt iron with a 3/16" bit plus two spare solder, heat-sink and a booklet 'How to solder', in presentation display box	£7.28

VEROBOARD

2201	2.5"x5" .1 Copper	£0.71	2211	2.5"x2.5" .15 Copper	£0.63
2201	2.5"x3.75" .1 Copper	£0.61	2212	3.75"x17" .15 Copper	£2.39
2203	2.5"x17" .1 Copper	£2.14	2213	3.75"x5" .15 Copper	£0.90
2205	3.75"x3.75" .1 Copper	£0.71	2217	3.75"x17.9" .1 Plain	£1.79
2206	3.75"x17" .1 Copper	£2.76	2218	3.75"x2.5" .1 Plain	£0.44
2207	4.75"x17.9" .1 Copper	£3.61	2219	5"x3.75" .1 Plain	£0.68
2208	2.5"x1". 5 in pack	£0.85	2223	2.5"x5" .15 Plain	£0.37
2204	3.75"x5" .1 Copper	£0.79	2225	5"x3.75" .15 Plain	£0.56
2210	2.5"x5" .15 Copper	£0.64			

BIB HI-FI ACCESSORIES

806	J	Compact tape head cleaning kit	£1.22
810	23	Tape Editing kit	£2.65
811	24	Cassette Tape editing and joining kit	£2.76
813	29A	Salvage cassette	£0.51
814	31	Cassette Head cleaning tape	£0.71
817	36A	Record & Stylus cleaning kit	£0.46
818	41	8-track Cartridge tape head cleaner	£1.24
819	42	Groove Kleen auto metal record cleaner	£2.65
826	52A	Cassette storage tray (holds 10)	£0.92
827	53	Hi-Fi stereo test cassette	£3.17
829	60	Chrome finish 'Groove Kleen (plastic)	£2.12
834	69	Anti-static Hi-Fi cleaning liquid	£0.35
838	78	Cassette hand tape winder	£1.50

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 PrimaryD 55V @ 2A Secondary	£7.30	P&P £1

SPECIAL OFFER

2042 240V Primary 0 20V @ 2A Secondary. By removing 5 turns for each volt from the secondary winding any voltage up to 20V @ 2A is easily obtainable. Ideal for the experimenter £1.50 P&P 86p

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	4⅛in	1⅜in	£1.79
158	9in	5¼in	2½in	£2.43

ALUMINIUM BOXES. Made from bright ali 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	2½in	5⅛in	2⅛in	12in	3½in	8in	£5.45
168	1⅜in	7¼in	4in	16in	4½	11in	£8.21

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BAKER 50 WATT AMPLIFIER **£69** Post £2

Superior quality ideal for Halls/PA systems. Disco's and Groups. Two inputs with Mixer Volume Controls. Master Bass, Treble and Gain Controls. 50 watts RMS. Three loudspeaker outlets 4, 8, 16 ohm. AC 240V (120V available). White wording on black cabinet.

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STEREO PRE-AMP KIT. All parts to build this pre-amp. 3 inputs for high medium or low gain per channel, with volume control and P.C. Board. Can be ganged to make multi-way stereo mixers. **£2·95**

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Complete kit of parts with R.C.S. printed circuit. Three channels. Up to 1,000 watts each. Will operate from 200MV to 100 watts signal source. Suitable for home Hi-Fi and all Disco Amplifiers. Cabinet extra £4·50. **£18** Post 50p

200 Watt Rear Reflecting White Light Bulbs. Ideal for Disco Lights. Edison Screw 75p each or 6 for £4, or 12 for £7.50.

MAINS TRANSFORMERS Primary 240V A.C. ALL POST 99p

250-0-250V 70mA. 6·5V. 2A	£3·45
250-0-250V 80mA. 6·3V 3·5A. 6·3V 1A	£4·60
330-0-330V 200mA. 6·3V 3A+6·3V 2A+6·3V 2A	£12·00
300-0-300V 120mA. 2x6·3V 2A C.T.: 5V 2A	£10·00
220V 45mA. 6·3V 2A	£2·50

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Tapped outputs available

2 amp 3, 4, 5, 6, 8, 9, 10, 12, 15, 18, 25 and 30V	£6·00
1 amp 6, 8, 10, 12, 16, 18, 20, 24, 30, 36, 40, 48, 60	£6·00
2 amp 6, 8, 10, 12, 16, 18, 20, 24, 30, 36, 40, 48, 60	£9·50
3 amp 6, 8, 10, 12, 16, 18, 20, 24, 30, 36, 40, 48, 60	£12·50
5 amp 6, 8, 10, 12, 16, 18, 20, 24, 30, 36, 40, 48, 60	£16·00

6V. 500mA	£2·00	6-0-6V. 100mA	£1·50
12V. 100mA	£1·30	20V. 40V. 60V. 1 amp	£4·00
12V. 750mA	£1·75	12V. 3 amp	£3·50
10-0-10V 2 amp	£3·00	10V. 30V. 40V. 2 amp	£3·50
30V. 5 amp and 17V-0-17V. 2 amp	£4·00	12V. 2 amp	£3·25
0-5, 8, 10, 16V. ½ amp	£2·50	20V. 1 amp	£3·00
9V. 3 amp	£3·50	20-0-20V. 1 amp	£3·50
15-0-15v 2 amp	£3·75	30V-0-30V. 2 amp	£8·00
30V. 2 amp	£3·50	2 of 18V. 6 amp. each	£11·00
30V. 1½ amp	£3·30	12-0-12V. 2 amp	£3·50
		9V. ½ amp	£1·50

AUTO TRANSFORMERS 115V to 240V 500W ... £10.00

CHARGER TRANSFORMERS – CHARGER RECTIFIERS

6-12V-3a	£4.00	6-12V-2a	£1.00
6-12V-4a	£6.50	6-12V-4a	£2.00

R.C.S. LOUDSPEAKER BARGAINS

3 ohm. 6×4in. £1·50. 7×4in. £1·50. 8×5in. £2·50. 6½in. £2·20. 8in. £2·60. 10in. £3·50. 12in £4·50.
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All parts and instructions with Zener diode printed circuit, rectifiers and double wound mains transformer input 200-240 a.c. Output voltages available 6 or 7.5 or 9 or 12V d.c. up to 100mA. State voltage.

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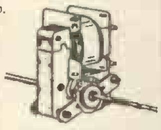

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4006	.86	4060	1.10
4007	.26	4063	1.05
4008	.78	4066	.48
4009	.40	4067	3.60
4010	.40	4068	.22
4011	.26	4069	.26
4012	.22	4070	.33
4013	.40	4071	.24
4014	.78	4072	.24
4015	.78	4073	.24
4016	.40	4075	.21
4017	.74	4076	.93
4018	.78	4077	.30
4019	.40	4078	.22
4020	.92	4081	.22
4021	.98	4082	.22
4022	.87	4085	.75
4023	.22	4086	.75
4024	.66	4089	1.40
4025	.20	4093	.68
4026	1.56	4094	1.70
4027	.40	4095	.95
4028	.72	4096	.95
4029	1.04	4097	3.18
4030	.45	4098	1.05
4031	2.08	4099	1.25
4032	1.10	4502	.97
4033	1.37	4508	2.35
4034	1.99	4510	.87
4035	.92	4511	.87
4037	.96	4512	.85
4038	1.03	4514	2.21
4040	.98	4515	2.21
4041	.77	4516	.97
4042	.69	4517	3.55
4043	.84	4518	.97
4044	.84	4520	.97
4045	1.27	4527	1.37
4046	1.09	4532	1.07
4047	.82	4556	.59
4048	.50	4585	1.02
4049	.40	40106	.65
4050	.45	40160	.74
4051	.70	40161	.74
4052	.70	40162	.74
4053	.70	40163	.74
4054	1.05	40174	.74
		40194	.93

LINEAR

CA555CG	.20
CA741CG	.38

DIODES

IN4001	.05
IN4002	.05
IN4003	.06
IN4004	.06
IN4005	.06
IN4006	.07
IN4007	.07
IN4148	.04

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8ZY88 3.3V to 30V 400mW .07 each

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5% carbon film resistors. High stability, low noise ¼W E24 range of values 1R-1M .07 for 5 pieces 1 value only.

TRANSISTORS

ZTX107	.09
ZTX108	.09
ZTX109	.09
ZTX300	.10
ZTX310	.10
ZTX320	.11
ZTX330	.11
ZTX450	.12
ZTX500	.12
ZTX502	.12
ZTX504	.12
ZTX750	.20

DIL SOCKETS

8P	.09
14P	.11
16P	.13
18P.	.15
20P	.17
22P	.18
24P	.20
28P	.25
40P	.35

POWER

2N 2102	.60	2N 4036	.65
2N 3053	.31	2N 5038	3.01
2N 3055	.39	2N 5240	1.83
2N 3439	.61	2N 5294	.42
2N 3440	.43	2N 5296	.35
2N 3442	.99	2N 5320	.51
2N 3553	1.58	2N 5756	.91
2N 3773	1.70	2N 5838	1.40

Miniature Toggle

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PE/10/80

PE VOLUME 16 No. 10 OCTOBER 1980

CB—OPEN CHANNEL

AT LAST we have the Government's proposals on CB and we are pleased to see that they propose to allow the use of this facility in the UK. But wait, what are they really giving us? A very short range system for which equipment will be expensive, a system which we believe will be of little use or value to anyone—users or manufacturers.

Some manufacturers have indicated that they consider the use of a 928MHz system would be so small that it would not be worth producing equipment. What use is a range of about 10 miles maximum—considerably less in cities—when the equipment will be very expensive.

We believe the Government is simply paying lip service to public pressure for a system. They may have been misled by the Home Office who have always been against any service and who must realise that, if instigated, these proposals will mean little or no extra work for them or anyone else. Alternatively, they may have misguidedly taken a lead from West Germany. The Government there has recently announced the proposed introduction of a 900MHz service in the future, but West Germany already has 27MHz CB and the 900MHz service will be an addition to that, which is a different kettle of fish.

The Government is now planning to clamp down on illegal use of 27MHz—there have been a number of convictions and proposed laws to ban the advertising and sale of any 27MHz systems will at least ensure that transceivers are no longer openly available in this country. This is a move with which we approve, anything that can be done to prevent further illegal use of this frequency is sensible, but the Government—having said it is in favour of Open Channel (as they call it)—must now make proposals for a usable alternative. They must provide a system which will meet the needs of the general public, not a system that is designed to silence the voice of the CB associations without giving anything away.

We suggest that they think again, that they seek some more informed, less biased, opinion and that they try to act in the public interest and not just appear to do this.

Of course, some may say that any service is better than none. We do not concur, if 928MHz is introduced it will be virtually useless to the general public and will prevent any usable service ever being introduced—as indeed it may well be intended to do. The Government have stated that only a small increase in the Home Office staff will be needed to control the service—even with all the civil service red tape—so perhaps they do realise it will be of little use.

We do not want to follow the Australians, with all the problems they have found with 27MHz, but we feel that this useless sop will only tend to encourage illegal use of 27MHz.

Let's stop pussyfooting around and get a viable system off the ground. A system that will ensure a good service and not encourage the cowboys.

It's not too late (hopefully); in a reply to a written question from Mr. Patrick Wall MP, Mr. William Whitelaw made the following statement ". . . I intend to publish a discussion document on Open Channel within the next few weeks, and I shall take the public reaction to this into account in reaching final decisions." Incidentally it would appear that "the next few weeks" in Government terms is in fact 13 weeks so things could move slowly.

Mike Kenward

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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.

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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.

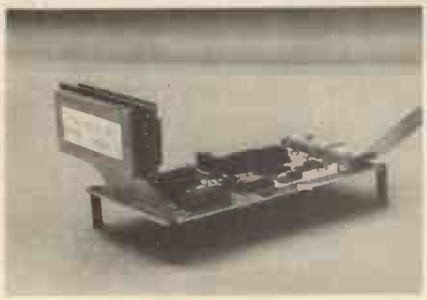
by David Shortland and Jasper Scott

VERSATILE DISPLAY

For those occasions when a VDU is overkill, and yet illuminating fixed legends is insufficient, Amber Controls have come up with an intelligent 2-line alpha-numeric display subsystem.

The liquid crystal 32 character display is microprocessor controlled, and its 5×7 dot matrix elements enable full ASCII upper and lower case. A further 5×1 matrix facilitates the use of a cursor.

Surplus programming capacity has allowed editing, split screen use and several modes of interfacing to be included.



An attractive feature of the Visual Display Module is its ability to display factory programmed messages, and even graphics, on receipt of the ASCII "ESC" code, followed by A to Z.

Optical isolation of the serial input and output allows TTL, 20mA current loop or V24 connection. There is also a strobed parallel input for direct keyboard interface.

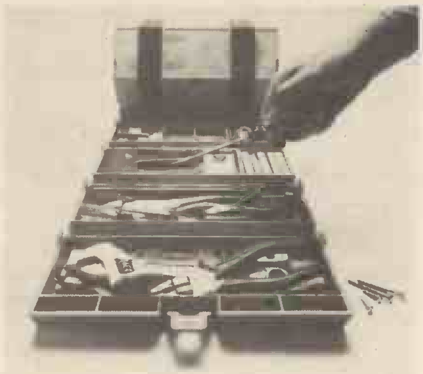
Ease of interface having been assured electronically speaking by the use of a micro', the designers went on to make mechanical integration into a system simple too, by linking the display to the p.c.b. with a flexible cable. Power consumption is less than 2 watts.

Details: **Amber Controls Ltd., Central Way, Walworth Ind. Estate, Andover, Hants. (0264 65951).**

NEAT AND TIDY

Here at last is an answer to the prayers of many constructors who are looking for a compact yet spacious means of storing tools and components—the Rolykit, from the Dutch Hagemeyer group.

Looking at the ingenious yet somehow obvious design of the Rolykit, it is surprising that something similar was not invented long ago.



When closed, it can be shaken, even thrown in the air and then opened to reveal everything still neatly in its place, conveniently laid out and ready for work. Some of the compartments are large enough to accommodate pliers, cutters, and reels of wire, while others are divided into smaller units, ideal for components.

The Rolykit comes in two sizes priced at around £12 and £15, and should be available from leading retail outlets and chain stores.

SPACE-AGE STATION

The new version of the Antex TCSU1 soldering station, meets the latest requirements for temperature-controlled soldering of delicate circuits and semi-conductors. The station is moulded in one of the toughest and most durable moulding materials available.

A significant addition is the anti-static earth connection to protect MOS devices from the damage, often unnoticed until too late, caused by static electricity. By inserting the jack with the special earthing cable in the socket at the side of the unit, a connection can be made to a specially made "earth" to eliminate any static electricity charges.

The soldering station is supplied with either the miniature CTC 40 watt iron or the XTC 50 watt model. Both models are fitted with 5-conductor silicone burn-free cable and 5 pin DIN sockets to connect with the 24 volt supply from the station. Thermocouples, fitted at the front of the irons, sense the temperature which is kept at a pre-set level anywhere between 65 and 420°C with an accuracy of 2 per cent. A range of 3 long-lasting bits, heavily coated with iron, is included with each iron for micro, miniature or ordinary soldering work. These bits slide easily on or off the stainless steel shafts of the irons; screws which may cause oxidation or "freezing" of bits to shafts and damage to the irons, have been carefully avoided.

Avoided also are such evils as magnetic fields, arcing transients or spikes; switching is done electronically at zero voltage.

The separate sponge tray which is supplied with each station, can be taken to a tap; this avoids spilling of water over the station.

The price for the TCSU1 (including either the CTC40 or the XTC50) is £38 plus VAT. Further information is available from: **Antex Ltd., Mayflower House, Plymouth, Devon (0752 67377).**

KEYBOARD CASE

A robust ABS case for self-contained alpha-numeric keyboards is now available from West Hyde Developments Ltd.

Known as the Princess Keyboard, the enclosure is vacuum formed in two halves which are clipped and then screwed together for rigidity in final assembly. The ABS plastic is

easy to drill, punch and clean and the base incorporates a series of ribs for simple mounting of many proprietary keyboard assemblies.

The price for the Princess Keyboard is £10·75, and it is available direct from:

West Hyde Developments Ltd., Unit 8, Park Street Industrial Estate, Aylesbury, Bucks. HP20 1ET.

ELCB

The two main problems associated with conventional fuses is that they are too slow to protect equipment from serious damage and that they offer little protection against serious electrical shock since their ratings and slow operation may allow fatal currents to flow.

The earth leakage circuit breaker overcomes these problems by sensing any small earth leakage current flowing in a circuit or any equipment connected to it. This is achieved by comparing the currents in the live and neutral conductors and detecting any small imbalances. Because of its high sensitivity the ELCB can isolate the circuit or equipment before any serious damage can result.

A comprehensive range of ELCBs have now been introduced by B & R Relays. Called the HO6 Mainsafe series, they feature a wide range of ratings from 25 to 80 amps, with trip

ratings from 30mA up to 500mA. This new range together with the existing HO4 13 Amp portable ELCB gives B & R full coverage of all ELCB applications.

The wide range of models available make it possible to protect an installation in a simple cost effective manner. For instance, overall house or building protection can be provided by fitting say a 63 or 80 Amp HO6 Mainsafe to give a 100 to 300mA trip sensitivity—sufficient to guard against fire or equipment damage. If further protection against electrocution is required, a more sensitive HO6 Mainsafe with, say, a 30mA sensitivity can be fitted to give protection on specific circuits or socket outlets. Alternatively, individual socket or appliance protection, eg. in a garage or damp location can be obtained using the HO4 13 Amp portable ELCB into which the appliance is plugged via a standard 13 Amp socket.

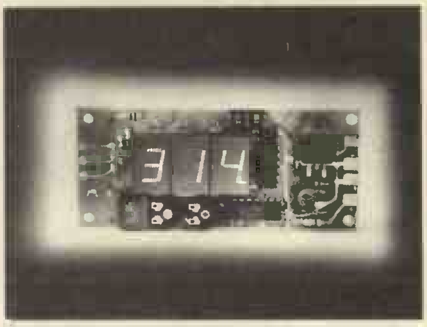
For further information contact B&R Relays Limited Templefields, Harlow, Essex CM20 2BG.

INTRODUCING RISCOMP

A new component shop supplying a wide range of components, test equipment and books to the hobbyist has been opened by Riscomp Ltd. The hours of opening are 9.00 a.m. to 5.00 p.m. Monday to Saturday, closed all day on Wednesdays.

Coinciding with the opening of their shop, Riscomp have introduced a low cost digital voltmeter known as the DVM 314. This module features a full 3-digit display with 10·9mm digits, and has a display sensitivity of −99mV to +999mV with an accuracy of 0·1 per cent ± 1 digit. A single d.c. supply of between 7–12V capable of providing 220mA max. is required to power the unit, thus allowing the module to be operated by either a battery such as the PP9 or a suitable mains operated power supply.

The basic 1V maximum reading may be easily extended by the use of simple resistive attenuators with the required decimal point being selected by grounding the appropriate pad on the module.



Measuring 41 × 95 × 10mm the unit is supplied with a full instruction sheet which includes suggested values for resistive attenuators, together with instructions for measuring a.c. voltage, current, resistance, and temperature.

Priced at £11.95 plus VAT, the DVM 314 is available to personal callers or by mail order from Riscomp's new shop at the following address: **Riscomp Ltd., 21 Duke Street, Princes Risborough, Bucks. (084 44 6326).**

SERVICE CASE

A new combined tool case and component cabinet has just been introduced by Link-Hampson.

The outer case is made of black simulated leather with a moulded carrying handle. Extra strength is given to the case by incorporating reinforcing side straps. The external dimensions of the case are 380mm × 317mm × 203mm.

A lift up top gives access to a tool carrying tray whilst the component storage drawers are accessible by folding down the front panel.

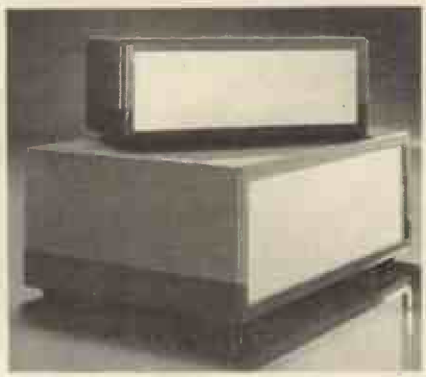
The price of the case, model 2501E, is £29·95 ex. VAT and p&p.

Link-Hampson Ltd., 5 Bone Lane, Newbury, Berkshire (0635 44796).

VERO CASES

To complement their existing range of grey cases Vero have introduced two models in two-tone brown.

The first type model 75/1713F (154 × 85 × 60mm) has a unique clip together design which requires no fixing screws. The front and rear panels are retained in position when the two halves are assembled.



The second type model 75/1714A (205 × 140 × 75mm) is the usual two section case held together by four screws. Front and rear panels are included as well as fixing points for horizontally mounted p.c.b.s.

The cases are priced at £3·58 (model 75/1713F) and £2·45 (model 75/1714A) excluding VAT and p&p.

Vero Electronics Limited, Industrial Estate, Chandlers Ford, Eastleigh, Hants.

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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).
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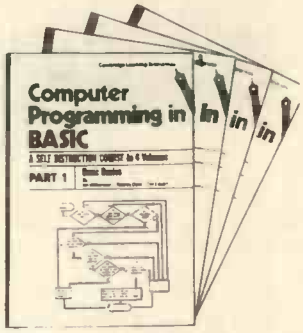

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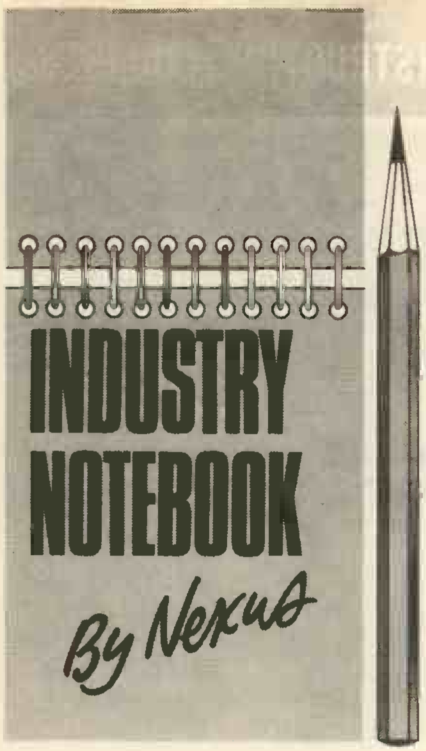

Recession

The in-word this year is recession. We hear it morning, noon and night, presented generally in terms of utter disaster and catastrophe. Such pessimism is entirely misplaced. Surely we should be optimistic because the recession has precipitated a shake-out in industry that is long overdue by a good 20 years, perhaps even longer. Everyone knew that it had to come and that when it did the process would be painful. And in the older industries, more painful than most.

But when we look at the young industries, of which electonics is the most striking example, quite a different picture emerges. GEC's recently announced results show the group cracking through the £3 billion turnover 'barrier' despite unfavourable trading conditions further complicated by industrial disputes. About one third of the total business is now in electronics, automation and telecommunications which showed a 21 percent increase in turnover and a 33 percent increase in pre-tax profit. And you only have to look at the advertisements in the national and trade press to see that GEC's main worry is how to recruit enough engineers.

The strength of the pound sterling is supposed to be 'killing' exports. GEC's exports were up to £805 million. Killing means extinction, quite different from the actuality that the high value of the pound merely makes exporting more difficult and that the converse of a weak pound would make every import of raw materials more expensive. A case of swings and roundabouts.

I have picked out GEC as an example only because their year-end results are the most recent to hand. But the same applies to the lesser giants of the professional electronics industry, such as Racal Group, Plessey and ICL, and smaller groups such as Unitech and companies like Farnell.

If we believe that a measure of performance is seen in the gross returns to shareholders in dividends and capital gains in the past ten years, and the profits must have come from somewhere, it is instructive to examine a recent league table of the 50 top business performers in the UK published in 'Management Today' last June. Racal emerges as the clear winner with a percentage gain of 2,008 percent. Electrocomponents was fourth, Farnell sixth, ICL eleventh and Unitech thirteenth. In these terms, Plessey, GEC and Ferranti are nowhere in the top 50, only steady successful plodders rather than get-up-and-goers.

To show how misleading the media can be in spreading gloom we only have to look at the headline 'Racal Disappoint with £63 million'. That was last year's profits as reported by a business editor. It is so easy to overlook the fact that only a decade ago Racal's total group turnover was only £17·1 million and this was the group's 25th consecutive year of record turnover and profit growth.

The other side of the coin must not be overlooked. Decca and EMI, both failing in performance and now under new management with Racal and Thorn respectively, should start prospering again. Plessey now revitalised, only achieved this through shedding dead wood with painful and massive redundancies. Nasty but necessary medicine.

Well, there are ups and downs in all businesses, some winners, some losers, and in a world recession it is tough going for everyone.

As far as electronics is concerned there is certainly no need for despair except in one single aspect. It is not the sort of industry which creates mass employment. In fact the industry needs relatively less labour per unit of income year after year. Printed and integrated cicruits have transformed the manufacturing side of the business. On the other hand the enormous increase of usage has generated a demand for an increasing army of installation and maintenance engineers.

One of the paradoxes of the present situation is the number of complaints of overtime being cut in factories. Whatever happened to the sustained campaign for shorter hours and longer holidays?

The Chip Scene

As I write there is still no decision on INMOS, an ominous sign reflecting lack of enthusiasm for, if not imminent abandonment of, Government (i.e. taxpayers) support. But at least one aspect of the tangled saga of the chips has been resolved. The GEC-Fairchild joint project has been abandoned through lack of agreement with Fairchild's new owners, Schlumberger. GEC has now acquired the original Fairchild share in the new factory at Neston, Cheshire. But instead of making chips the Newton plant will produce the Sting Ray lightweight anti-submarine torpedo for which Marconi Space and Defence Systems have an initial £200 million contract for final development and first production.

Sting Ray is potentially one of the UK's brightest export projects. It is perhaps as much as five years ahead of the competition, certainly three years, and has built-in 'intelligence' in both the search and terminal homing phases of operation. Sales are expected to exceed £1 billion in the years ahead.

Energy

Before recession snatched the headlines from the chip the fashionable topic was energy. The problem hasn't gone away, only faded into the background in headline appeal. And so, almost ignored, was the world's largest ever commercial contract for solar energy won by Lucas Energy Systems Ltd in the British-based Lucas engineering group. Under the contract 2,550 solar-power units are being built to power a radio-telephone network linking hundreds of villages in the mountains and equatorial forests in the interior of Columbia. Together the power units will generate a peak power of 100kW from solar energy to charge batteries to a total of 2,400kWh.

But that's not the end of the good news. It is fashionable today, at least in the UK, to regard with scorn, if not outright contempt, the EEC. And yet the European Commission has recently voted £530 million to energy research, some 50 percent increase in funding and now comparing well with similar programmes in the United States, the Soviet Union and Japan.

A substantial sum will be spent on fusion research, the cornerstone of which is the Joint European Torus (JET) which is under construction in the UK at Culham and due to be completed and ready for the first vital experiments in 1983.

Those still fearful of the consequences of nuclear energy should be reassured by big spending on reactor safety projects, and in protecting the environment. And enthusiasts for alternative energy systems should be pleased with a doubling of research funds in solar energy to £14 million with an element of technical support for third-world countries who, in any case, in their sunnier climates are likely to be the main beneficiaries.

I note too, that Gulf and Western Industries in New York has a prototype Volkswagen 'Golf' modified for electric traction with a range of 155 miles at 55m.p.h., and it goes further at lower speeds. The zinc chloride battery is one third of the weight of a lead-acid battery of the same capacity. G & W hope to be in production with electric traction units by the mid-80s.

Monopolies

Debate will be at furious level on the even very limited weakening of monopoly power in posts and telegraphs in the UK. But optimists like myself believe that the threat of modest competition will have a galvanising effect on efficiency—and that can't be bad.

MICRO-BUS

Compiled by DJD.

Appearing every two months, Micro-Bus presents ideas, applications, and programs for the most popular microprocessors; ones that you are unlikely to find in the manufacturers' data books. The most original ideas often come from readers working on their own systems, and payment will be made for any contribution featured.

THIS month's Micro-Bus examines the Acorn Teletext VDU, an unusual memory-mapped VDU with the ability to display Prestel and Teletext pictures. The VDU card can be used with the low-cost System One microcomputer, and several programs are presented to demonstrate the use of the VDU with the System One for graphics.

BLOCK DIAGRAM

A block diagram of the Acorn Teletext VDU is shown in Fig. 2. It consists of three main parts: the VDU memory, the controller chip, and the teletext character generator. The VDU displays the contents of the 1K of memory, which is switched between the VDU and the processor for half of each memory cycle; in other words, access to the VDU is transparent so that the processor can read from or write to the screen memory without affecting the display. The VDU is normally configured for a format of 25 lines of 40 characters, thus using 1000 bytes of the 1024 RAM locations. This format includes an extra line over the teletext format, which is 24 × 40. The memory is normally addressed as locations #0400 to #07FF.

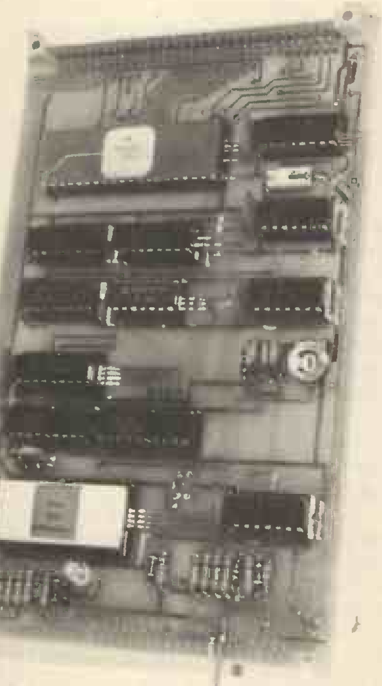

Fig. 1. The Acorn Teletext VDU card

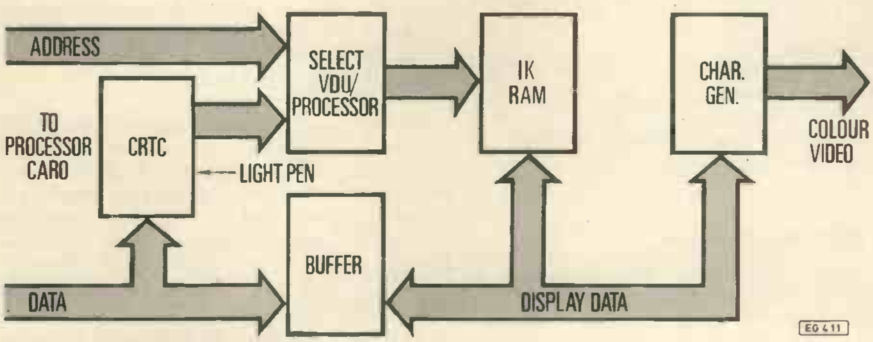

Fig. 2. Block diagram of the teletext VDU card; it interfaces to the computer's address and data lines

SCREEN FORMAT

The format of characters on the screen is controlled by the 6845 CRT controller chip, and the format can, to a certain extent, be reprogrammed simply by altering constants stored in the 6845's registers. The 6845 is addressed as two memory locations; an address register and a data register. In fact the 6845 contains a total of 18 registers; the number loaded into the address register determines which of the other registers is selected as the data register. A drawback of using the CRTC is that it must be programmed before any display will be obtained. The routine of Fig. 3 illustrates how to do this using the 6502 micro. The routine writes the sixteen values from a table after the program to registers #00 to #0F respectively, and sets the display up in 25 × 40 format with a flashing-underline cursor.

```
                     ;       SET UP CRTC REGISTERS
                     ;       ON TELETEXT VDU.
                     ;
                     CRTA    =$0800             ADDRESS
                     CRTB    =$0801             DATA
                     RESTRT  =$FF04             IN MONITOR
                     ;
0000                         .=$0980
0980  A0 OF          SETCRT  LDY   £$0F         NO. OF REGS
0982  8C 00 08       LOOPS   STY   CRTA         SELECT REG
0985  B9 91 09               LDA   CRTTAB,Y     GET VALUE
0988  8D 01 08               STA   CRTB
098B  88                     DEY
098C  10 F4                  BPL   LOOPS
098E  4C 04 FF               JMP   RESTRT       BACK.
                     ;
0991  3F             CRTTAB  .BYTE $3F,$28,$33,$05
0995  1E                     .BYTE $1E,$02,$19,$1B
0999  00                     .BYTE $00,$09,$68,$09
099D  04                     .BYTE $04,$00,$07,$FF
                             .END
```

Fig. 3. Program for the 6502 micro sets up the VDU card for a 25 × 40 display, and a flashing-underline cursor

Registers #00 to #09 determine the screen format. For example, to obtain a format of 16 rows of 32 characters set register #01 (number of characters per line) to #20, and register #06 (number of lines) to #10. The display can be turned off completely, without affecting the contents of the display memory, by setting register #06 to #00.

Registers #0C and #0D contain the high and low bytes respectively of the screen start address. The start address can be changed to alter the mapping of memory to the screen; for example, incrementing it by 40, the number of locations per line, will scroll the display.

The CRTC also provides a cursor, which can be flashing or static, and whose shape can be programmed. The type of cursor is determined by registers #0A and #0B. For the normal flashing underline cursor register #0A has the value #68; or cursors can be obtained by altering this register as follows:

Function:	Value:
Cursor off	#1F
Static block	#00
Slow flashing block	#60
Fast flashing block	#40

The position of the cursor on the screen is determined by registers #0E and #0F, which contain the high and low bytes of the cursor address.

The CRTC also provides a light-pen strobe input; a logic-level transition on this input will cause the address of the cell currently being displayed to be stored in the light-pen address registers, #10 and #11.

TELETEXT CONTROLLER

The character generation and display is performed by the SAA5050 Teletext Character Generator, which in addition to being able to display the usual and lower-case character set, has many attractive features such as: double-height characters; the ability to flash characters; display of characters in six colours or white against a background of any colour, black, or white; and display of two different types of graphics. Furthermore, most of these options can be used in combination.

Most memory-mapped VDUs use spare bits in the display memory to select special options for each character; for example, the top bit of the character could be used to determine whether the character is displayed static or flashing. In the teletext VDU there are too many different options to enable them to be specified in this way for each character, so a rather cunning method is used instead. Certain control codes, when present in a line, change the state of subsequent characters on that VDU line. Thus a line will normally be steady, but if a 'flash' code is put on the VDU, all the remaining characters on that line will flash. It is even possible to make one word in a line flash by preceding the word with a 'flash' code, and following it by a 'steady' code.

The Teletext method of selecting special functions has one drawback: the control code will appear on the VDU as a blank cell, corresponding to the background colour; so, for example, it is not possible to display a line of contiguous characters all in different colours; there has to be a blank between each character.

GRAPHICS

To provide the facility for plotting graphs and histograms the character cell is divided into six picture elements, or "pixels", each of which can be either set to a colour, or cleared to the background colour. The state of each cell is determined by one bit of the code, as shown in Fig. 4. For the graphics symbols, bit 5 is always set. To display codes as graphics, rather than characters, they are preceded by a code specifying graphics and the required colour.

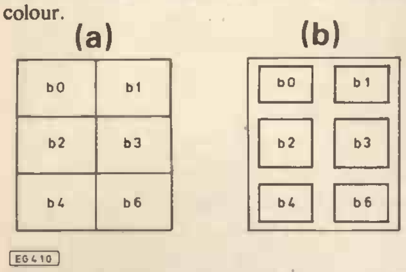

Fig. 4. Diagrams showing how the teletext graphics symbols are constructed for: (a) contiguous graphics, and (b) separated graphics

The usual graphics mode is called 'contiguous graphics', but there is also an option called 'separated graphics' in which the pixels are separated by a thin border; see Fig. 4 (b).

If the whole VDU screen is to be used for graphics the first character of each line should be a 'graphics colour' code; the overall resolution is thus 78 × 75. A routine to clear the display and set it up for white graphics is shown in Fig. 5.

```
                       ;       CLEAR SCREEN FOR GRAPHICS
                       ;       TELETEXT VDU.
                       ;
                       ADDS   =$0023              CELL POINTER
                       RESTRT =$FF04              IN MONITOR
                       ;
.0000                         .=$0E80
0E80  A0 00     CLEARS LDY    £0
0E82  A9 20            LDA    £$20                SPACE
0E84  99 00 04  CLEAR  STA    $400,Y              DO 256 BYTE
0E87  99 00 05         STA    $500,Y                BLOCKS.
0E8A  99 00 06         STA    $600,Y
0E8D  99 00 07         STA    $700,Y
0E90  C8               INY
0E91  D0 F1            BNE    CLEAR
0E93  84 23            STY    ADDS                ZERO
0E95  A9 04            LDA    £$04                SET ADDS TO
0E97  85 24            STA    ADDS+1                SCREEN START
0E99  D8               CLD
0E9A  A2 18            LDX    £$18                25 LINES
0E9C  A9 17     SET    LDA    £$17                GRAPHICS WHITE
0E9E  91 23            STA    (ADDS),Y            START OF LINE
0EA0  A9 28            LDA    £$28                40 CHARS/LINE
0EA2  18               CLC
0EA3  65 23            ADC    ADDS
0EA5  85 23            STA    ADDS
0EA7  90 02            BCC    NOCY                CARRY?
0EA9  E6 24            INC    ADDS+1
0EAB  CA        NOCY   DEX
0EAC  10 EE            BPL    SET                 DO ALL 25 LINES
0EAE  4C 04 FF         JMP    RESTRT              STOP.
                       ;
                              .END
```

Fig. 5. Routine to clear the display, and initialise the display memory for graphics

EXAMPLES

Some examples of displays generated by the Teletext VDU are shown in Fig. 6. The top line demonstrates the use of colour. The default colour at the start of each line is white; to display the word CYAN in the colour cyan it is preceded by an "alpha cyan" code, and it is followed by an "alpha white" code to return to white characters.

The second line illustrates the use of a different background colour. The background colour can be set to the current colour with the "new background" code; since the default colour at the start of a line is white, a "new background" code at the start of a line will give a white background. It is followed by an "alpha blue" code to cause the subsequent characters to appear in blue, which is dark against the white background. The background is returned to black after the text with a "black background" code.

Fig. 6. Examples of the types of display possible with the teletext VDU

The double-height characters are obtained by putting the same characters on two successive lines, preceded in each case by "double height" codes. The VDU automatically displays the top halves of the letters on the first line and the lower halves on the second line.

The first graphics example shows two lines of contiguous graphics, preceded by "graphics white" and "graphics cyan" codes respectively. In the second graphics example the lines are the same, but are also preceded by "separated graphics" codes.

GRAPH PLOTTING

The following two programs illustrate how the Acorn Teletext VDU can be used for simple graph-plotting. The routines were devised

```
                       ;       PLOT POINT AT (XC,YC)
                       ;       ON TELETEXT VDU.
                       ;
                       XC     =$0020              X COORDINATE
                       YC     =$0021              Y COORDINATE
                       ADDS   =$0023              CELL ADDRESS
                       ;
0000                          *=$0200
0200  D8        PLOT   CLD
0201  E6 21            INC    YC                  CALCULATE WHICH
0203  A9 07            LDA    £$07                  LINE...
0205  85 24            STA    ADDS+1
0207  A9 C1            LDA    £$C1
0209  85 23            STA    ADDS                BOTTOM LEFT
020B  A4 21            LDY    YC
020D  A2 02     YCALC  LDX    £2                  DIVIDE BY 3
020F  86 21     LOOP   STX    YC
0211  88               DEY
0212  F0 10            BEQ    XCALC               DONE Y?
0214  CA               DEX
0215  10 F8            BPL    LOOP
0217  A5 23            LDA    ADDS                MOVE UP BY
0219  38               SEC                          ONE LINE.
021A  E9 28            SBC    £40                 CHARS/LINE
021C  85 23            STA    ADDS
021E  B0 ED            BCS    YCALC
0220  C6 24            DEC    ADDS+1              CARRY
0222  90 E9            BCC    YCALC               I.E. ALWAYS
0224  18        XCALC  CLC
0225  66 20            ROR    XC                  DIVIDE BY 2
0227  90 2F            BCC    EVEN
0229  A5 21            LDA    YC                  Y REMAINDER
022B  D0 04            BNE    NZERA
022D  A9 02            LDA    £$02                PIXEL MASK
022F  D0 0A            BNE    CONT                I.E. ALWAYS
0231  C9 01     NZERA  CMP    £$01
0233  D0 04            BNE    NONEA
0235  A9 08            LDA    £$08                PIXEL MASK
0237  D0 02            BNE    CONT                I.E. ALWAYS
0239  A9 40     NONEA  LDA    £$40                PIXEL MASK
023B  85 21     CONT   STA    YC                  PLOT POINT..
023D  A5 23            LDA    ADDS                GET ADDRESS
023F  18               CLC                          OF LINE.
0240  65 20            ADC    XC                  ADD COLUMN
0242  85 23            STA    ADDS                  NUMBER.
0244  90 02            BCC    DONE
0246  E6 24            INC    ADDS+1              CARRY
0248  A0 00     DONE   LDY    £0
024A  A5 21            LDA    YC                  GET MASK
024C  31 23            AND    (ADDS),Y
024E  D0 07            BNE    RETN
0250  B1 23            LDA    (ADDS),Y
0252  18               CLC
0253  65 21            ADC    YC                  ADD IN MASK
0255  91 23            STA    (ADDS),Y
0257  60        RETN   RTS                        RETURN.
0258  A5 21     EVEN   LDA    YC                  NO REMAINDER
025A  D0 04            BNE    NZERB
025C  A9 01            LDA    £$01                PIXEL MASK
025E  D0 DB            BNE    CONT                I.E. ALWAYS
0260  C9 01     NZERB  CMP    £$01
0262  D0 04            BNE    NONEB
0264  A9 04            LDA    £$04                PIXEL MASK
0266  D0 D3            BNE    CONT                I.E. ALWAYS
0268  A9 10     NONEB  LDA    £$10                PIXEL MASK
026A  D0 CF            BNE    CONT                I.E. ALWAYS
                       ;
                              .END
```

Fig. 7. Routine for the 6502 micro to plot a point at specified coordinates on the teletext VDU

by *Peter Mayne* of London, who uses the VDU with an Acorn System One microcomputer.

The PLOT routine, in Fig. 7, plots a point, or pixel, on the display at the coordinates specified in the locations XC and YC. The coordinates (0,0) correspond to the bottom left-hand corner of the display, and (77,74) to the top right. Note that XC and YC are modified by the PLOT routine.

The program works by finding, in ADDS, the address of the location that contains the required pixel, and determines a number to add to that location to set the required pixel. Since there are three pixels per cell in the Y direction, the routine must divide the value of YC by three to find which line contains the required location.

The GRAPH program, Fig. 8, demonstrates how the PLOT routine can be used to plot a graph of an equation. As it stands, the program plots $Y = \frac{1}{2}X + 16$ for values of X from 0 to 63. The program also draws axes, and finally labels the graph with the equation; see Fig. 9. A delay is included to slow down the plotting.

```
                    ;       PLOT A GRAPH
                    ;
                    XC      =$0020              X COORDINATE
                    YC      =$0021              Y COORDINATE
                    XVAL    =$0040
                    PLOT    =$0200              PLOT POINT
                    RESTRT  =$FF04              IN MONITOR
                    WAIT    =$FECD              DELAY
                    ;
0000                        .=$0300
0300  A2 00         GRAPH   LDX   £0            FOR EACH
0302  86 20         DRAW    STX   XC              VALUE OF X..
0304  A9 00                 LDA   £0
0306  85 21                 STA   YC
0308  86 40                 STX   XVAL
030A  20 00 02              JSR   PLOT          X AXIS
030D  A6 40                 LDX   XVAL
030F  86 21                 STX   YC
0311  A9 00                 LDA   £0
0313  85 20                 STA   XC
0315  86 40                 STX   XVAL
0317  20 00 02              JSR   PLOT          Y AXIS
031A  A6 40                 LDX   XVAL
031C  86 20                 STX   XC
031E  8A                    TXA                 GET X VALUE
031F  4A                    LSR   A             DIVIDE BY 2
0320  18                    CLC
0321  69 10                 ADC   £16           ADD 16
0323  85 21                 STA   YC            GIVES Y
0325  86 40                 STX   XVAL
0327  20 00 02              JSR   PLOT          PLOT POINT
032A  A6 40                 LDX   XVAL
032C  A0 20                 LDY   £$20          DELAY
032E  20 CD FE      SLOW    JSR   WAIT
0331  88                    DEY
0332  10 FA                 BPL   SLOW
0334  E8                    INX                 NEXT X..
0335  E0 40                 CPX   £$40          ALL DONE?
0337  D0 C9                 BNE   DRAW
0339  A2 58         AXES    LDX   £'X           LABEL AXES
033B  8E 01 04              STX   $401
033E  E8                    INX                 GET 'Y
033F  8E E3 07              STX   $7E3
0342  A2 07                 LDX   £7            PUT TITLE
0344  BD 50 03      TITLE   LDA   CHARS,X
0347  9D 21 06              STA   $621,X
034A  CA                    DEX
034B  10 F7                 BPL   TITLE
034D  4C 04 FF              JMP   RESTRT        STOP.
                    ;
0350  07            CHARS   .BYTE $7            ALPHA WHITE
0351  59 3D 5C              .BYTE 'Y=½'
0354  58 2B 31              .BYTE 'X+1'
0357  36                    .BYTE '6'
                            .END
```

Fig. 8. Program for the 6502 micro to plot a graph on the teletext VDU

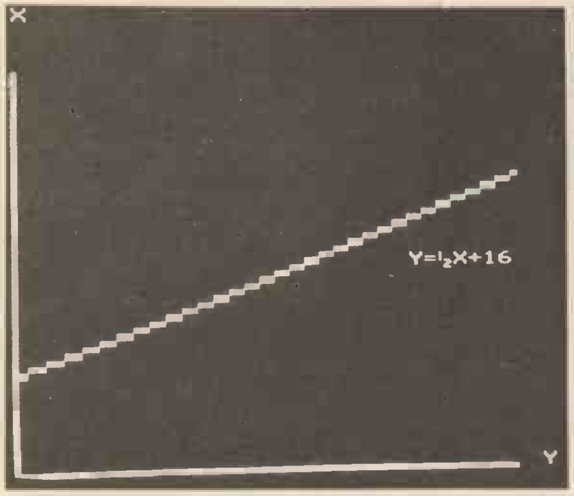

Fig. 9. Graph produced by the program of Fig. 8

Before running the program, the routines of Fig. 3 and Fig. 5 should be loaded and executed at #0980 and #0E80 respectively to initialise the CRTC and clear the screen for graphics.

NINE PROBLEMS REVISITED

One of the problems posed in the April Micro-Bus asked for a way to reverse the bits in a byte, on the 6800 micro, in under 10 cycles. A solution in hardware was proposed, but *John Diamond* of Coventry has solved the problem using only software by providing a look-up table in which each byte gives the reverse of that byte's position in the table. The six-byte routine to reverse a byte, shown in Fig. 10, then takes only 9 cycles. It uses self-modifying code to avoid having to use the index register, thus saving several cycles. A further cycle can be saved by using zero-page memory.

The listing of Fig. 10 also includes an initialisation routine to generate the 256-byte look-up table. Other functions could be implemented simply by providing a different table.

Another of the problems was to write a programme to find the highest prime factor of a number using a rudimentary machine-code called MINIL. The solution was given without explanation, and readers were asked to provide one. *J. Rennie* of Somerset wrote:

"Your challenge to provide an explanation of the MINIL program . . . proved to be quite irresistable, and I found the task most interesting. The program is based on a fairly simple algorithm (see flowchart of Fig. 11). Let N denote the number whose highest prime factor is to be found. Thus $N = (P_0 \times P_1 \times \ldots \times P_n)$, where P_0 to P_n are the n prime factors of N. The algorithm finds the highest factor of N, working down from N – 1, which is $(P_0 \times P_1 \times \ldots \times P_{n-1})$. This new number is then denoted N, and the process is repeated to give the new factor $(P_0 \times P_1 \times \ldots \times P_{n-2})$. This is repeated until only P_0 is left. No more factors can be found and P_0, the highest prime factor of the original number, can be output.

"In the original MINIL program registers D and A hold the current values of N and X respectively, while steps 4–10 find the factors of N. The two loops NOT and NEW are identical to loops 1 and 2 of the flowchart."

A similar explanation of the program was received from *Doug Letts* of London. Readers interested in the MINIL language may like to try writing programs which find the greatest common divisor of two numbers, the integer part of a number's square root, and the factorial of a number. But be warned: one of these problems is impossible, and the other two are not simple!

```
                        * REVERSE ACC. A INTO ACC. B
                        *
E0E3                    CONTRL   EQU      £E0E3
0200                    TABLE    EQU      £0200
                        * MAIN PROGRAM
0100                             ORG      £0100
0100  B7 01 05          START    STA  A   START+5  5  CYCLES
0103  F6 02 00                   LDA  B   TABLE    4  CYCLES
                        * END OF REVERSING ROUTINE
                        *
                        * INITIALISATION ROUTINE
                        *
0180                             ORG      £0180
0180  CE 02 00                   LDX      £TABLE
0183  4F                         CLR  A
0184  36                LOOP     PSH  A
0185  C6 80                      LDA  B   ££80         THESE SIX BYTES
0187  48                REVRSE   ASL  A                REVERSE A INTO B
0188  56                         ROR  B                IN 66 CYCLES
0189  24 FC                      BCC      REVRSE
018B  E7 00                      STA  B   0,X
018D  32                         PUL  A
018E  08                         INX
018F  4C                         INC  A
0190  26 F2                      BNE      LOOP
0192  7E E0 E3                   JMP      CONTRL
                                 END
```

Fig. 10. Routine to reverse the bits in a byte on the 6800 micro, together with a program to generate the table used by the routine

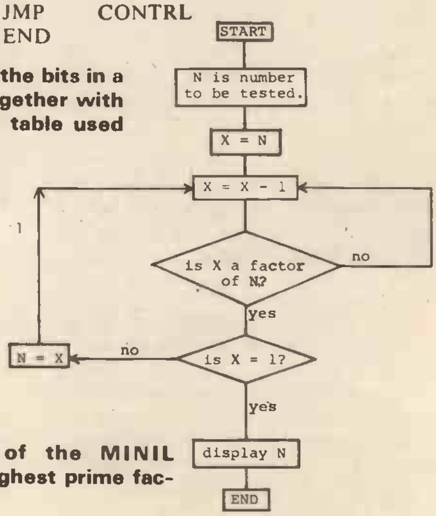

Fig. 11. Flowchart of the MINIL program to find the highest prime factor of a number

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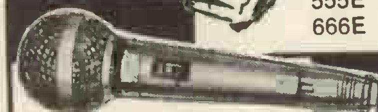

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Semiconductor UPDATE...

FEATURING LM1871 LM1872 HM6564 TO237 TDA1085A R. W. Coles

CONTROL PAIR

We can expect to see large numbers of cheap and capable radio control systems on the market in the near future, thanks to National Semiconductor. I suspect that many of these cheaper systems will fall into the category of "toys", even though these "toys" will be endowed with a digital proportional multi-channel control system which might have cost hundreds of pounds a few years ago!

At the heart of the new systems will be a pair of integrated circuits which between them comprise over 90% of the components required to build a complete 27MHz remote control transmitter and receiver system with two proportional channels and two on-off channels. The transmitter device is the LM1871, and with the addition of a few passive components an aerial, and a battery of between 5 and 16 volts, this diminutive 18 pin device can deliver a radiated signal sufficient to provide a reliable link to the receiver at ranges of at least 100 metres. The transmit frequency would normally be crystal controlled, and the operator controls can be provided by a couple of 500k pots (for the proportional channels) and a couple of toggle or push-button switches (for the on-off channels). The two pots can of course be linked to a joystick mechanism for the control of model aircraft or similar vehicles.

At the receive end another 18 pin device, the LM1872, is used to implement a sensitive and selective single conversion superhet with digital detection and decoding circuits and a powerful a.g.c. system. The LM1872 runs from a 6 volt battery supply and uses a crystal controlled local oscillator and a 455kHz i.f. frequency to obtain a sensitivity of better than 15 microvolts. After decoding, the two proportional channel outputs provide variable width pulse streams for direct input to most control servos. The two on-off channels are latched and their outputs can source or sink up to 200 mA, sufficient to operate motor control relays or other actuating circuits directly.

The basic package offered by the chip set from National is undoubtedly aimed at the high volume market where costs need to be held to just a few pounds per system, but by suitable alterations and additions to the basic circuit it is possible to produce a system with additional proportional channels and with increased transmitter power for greater range. In short these devices should prove of great interest to serious radio control enthusiasts as well as to those of us looking forward to more fun on Christmas Day!

MOTHER CHIP

There is a lot of talk about 64K RAM chips at the moment, and many large advertisements in the professional journals proclaiming the imminent arrival of these devices from Texas, Motorola, and others. These new devices will all be NMOS dynamic parts, as this technology is always in the lead as far as capacity and cost per bit are concerned. Other technologies such as NMOS-static and CMOS-static are always one and two generations behind respectively, as evidenced by the current NMOS-static state of the art, a 16K device organised as 2K x 8 and the equivalent in CMOS-static, a 4K device organised 4K x 1 or 1K x 4.

These lower capacities are related directly to the physical size of the basic storage devices on the chips concerned. Dynamic storage cells are very small and simple, the other technologies use bigger and more complex cells and so we have to make do with fewer of them for the same price.

In an attempt to short circuit the CMOS size disadvantage, Harris have come up with a new and quite unique device coded the HM6564. This new offering to those who need both large memory capacity *and* the well known advantages of CMOS low power technology, effectively leap-frogs two generations by being a 64K CMOS-static device, no less, and released at the same time or even *before* the 64K NMOS dynamics. An amazing breakthrough in CMOS memory technology? Not really. The HM6564 uses a single ceramic dual in line package with 40 pins, but mounted on the package are no less than 16 separate 4K x 1 chips which in themselves are standard devices usually packaged separately.

To the user, the HM6564 appears as two 8K x 4 arrays each with independent chip enables and write enables. A likely connection configuration would be to link the two blocks to form an 8K x 8 array of static RAM memory with a standby power consumption of only 5mW.

Because of the labour intensive nature of this type of packaging these devices will never be cost competitive with the NMOS dynamics, but for some applications where the small size of such a large parcel of memory can be put to good use, they will undoubtedly fill a real need.

COOL CUSTOMER

National have a new package to compete with TO5s where the older devices are used close to their maximum power dissipation, as they may be in stereo power amplifiers for example. The new package, coded TO237 is about the same size as any other plastic transistor package except that it sports a heat radiator tab on the top and has its leads preformed to fit the TO5 pin circle. The package uses a new patented epoxy plastic and National claim that devices using it can last up to eight times longer than equivalent devices packaged in metal cans, because the transistor chip is kept so much cooler for a given dissipation.

There are already 65 standard transistor types available in the TO237 package, including *pnp* and *npn* types and some direct replacements for standard TO5 devices. Prices are about 40% of the equivalent metal can price.

MOTOR CONTROLLER

The speed control of series wound a.c. motors is an ideal case for the use of phase-angle control via a triac power switch. Such motors are to be found in power tools, washing machines and fans, and the simplicity of triac speed control has made the technique popular even for low cost appliances.

Speed control can be achieved either open-loop, where no account is taken of load fluctuations, or closed loop where the motor back-EMF is used as feedback to stabilise motor speed even in the face of load changes.

A new circuit from Motorola, the TDA 1085A, is a complete motor control subsystem in a 16 pin package. Able to be used in both open and closed loop controller schemes, the new device needs only a few passive components and a triac to turn it into a cheap and capable speed controller. For applications requiring only a "slow" "medium" and "fast" speed selection there are programming package pins available to minimise external circuitry. Fully variable speed control is possible by means of an external 100k pot. To overcome surge currents due to stalled or stopped motors, the TDA 1085A, features a "soft start" circuit and current limiting.

This could be the answer for that drill speed controller you have always promised yourself!

CINE FRAME COUNTER

STEPHEN IBBS

WHEN MAKING cine films it is often necessary, e.g. for fades, single-frame sequences etc., to be able to count accurately how many frames have been exposed. Most cine cameras nowadays have a set of flash contacts that close once per frame. The project described here uses this fact to produce a three digit frame counter capable of counting from single frame to full speed. The display can be blanked to save battery power but still retaining the count facilities, or can be set to zero by merely turning the power off briefly. The unit is connected to the cine camera by a flash lead and has proved itself to be of immense value.

HOW IT WORKS

IC1a and b are connected as a monostable multivibrator, (See Fig. 1) the purpose of which is to 'debounce' the flash contact switch S2 inside the cine camera. This is necessary otherwise spurious figures would result. The clock pulses are fed into IC2 which is quite a recently developed i.c. This is the 4553, a 3 digit BCD counter/driver. This chip produces a BCD output, which is fed into IC3, a BCD decoder and 7 segment display driver. The output is fed to all three displays at once, but only one is switched on at any one time because the cathodes are connected back to pins 2, 1, and 15 of IC2. The capacitor between pins 3 and 4 of IC2 control how fast the switching takes place between the digits, and the value of 1n makes the switching so fast that it looks like a continuous display. This technique is called multiplexing and is an ingenious way of saving on interconnecting wires and battery drain.

Normally pin 4 of IC3 is held high by R8, but if S3 is closed, pin 4 is brought low, and this blanks the display, but does *not* affect the counting process. This is a useful way of saving battery power during long count periods.

Pin 13 of IC2 is a reset pin which makes the display read 000 when it is high. To make sure that the display reads this at switch-on, a brief reset pulse is fed to this pin via C3. Pin 13 is then brought low by R4, and counting can start. This takes but a fraction of a second.

CONSTRUCTION

Readers are advised to use a p.c.b., and a recommended design is given in Fig. 2. Check that the i.c.s are mounted the right way round. The awkward part about construction is the mounting and wiring of the 3 digits. The author mounted them in 0·1in. stripboard, breaking tracks where necessary.

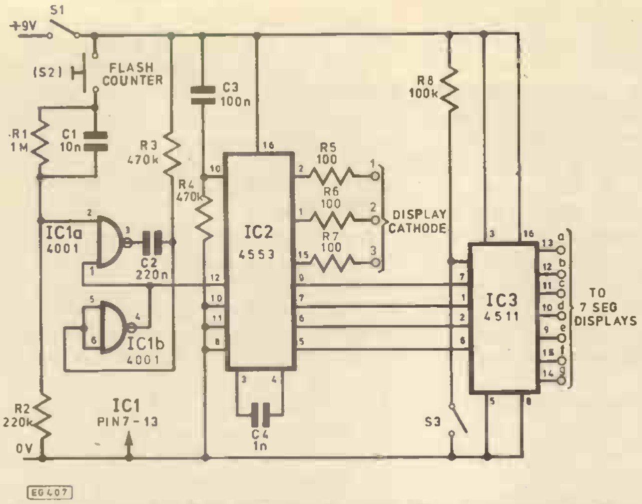
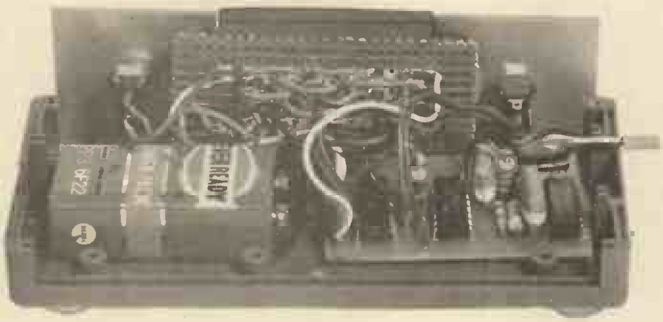


Fig. 1. Circuit diagram. S2 is the flash contact switch inside the cine camera.

The appropriate pins were then wired together with short lengths of insulated wire. A section of the front panel of the Verobox (aluminium) was cut away, and the display mounted using spacers and epoxy resin. The mounting pillars were removed with a hot wire, and the p.c.b. stuck down with double sided sticky pads. The two switches were mounted either side of the display, and a piece of red perspex placed in front of the display to improve the contrast. Constructors may like to add a push-to-make switch, in parallel with C3, to enable the display to be set to zero without switching the power off. Leads were then run from IC3 to the various digit segments, and the three cathodes, which are not wired together(!) are joined to the appropriate pins 2, 1, 15 of IC2.

A small hole was drilled in the back panel, and a long flash lead was purchased, one end cut off and soldered to the p.c.b. in the S2 position, and the other end is then connected to the cine camera.

If constructors find that they are still getting spurious counts (more than they have shot), it means that they have a "noisy" switch, and C2 needs to be increased slightly, to lengthen the monostable pulse.



COMPONENTS . . .

Resistors

R1	1M
R2	220k
R3,R4	470k (2 off)
R5-R7	100 (3 off)
R8	100k

Capacitors

C1	10n
C2	220n
C3	100n
C4	1n

Integrated Circuits

IC1	4001
IC2	4553
IC3	4511

Miscellaneous

S1	SPST min. toggle
S3	SPST min. toggle

Verobox
3 off l.e.d. 7 segment CC displays
P.c.b. or stripboard
Red perspex
Battery clip

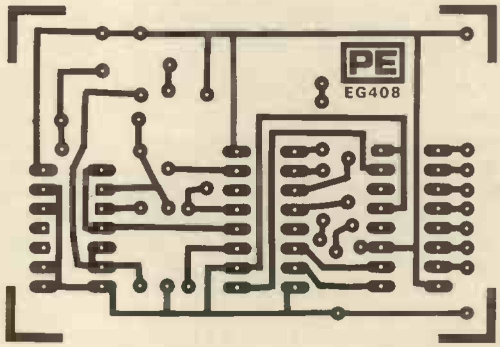


Fig. 2. Printed circuit layout (actual size)

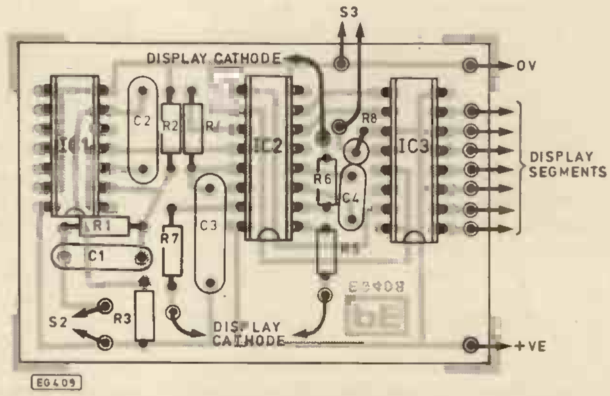


Fig. 3. Component layout. In the prototype, a piece of stripboard was used to mount the displays behind the front panel window.

FRANK W. HYDE

THE LEASAT COMMUNICATIONS SATELLITES

The Leasat Communications Satellites are a new generation tailored to the Shuttle era. They will be part of a new network. The network was primarily aimed at ships and submarines and a major part of the leasing will be taken up by the Defence Department of the United States. This means that it will constitute a part of the defence communications of the Navy, Army and Air force.

Production work is already under way at Hughes Aircraft and the operation of the four control stations together with the control centre will be carried out by Hughes Communications Service. The control centre will be at Los Angeles and the four control stations will be Guam, California, Virginia and Hawaii. The service will be leased for 67 million dollars per annum. Initial launch data provides for the first satellite to be put into orbit in January 1984.

The Leasat design is based on the previous successful vehicles Syncom 4. Hughes were responsible for the cost effective spin-stabilised satellite concept. The design is directed at shuttle launching and this has made it possible to do a number of useful modifications to the shape of the satellite and also make savings of space. The satellite will be increased in diameter to 14 feet. The space on board the shuttle available for the satellite is 15 feet. The net result is that the satellite can be expanded in diameter and shortened in length thereby saving launch costs. At the moment it means that the launch date is dependent on shuttle progress so that already some delays have put the date back to 1984. However the avoidance of the cost of the expendable launch vehicles has enabled the satellite itself to be modified. Major testing has already begun on the ejection system, aerial interference tests and the firing of the satellites propulsion stages. The satellite weighs about 15,000lbs.

The advantage of the new design is that more space is available in the satellite and the propulsion system can be mounted internally. The launch system is called the Frisbee technique because the satellite is thrown clear of the shuttle with the spin motor set for a 2rpm rate. It is released by a spring catch giving a velocity of 1·5 feet/second. The satellite is easily clear of the shuttle and then the spin is increased to 30 rpm. The perigee kick motor is fired at 45 minutes after release. The motor kick lasts one minute. The satellite is then injected into the geosychronous orbit and the twin apogee liquid fuel thrusters are fired to circularise the orbit. Meanwhile the apogee motor case is jettisoned.

Once the orbit is attained the folded aerials will be deployed. These consist of two helical arrays, one for transmission and one for reception. They have an allocated frequency in the UHF band. There are also aerials for the SHF band. Station keeping will be carried out using a monopropellant system of hydrazine by stategically placed thrusters also built by Hughes.

LANDSAT 2

Landsat 2 which was retired from service at the beginning of the year has been restored to operational status. Engineers decided that it was the flywheel lubrication that was at fault. After several unsuccessful attempts to reactivate the three axis system the matter was left for several months. However during a communication exercise the flywheel responded, with the possibility of normal operation. By this time though the gas for attitude control had become depleted.

Research had been carried out with a view to using magnetic torque to keep the satellite operational. This has been a successful ploy. the satellite has three magnetic coils, one on each axis. By energising the coils at preselected points in orbit, the accumulated momentum which causes the flywheel to saturate, can be dissipated without the use of the gas.

Landsat 2 is now providing better imaging than before. There is still a problem because the four recorders are out of action. Communication therefore has to be direct to the ground.

COMET CHASER GIOTTO

The European Space Agency Science Programme Committee made the final decision to go it alone with a mission to intercept Halley's Comet. The point of interception will be just after perihelion, the point when it is nearest to the Sun, when for four hours the spacecraft will collect data. The flyby will take place in 1986 and it is hoped that much more will be known of the nature and composition of cometary bodies.

The Ariane will be used as the launcher and the tracking will be carried out by using the Parkes Radio Telescope in Australia and the Weilheim facility in Germany.

It is of the utmost importance to science that this encounter with Halley's Comet should take place not only because this opportunity will not come again for 75 years or so but also because science needs to know as much as possible about the cometary bodies; What is their make up? and how do they fit into the scheme of the Solar System the Galaxy and the Universe? During that period of 75 years there will be such tremendous strides in space techniques it is important, as soon as possible to have confirmation or perhaps modification of the present cosmological theories.

SMM, THE SOLAR MAXIMUM MISSION

In February this year the special spacecraft SMM was launched upon a mission to study a star. That star is the nearest one to the Earth. It is the Sun, pouring down upon the surface of the Earth radiation over the full extent of the electromagnetic spectrum, giving life and destroying life for this is raw nature. Like so many items of study by scientists the more that is discovered the more there remains to be studied and understood. It provides the means for communications and is also the cause of preventing those very communications. It causes the atmosphere to become a destroyer while providing the means of subsistence for the flora and fauna of the Earth.

The spacecraft SMM will endeavour by its programmed activities to examine the radiations, the flares, the second to second changes on the surface and from this, the observers will try to make sense from the data. The Sun is in the act of destroying even itself by flinging vast amounts of its substance away every second. What appeared to the naked eye a signpost of stability is now known to be unstable, varying in size, with a temperature in its interior beyond anything that could be developed by man. Mankind by gradually sifting data and learning how to tame this controller of destiny is able in some measure to turn the situation to advantage. Part of this story is the proposal to collect the energy, beam it down to Earth and light up and warm towns and cities.

On board SMM there are seven instrument packages each with its own mission task. They are the gamma-ray spectrometer, the hard X-ray imaging spectrometer is an extremely sensitive instrument that can resolve down to 8 minutes of arc and detect X-rays with energies of the order of 3·5 to 30keV. There is also a hard X-ray burst spectrometer to deal with some of the puzzles of the X-ray burst stars. This instrument has a caesium iodide detector which can operate up to 300keV with a duration as short as 10ms.

An X-ray Polychromator which can provide spectra of emission lines at wavelengths between 0·14 and 2·24 nanometres.

An active cavity radiometer with three pyroheliometers will measure the emission of the solar radiation from far infrared to ultraviolet at about 0·1 percent accuracy.

An ultraviolet spectrometer and polarimeter which has a reflecting telescope with a field of view of 4 arc seconds square. The resolution of this instrument is 3 arc seconds. The main purpose of the instrument is to scan the chromosphere and the corona. This is a new instrument not used before.

Finally there is the Coronagraph—polarimeter. It will be possible to take pictures of the corona with a vidicon camera with about 900 by 900 picture elements. This system will work in the wavelength region of 400 to 700 nanometres.

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LEAD TESTER

I.C. LARE B.Sc. M.Sc.

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MANY of the problems which occur in PA systems, be they for group or disco use, are the direct result of lead failure. It is worth remembering that a typical small group rig will need upwards of 40 signal leads and the probability of failure of at least one is fairly high. This is not surprising when it is considered that these leads suffer from repeated coiling, stretching, bending and beer. A faulty lead somewhere in the system can be very hard to find, particularly in the semi-darkness with time running out and so a lead tester must be considered as part of any PA setup. Regrettably, many lead testers available fail to check the lead properly, or do not stand up to life on the road, breaking down at the most vital moment.

The design presented here is for a tester that is easy to use, robust, and performs a rigorous test of the lead.

DESIGN PHILOSOPHY

In formulating a successful design the following conditions were drawn up.

a) Nearly all stage leads are either mono jack or balanced line with Cannon connectors. Other leads are sometimes used, but these tend to be rather diverse, and it is not possible to design an absolute tester for every combination. Accordingly, the tester was designed for jack and Cannon only.

b) The tester must be simple to operate. Once the lead is plugged in pressing a single button must initiate a complete test sequence.

c) Many testers check each core of the lead for open circuit, and then for shorts between signal cores and earth. This is acceptable for mono jack leads but fails when Cannon leads are tested. In such a lead a short between earth and a signal core will cause increased hum and some loss of signal, since the lead is then unbalanced—Fig 1. This will be found by a standard tester, but it will not find a short between the two signal cores which gives rise to total lead failure. The tester must therefore check each core, including the earth for open circuits, and also check for a short between any combination of cores.

d) The lead status should be clearly displayed, and the type of failure indicated. The display must be readable in poor light.

e) The tester must be self contained, robust and reliable.

THE CIRCUIT

The lead status is displayed on seven l.e.d.s, one green indicating that the lead has passed, the other six red ones corresponding to the possible failure modes. The circuit is designed around CMOS logic; this being compact and not requiring much supply current. It does however have one disadvantage since drive transistors are required for the l.e.d.s. TTL logic, although not requiring the transistors would present an unreasonable load on the battery.

The circuit is shown in Fig. 2. It consists of four D-type flip flops through which a '1' is clocked and used to check each

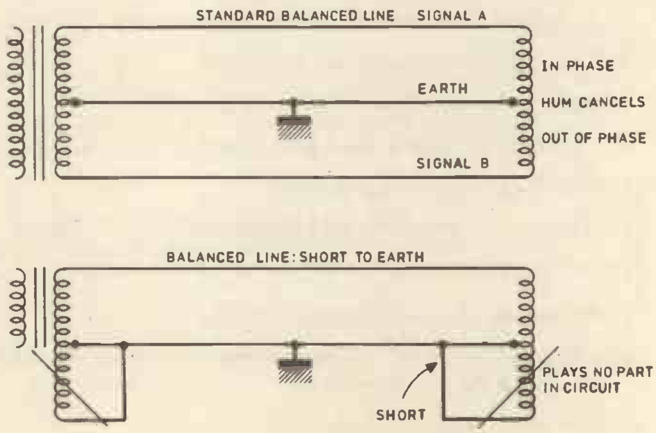


Fig. 1. Non-fatal short on line

lead core in turn. The three core test circuits are identical. If the core is intact both inputs to the Exclusive—OR remain the same and no output is generated. An open circuit will cause the EX-OR output to go high, lighting the relevent l.e.d. The diode across the EX-OR only enables the transistor drive when the associated flip flop is high to prevent spurious open circuit indications if a short circuit is present. Diodes D2–4 prevent a level clash if a short exists. The cores are pulled down by the 100k resistors. This value is high enough to allow faults involving the semi-conducting layer found in microphone cable to be detected.

Any short circuits will be detected by the AND gate connected to each pair of cores. Again, the relevent l.e.d. will light up in the event of a failure. If no failures are detected the fourth flip flop will be clocked lighting the 'O.K.' l.e.d.

When an l.e.d. lights the base of TR8 is pulled down, and the inhibit line goes high, stopping the clock. This means that the status of the lead is displayed until the test button is released. The clock is inverted to ensure that the inhibit will only generate a high to low transition, thus not affecting the flip flop states.

The flip flops are initially set and reset by IC1d which holds the relevant inputs high for a brief period after test is pressed. Diode D1 allows the capacitor to discharge quickly after test is released.

If a mono jack plug is to be tested switch S1 bypasses IC3a so that core B is not tested.

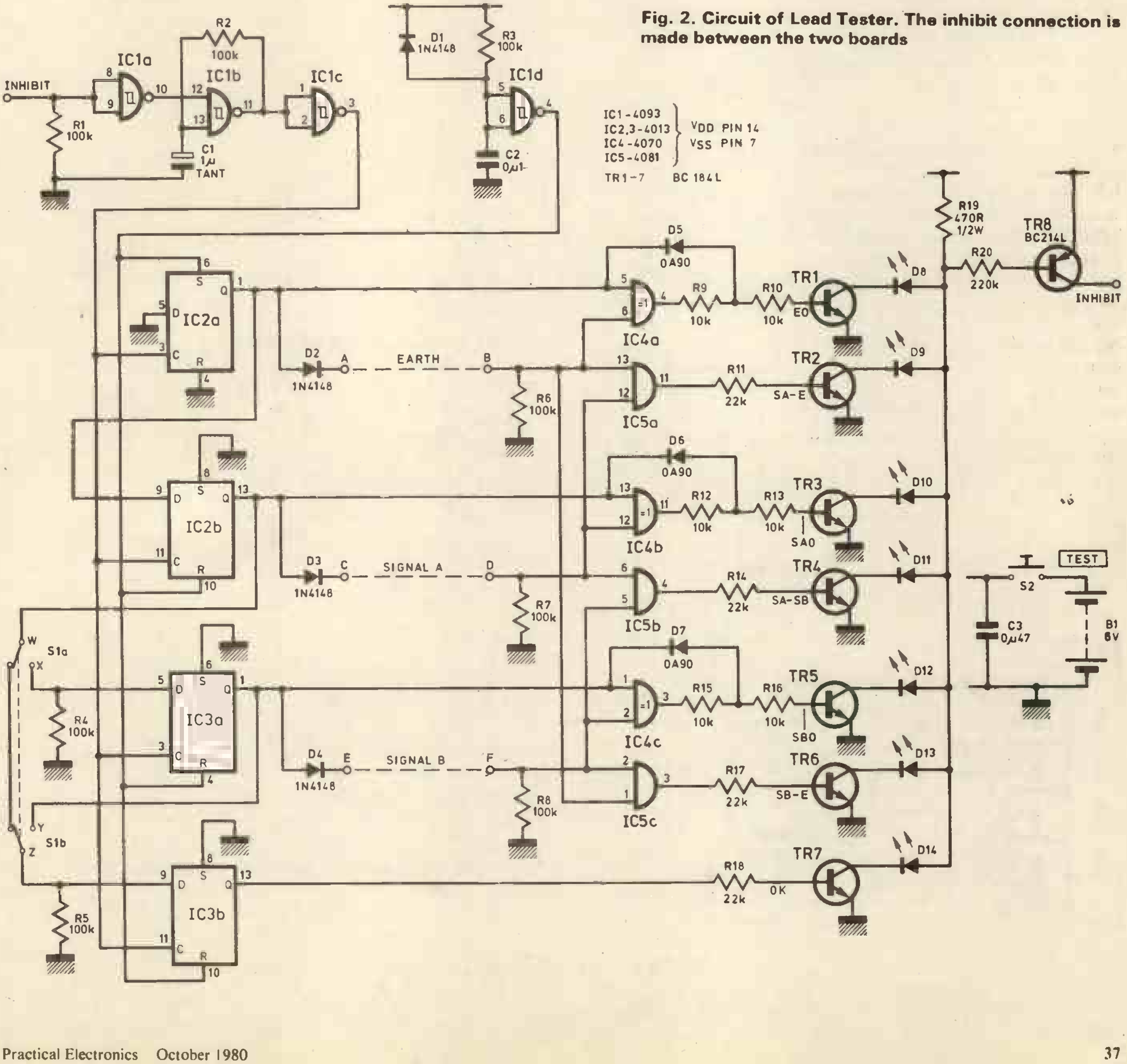
CONSTRUCTION

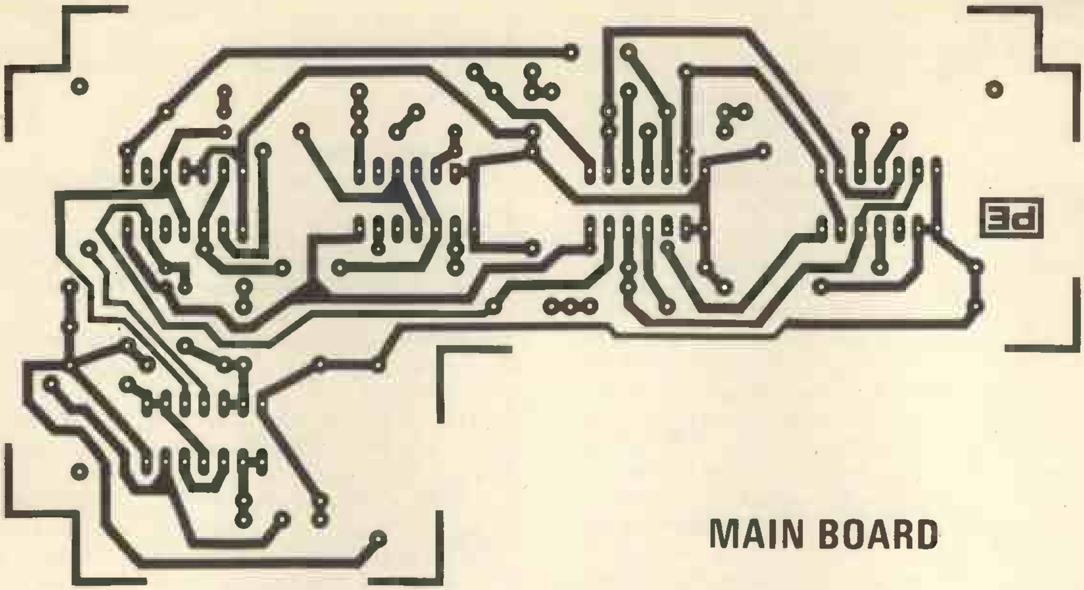
The tester was built into a die-cast aluminium box, measuring approximately 150 x 80 x 50mm. The parts are fairly tightly packed, and it suggested that care is taken if a different box is used. Two printed circuit boards were used, the main one holding all the i.c.s and associated components, the other the display l.e.d.s and driver transistors. The details of the p.c.b.s are shown together. It is not possible to use sockets for the i.c.s because of the greater depth of the board.

The main board is fixed into the bottom of the box with three 6 BA bolts, a nut serving to separate the board from the base of the box. The battery pack fits in the missing section of the p.c.b. and was held in place with a single angle bracket.

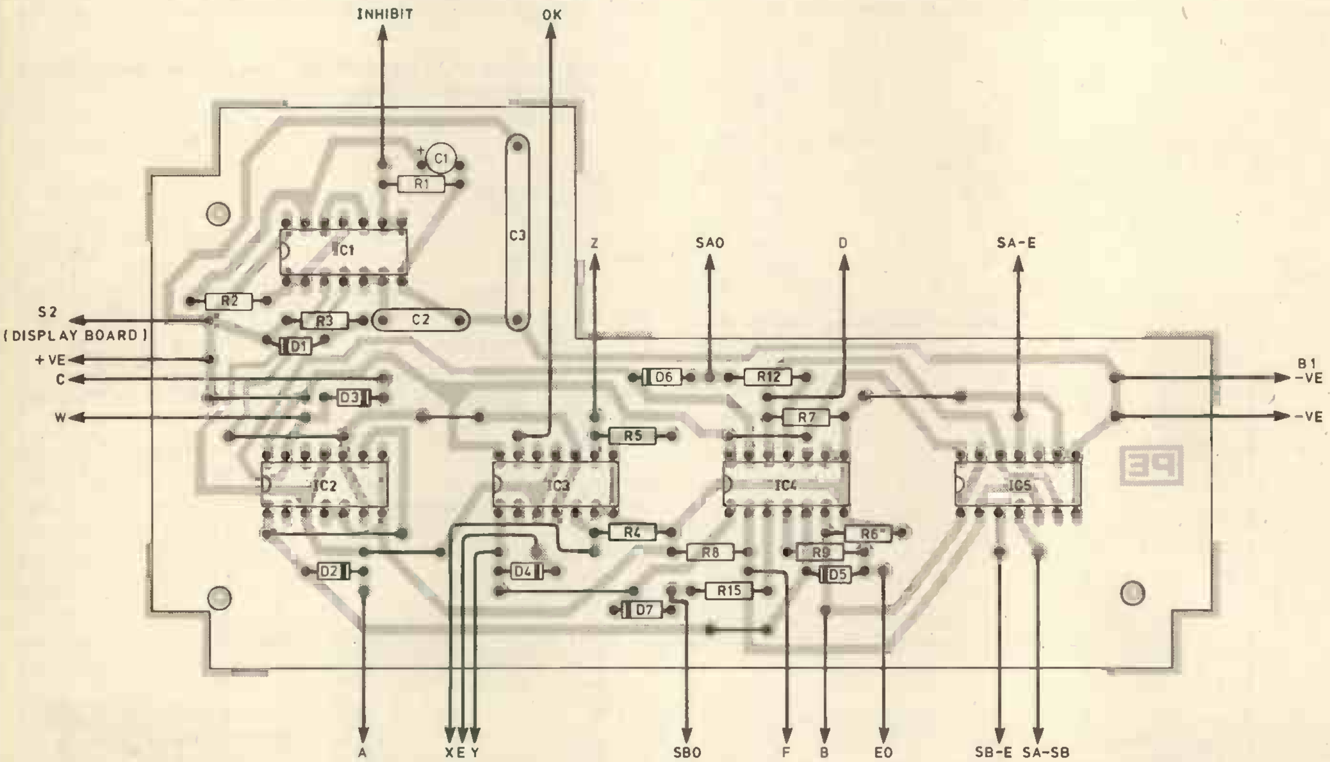
The l.e.d. display is arranged as a circle with the three cores drawn as spokes. An l.e.d. is placed on the circle between the spokes and on each intersection to correspond to

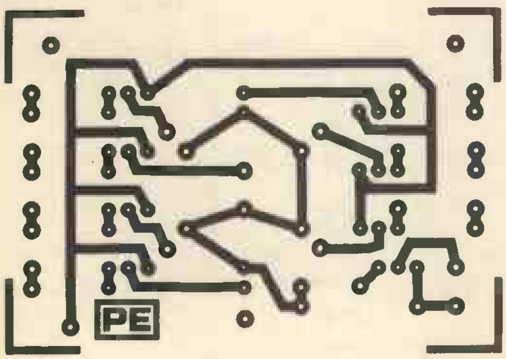
Fig. 2. Circuit of Lead Tester. The inhibit connection is made between the two boards

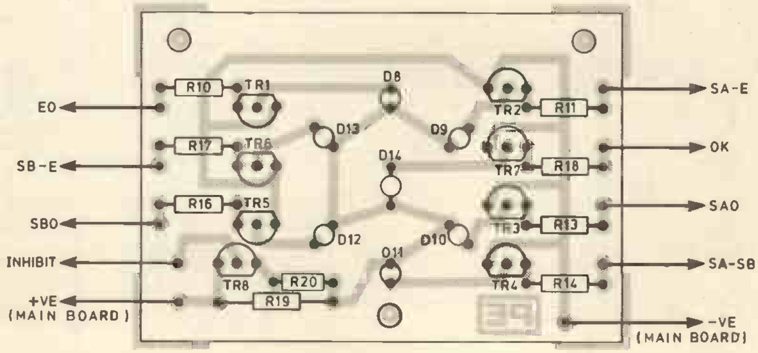




MAIN BOARD







DISPLAY BOARD

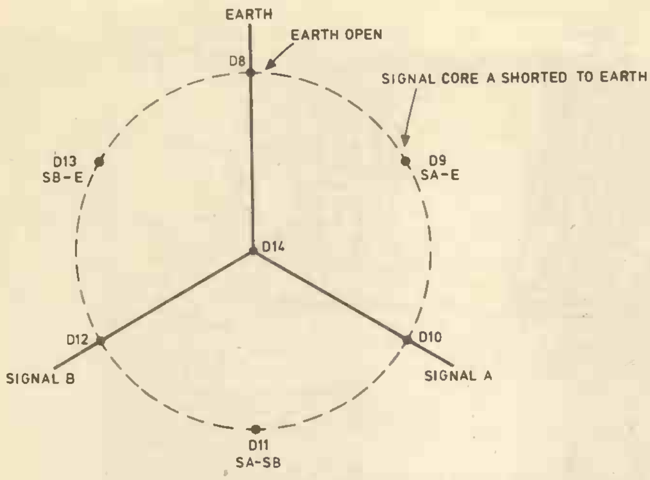


Fig. 3. Physical layout of l.e.d.s. The six on the circumference are red and the centre one green. The circle diameter should be 1in

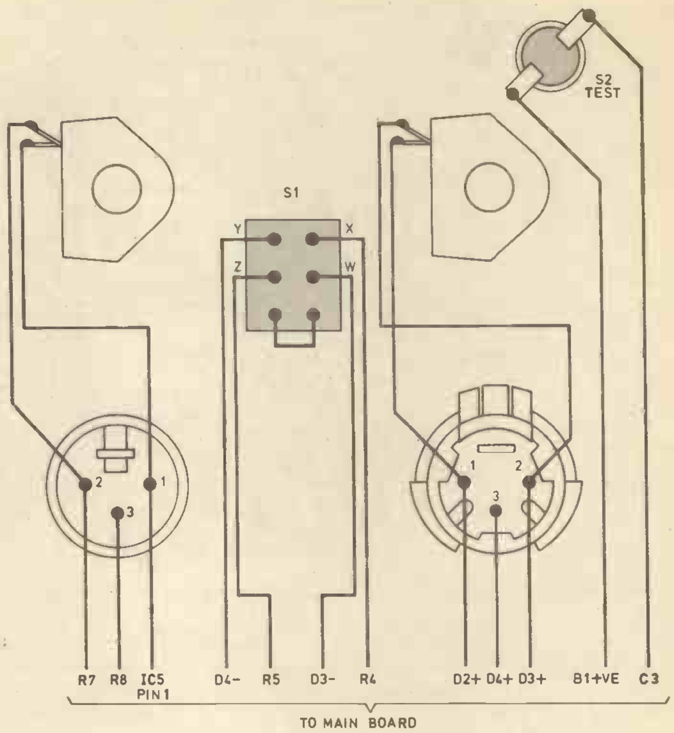


Fig. 4. Wiring from front panel components to main board

COMPONENTS

Resistors

R1–8	100k
R11, 14, 17, 18	22k
R9, 10, 12, 13, 15, 16	10k
R19	470R $\frac{1}{2}$ watt
R20	220k

All $\frac{1}{4}$ watt carbon unless indicated

Capacitors

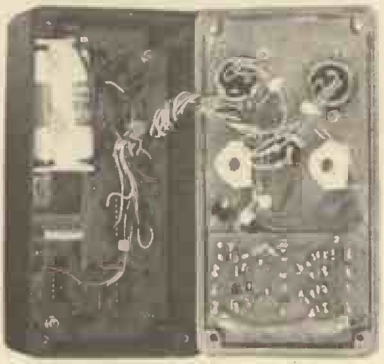
C1	1µF tant
C2	0·1µF polyester C280
C3	0·47µF polyester C280

Semiconductors

D1–4	1N4148
D5–7	OA90 or OA91
D8–13	Red 2·9mm
D14	Green 2·9mm
TR1–7	BC184L
TR8	BC214L
IC1	4093
IC2, 3	4013
IC4	4070
IC5	4081

MISCELLANEOUS

Die cast box, approx 150 x 80 x 50mm. Battery holder for four HP7 in cube layout. Battery clip. Miniature double pole double throw switch. Miniature push button. Jack sockets. Male cannon chassis plug. Female cannon chassis socket. P.c.b. pins. 6 BA pillars, 0·375in and 6 BA nuts and bolts.



Interior layout showing how main and display boards are mounted

short and open circuits. (Fig. 3). The green 'O.K.' l.e.d. is placed at the centre of the circle. The best way to drill the holes for these is to mark the centre position of the circle with a centre punch, and use a pair of compasses to draw a 1in circle. The top and bottom positions can then be punched in, and the remaining positions found by using the compasses as dividers. A 7/64in drill is exactly right for the 2·9mm l.e.d.s used.

The display p.c.b. is mounted on the top plate with three 6 BA pillars. These are fixed to the top panel with countersunk screws, the holes being filled and smoothed before spray painting the panel. White Letraset is used to complete the panel. The 'Test' button is placed for a right handed user, so the tester can be held in the left hand, and the thumb used to press the button.

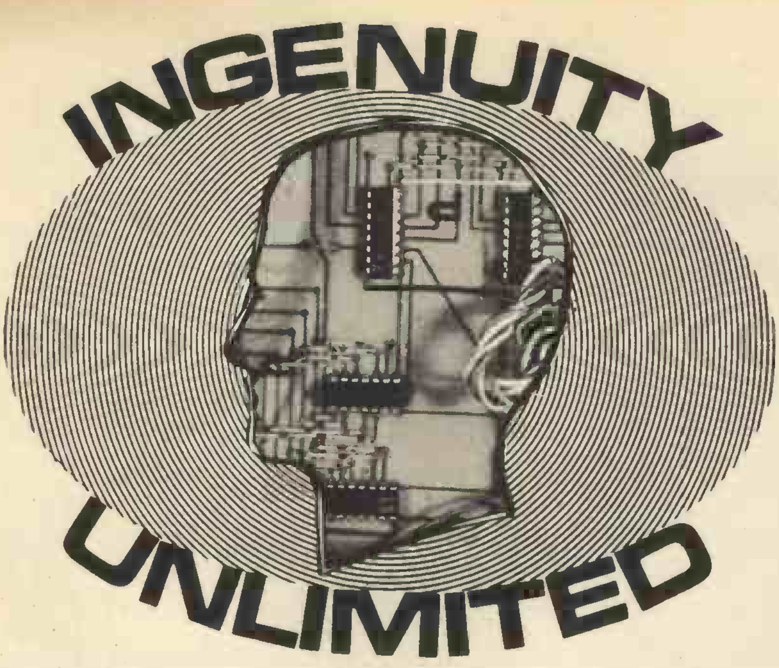
The 'Earth' test is connected to the body of the jack socket and pin 1 of the Cannons. Signal A is connected to the jack tip and pin 2, whereas the signal B is only connected to pin 3. It does not matter which Cannon is connected to which end of the test circuit.

TESTING

Testing of the unit should present no problems. If any are encountered it is useful to slow the clock down by adding a 47µ capacitor across C1. Removing the inhibit line should light all the open circuit l.e.d.s in turn followed by the 'O.K.' l.e.d. A set of crocodile clip leads is convenient for checking that each combination generates the correct fail condition.

USING THE TESTER

The tester is simple to use and the fascia legending is self-explanatory. No battery check is provided as such, simply pressing 'Test' with no lead connected lights the 'Earth' open l.e.d. providing such a check. Note that a lead that fails might give an 'O.K.' reading after it has been moved about. This is because a fault clearing will allow the test to continue. This is quite deliberate and useful for suspected intermittent leads. ★

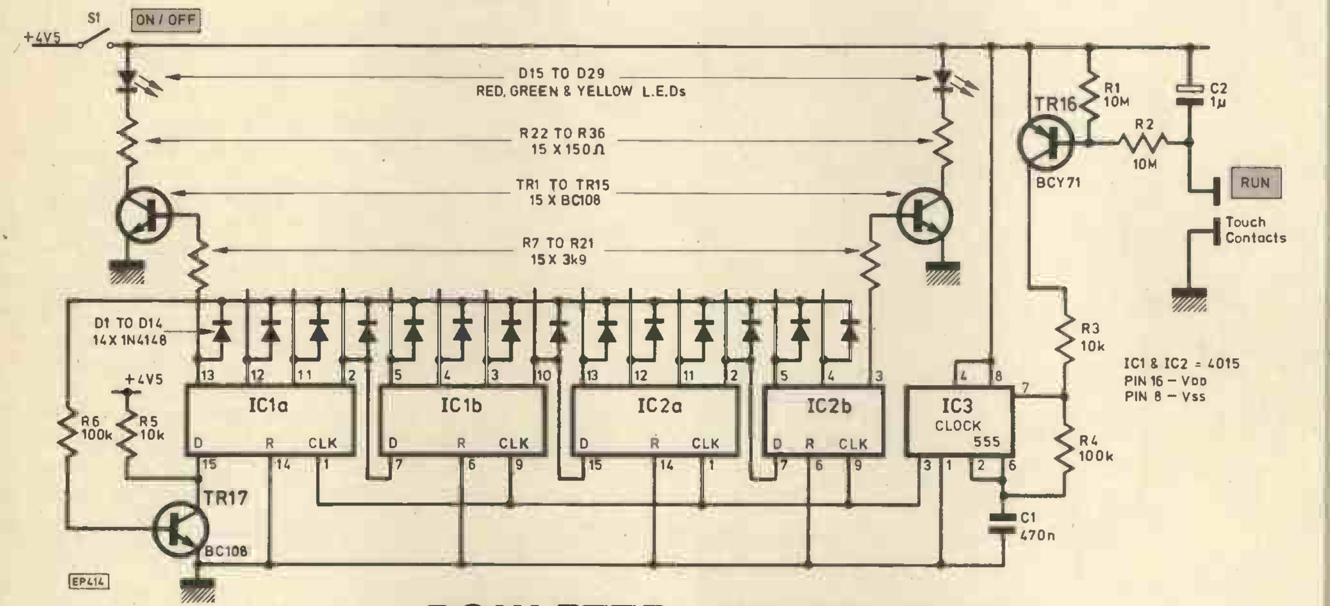


A selection of readers' original circuit ideas. It should be emphasised that these designs have not been proven by us. They will at any rate stimulate further thought.

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 that it has not been accepted for publication elsewhere.



ROULETTE WHEEL

THIS circuit was designed for the entertainment of my baby daughter, and is in the form of a row of multi-coloured l.e.d.s lighting in sequence.

However, I discovered by converting the clock circuit into one of a decaying frequency, and by arranging the l.e.d.s in a circle, it could also be used as a roulette wheel by the older members of the family.

It is based on two 4015 shift registers which were chosen for their low power consumption (it draws 30mA when running but with an increase of 50 ohms or so in the collector resistors it drops to 20mA).

Bridging the touch plates applies a negative voltage to the base of TR16 via R2, causing it to turn hard on, thus supplying the potential IC3 requires, enabling it to clock the shift register at a frequency set by R3, R4, C1.

The clock will continue to pulse when the finger is removed for a time period set C2, R1, R2 and TR16. C2 slowly drains through R2 + R1 as well as the transistor base, the slow turning off process of TR16 results in an equally slow drop in the voltage available to the clock circuit, resulting in the clock frequency gradually slowing to a halt.

The shift register circuitry is straightforward and the data input is controlled with the minimum of active components (Pin 15) IC1a. The data input will be kept low as long as there is a high present on any of the outputs fitted with a diode.

These diodes keep TR17 turned on, pulling (Pin 15) 'low'. A 'high' is only applied when all output 'highs' have been shifted to the final l.e.d. output (Pin 3) IC2b in this instance. On the following clock pulse D29 extinguishes and the 'high' applied to (Pin 15) moves it on one place, illuminating the first output l.e.d., and also resetting TR17 via D1. To prevent any more 'highs' being entered. Initial switch on can produce unwanted states on the output but they are eliminated when the run contacts are bridged. The final output (Pin 10) IC2b was not used in the prototype as only 3 l.e.d. colours were available to me, so 15 l.e.d.s was an obvious choice to keep the uniformity of the wheel.

A. J. Kitching,
Esh Winning,
Durham.

CAR ANTI-THEFT DEVICE

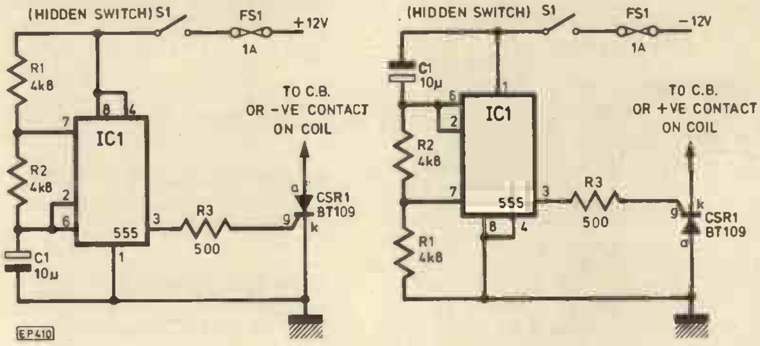
THE locks on most old cars are so worn that virtually any key will open and start them, making them easy prey for joyriders or thieves.

My solution to this is the circuit shown right. With the hidden switch in the 'on' position it is possible to start the engine but any attempt to drive the car off results in a series of 'kangeroo' hops, forcing any prospective thief to abandon the car within a few yards. The figure left is for negative earth and the right for positive earth.

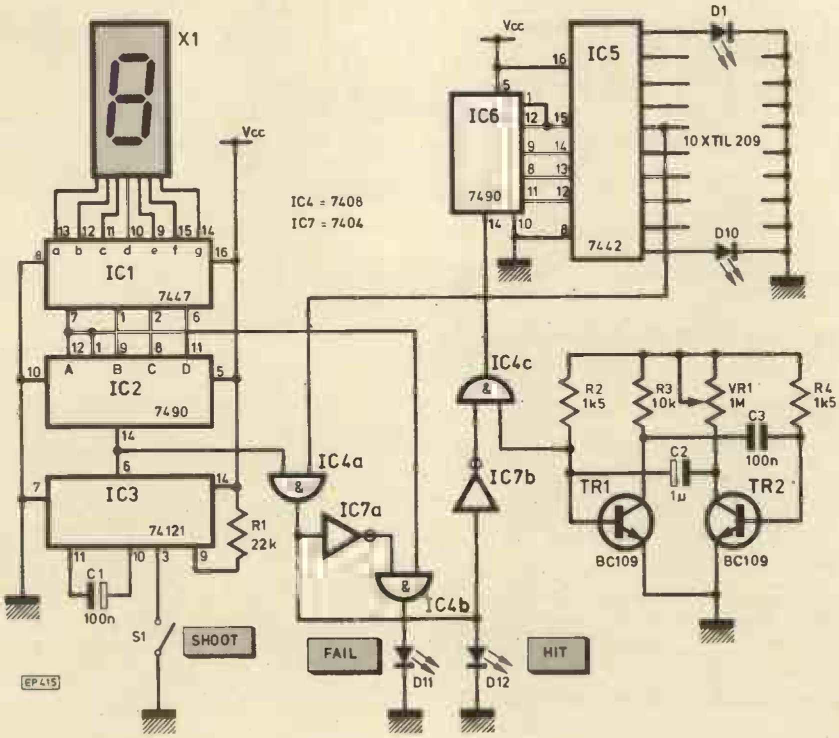
The device operates by shorting the contact breaker points for approximately 70ms in every 100ms.

The circuit consists of a 555 timer connected as an oscillator running at approximately 10Hz with its output triggering thyristor CSR1 via R3, so that it conducts when the points are open effectively short circuiting them and disabling the ignition.

Alastair Mutch,
Aberdeen.



SHOOT GAME



IN this circuit the transistors and their accompanying resistors and capacitors form a pulse generator (clock) whose frequency can be controlled by adjusting VR1. The output feeds a dual input 'AND' gate the output of which is high only when both inputs are high. The other input of this gate is initially high so that the output is high only when a clock pulse is generated. Therefore the 7490 received a series of pulses which are counted and a running total supplied in binary, this is converted by the 7442 into a decimal format and this is displayed by the l.e.d.s D1–10. Since only one l.e.d. can be on at any time this means that the light will appear to move across the array of l.e.d.s. The contestant has to try and press the switch at exactly the same instant as the centre l.e.d. is illuminated.

Upon pressing the switch a pulse is sent to the 74121 which sends out a fixed length pulse irrespective of the length of the input pulse. The length of the output pulse is determined by C1 and R1. The output of the 74121 feeds the input of a second 'AND' gate whose output is high when the switch and l.e.d. D5 are on together its output stops the counter and illuminates D12 indicating a hit. The output of the 74121 also feeds a binary counter which counts how many times the switch has been pressed and displays this value on the seven segment display.

After eight presses of the switch and no hits the D11 l.e.d. is illuminated indicating a fail. The circuit can be reset by temporarily disconnecting the power by a suitable switch.

D. Johnson,
Worsley,
Lancs.

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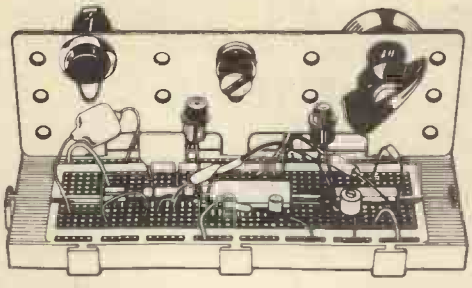

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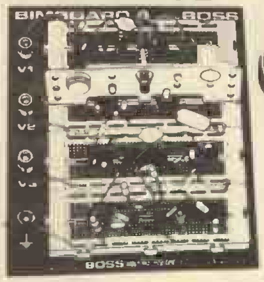

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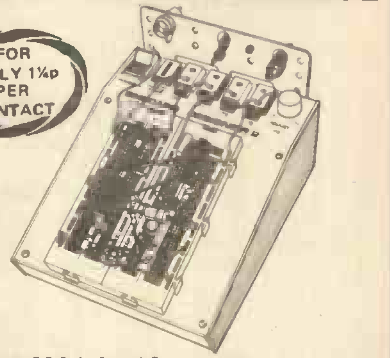

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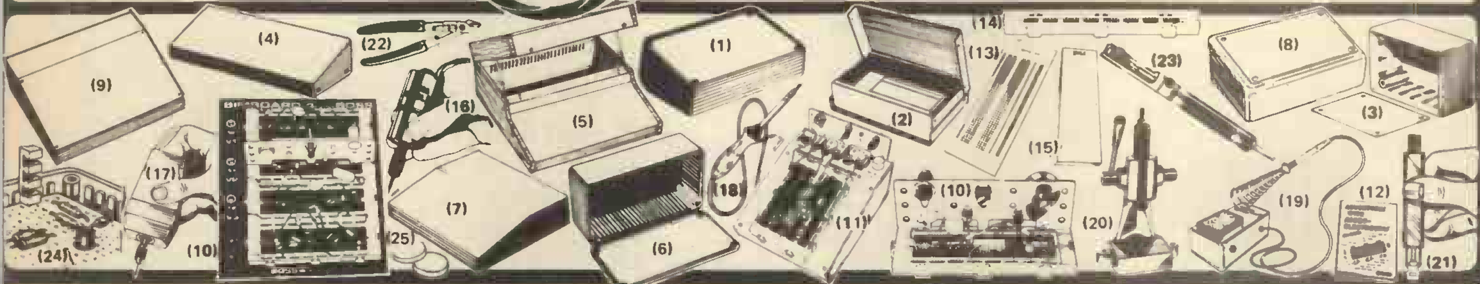

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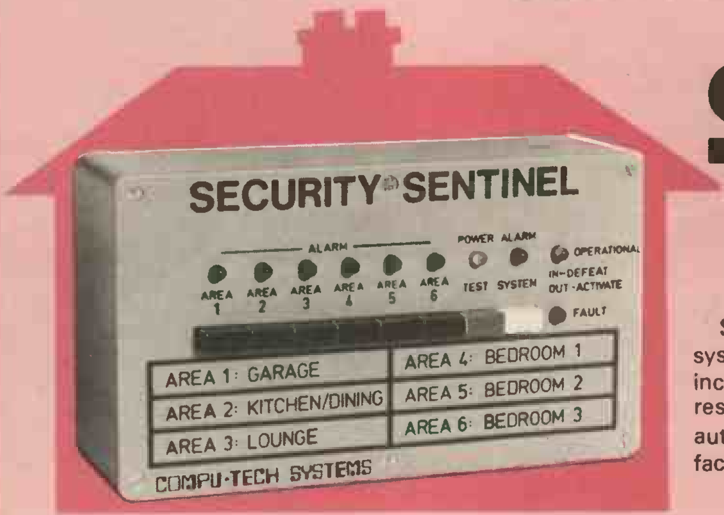

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SPEECH SYNTHESIS—Theory and hardware. PART 1

PRACTICAL
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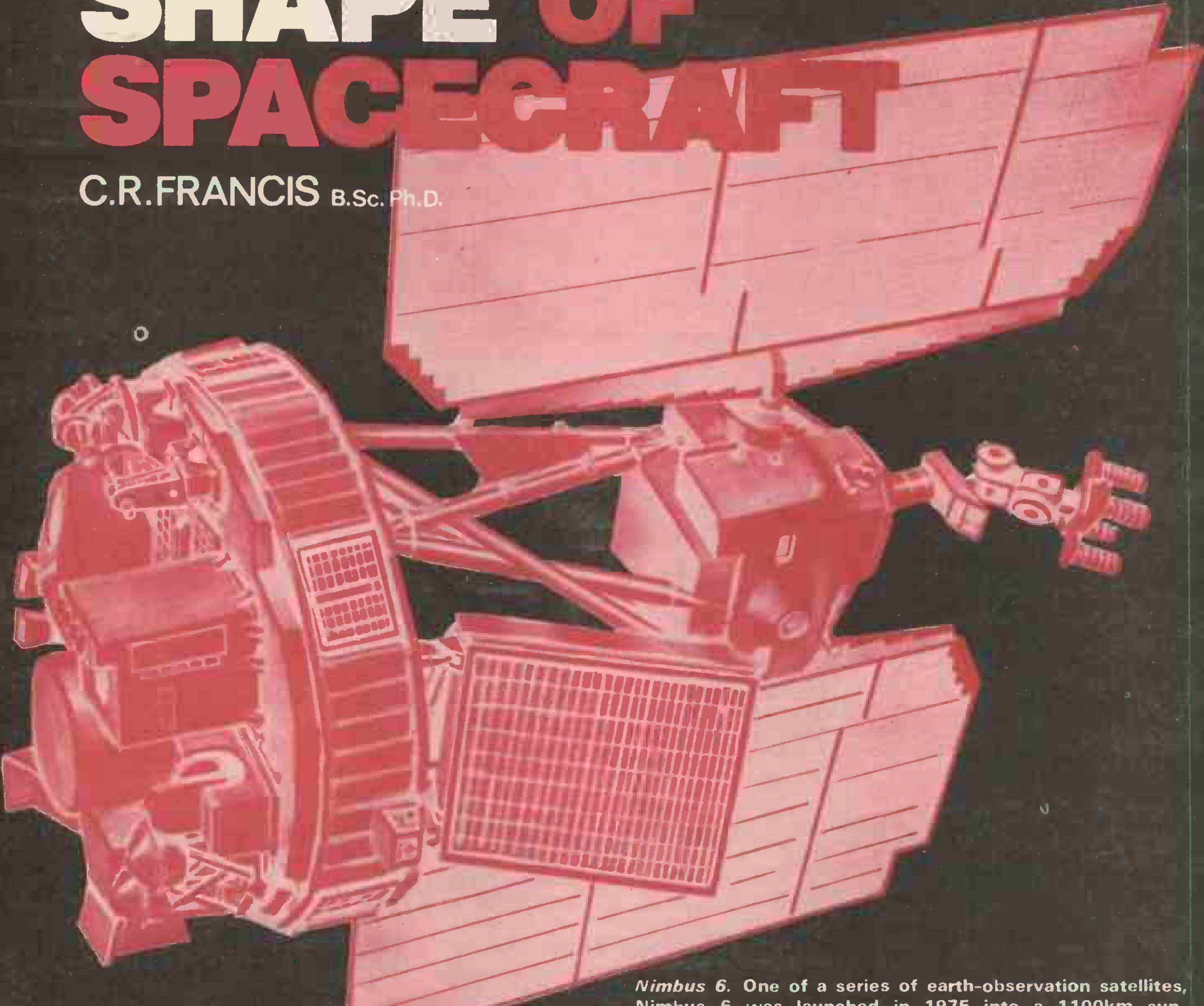
THE SHAPE OF SPACECRAFT

C.R. FRANCIS B.Sc. Ph.D.



Nimbus 6. One of a series of earth-observation satellites, Nimbus 6 was launched in 1975 into a 1100km sun-synchronous orbit, at an inclination of 100 degrees. The 830kg spacecraft is 3-axis controlled so that the instruments may remain earth-pointing. The attitude control system and the solar arrays are mounted as a separate unit linked to the payload assembly by an interconnecting truss. Thermal control louvres can be seen around the sensory ring. *(By courtesy of General Electric)*

IN THE years that have passed since the launch of the first Sputnik in 1957, the heavens have gradually become populated with our machines. There are many thousands of man made objects orbiting around the earth, a few dozen in independent orbits around the sun, and a few in trajectories which will take them out of the solar system forever. There are also scores of space vehicles lying on the surface of the moon and the planets, and many have re-entered the earth's atmosphere. The variation in shape, size and purpose of these objects is enormous. Even if we restrict ourselves to un-manned, non-landing spacecraft, and we ignore discarded jetsam such as clamps and ties, the variation is still very large.

The earliest spacecraft were of necessity very small and experimental, but nowadays it is not unusual for satellites to weigh several tons or to form parts of complex operational systems. Perhaps the best example of this is to be found in communications satellites: these are now a part of our everyday lives and many are operated and owned by commercial concerns. Experimental techniques have now largely been replaced by established design procedures.

TD-1A. **A structural model of the 472kg TD-1A spacecraft in position prior to space simulation tests. TD-1A was launched in 1972 into a 540km orbit, inclination 98 degrees, and was an ultra-violet astronomy satellite. It was 3-axis controlled and had a box-type structure. The only deployed appendages were the solar arrays which were flat panels.** *(By courtesy of European Space Agency)*

The designers of spacecraft are constrained by many factors different from those encountered by more earth-bound engineers. We shall be looking at the effects of these factors on the spacecraft subsystems in more detail later, but let's take environmental effects as an obvious example. While terrestrial environmental considerations may include the weather, dust, humidity and possibly even unauthorised tampering, the spacecraft designer is much more concerned by the influence of vacuum, radiation, micrometeoroids and the weightlessness of free-fall.

To the layman then the external appearance of spacecraft may seem diverse and puzzling. There have been spheres large and small, from Vanguard, not much bigger than a grapefruit to the 100 foot diameter Echo balloons. Other spacecraft resemble boxes; TD-1A is illustrated and the OGO series are also examples of this type. Drum-shaped spacecraft are common, Geos, Intelsat and Tiros for example, and there are other strange and exotic shapes.

Why must spacecraft have these different shapes? There are obviously many factors—the purpose of the satellite, its payload, is the principle driving force and this is expressed through demands on the satellite subsystems.

MISSIONS

On the whole, satellites exist to carry a payload into space (as always, there are exceptions, the British satellite X4, for example, was simply a technology demonstration exercise, with no payload as such). This is the ultimate driver of satellite characteristics. The payload may consist of a single item, or may comprise a collection of instruments, experiments and so on. The categories into which these payloads may be placed are numerous; Table 1 lists many of the types of mission.

Payloads make demands on the spacecraft. Their properties and requirements which may need to be satisfied are: mass, volume, shape, power, telecommands/control, telemetry, timing and synchronisation, instrument orientation, attitude measurement, attitude control, orbit control and thermal control.

Different payloads exhibit great variation in these properties and requirements. We may compare two examples; one representative of instruments carried as part of recent earth-observation payloads, the other typical of experiments carried by small scientific satellites in the late 60s and early 70s. The first is the Scanning Multichannel Microwave Radiometer, or SMMR, which has been flown on two American satellites, Seasat-1 and Nimbus 7, which were both launched in 1978. This instrument measures the microwave radiation emitted from the earth at 5 frequencies, in the range 6·6 to 37GHz; the characteristics of the earth's surface and the intervening atmosphere may be deduced from these measurements.

The second instrument is an ELF/VLF receiver which was flown on the British satellite Ariel 4 launched in December 1971. This experiment, which was designed at Sheffield University, also made measurements at 5 frequencies, but this time they were rather lower; ranging from 750Hz to 16kHz. These measurements are used in the study of wave-particle interactions in the magnetosphere. The important characteristics of these instruments are given in Table 2. Although there are great differences between the instruments, they do not, by any means, represent extreme cases.

We have pointed out that, in essence, the payload defines the characteristics of the spacecraft, but often the instruments in a payload are themselves constrained by the spacecraft capabilities. This may occur, for example if the agency responsible for a spacecraft announces the availability of limited space, power and mass, so that instruments or experiments must be designed within these limits.

Table 1.
Types of Space Mission

Scientific/Experimental	
Astronomical	
Communications	
Navigation	
Applications	
Earth Observation	Meteorological Earth Resources Environmental Monitoring Spy Satellites

Table 2.
Characteristics of two representative payloads

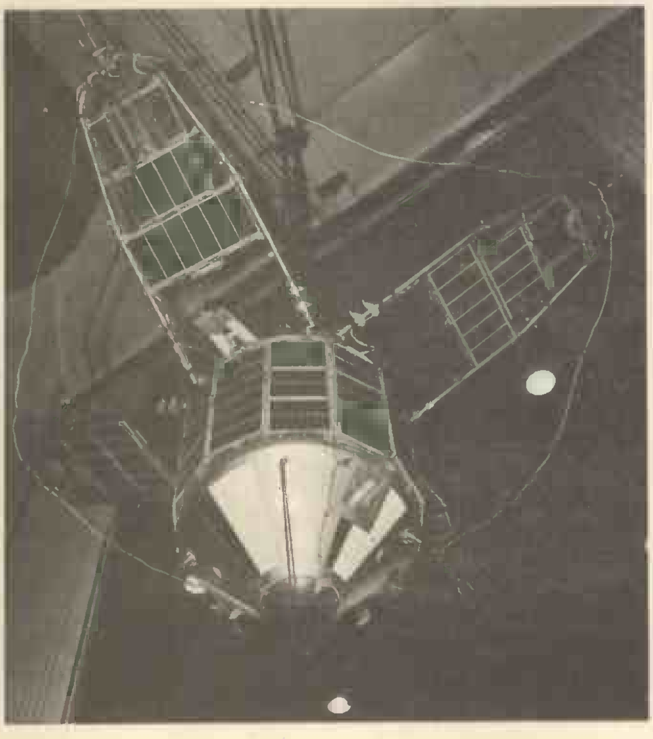
	SMMR	ELF/VLF Receiver
Mass	52kg	5kg
Size	2 boxes 15cm × 20cm × 33cm + 1 box 15cm × 20cm × 16cm + antenna 80cm diameter	1 box 20cm × 15cm × 15cm + loop antenna 3m diameter
Power	60W	0·35W
Data output	Digital 2000 bits/sec	Analogue, 17 channels sampled once every 27·92 sec. With 10 bit digitisation equivalent to 6 bits/sec
Telecommands/Control	12 commands	No commands 10 control pulses

Table 3.
Correspondence between payload characteristics and spacecraft subsystems.

Payload Characteristics	Spacecraft Subsystem
Mass Volume Shape Instrument orientation	Structure
Attitude measurement Attitude control Orbit control	Attitude and Orbit Control System
Telecommands Telemetry Orbit tracking Control and timing Synchronisation	Telecommand Telemetry and Control System
Thermal control	Thermal Control System
Power supply and regulation	Power System

The requirements of the payload are met by the various subsystems of the spacecraft. These include such things as the power system and the thermal control system. The correspondence between requirements and subsystems is given in Table 3. Although it is not, strictly speaking, a subsystem itself, the orbit chosen for a spacecraft is also selected in response to payload requirements, and it has, as we shall see, a profound effect on the entire spacecraft.

Ariel 4. **Ariel 4 was one of a series of British satellites. It was launched in 1971 into a 550km orbit at 83 degrees inclination. The 100kg satellite was used to study the ionosphere and magnetosphere. It was spin-stabilised with four deployable booms. There were many aerials, including the Sheffield VLF experiment loop aerial attached around the ends of the booms, alongside a magnetorque coil.** *(By courtesy of British Aerospace)*



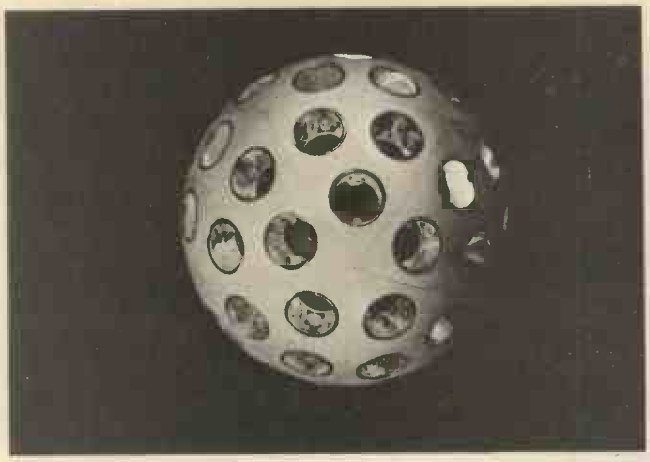
Intelsat 4. **Eight Intelsat 4 communications satellites were launched in the period January 1971 to May 1975, for the International Telecommunications Satellite Consortium, into geostationary orbit. Each was able to handle 5000 telephone channels (or 12 TV channels). The 595kg satellites have since been superseded by the Intelsat 4A and Intelsat 5 satellites. Although spin-stabilised the antennas could point continuously at the earth as they were mounted on a despun platform. Note the large area of the solar array required for the communications transmitters.** *(By courtesy of Hughes Aircraft Company)*

ORBITS

The orbit is the closed path the satellite traverses through space. Most spacecraft orbit the earth, and the orbit is in general eliptical, with the earth at one focus. In many cases these orbits are approximately circular; orbit insertion errors tend to ensure that few satellites orbit in perfect circles.

There are many special orbits. Perhaps the most widely known of these is the geostationary orbit. In this case the orbital altitude is chosen so that the satellite takes 24 hours to make one revolution; it therefore always remains above the same spot on the earth spinning below. This altitude is 35,850km. This is only strictly true for an orbit in the equatorial plane, for otherwise the spacecraft could move North and South of the equator during each orbit. Geostationary spacecraft are therefore normally stationed in or near the equatorial plane, and must be able to maintain their position there.

Another specialised orbit is the sun-synchronous orbit. Here the spacecraft is in a comparatively low altitude orbit (normally less than about a thousand kilometres) with a near-polar inclination. This inclination is carefully chosen so that the orbital plane precesses, under the influence of the earth's oblateness, at the same rate as the apparent motion of the sun around the earth during the year. In this way the sub-satellite track on the earth is



Starlette. **The French Starlette satellite was simply a 25cm diameter sphere, weighing 68kg, inset with corner-cube laser reflectors. Laser ranging enabled the orbit to be accurately determined, for geodetic purposes.** *(By courtesy of CNES)*

always at the same local time. This type of orbit is often used for remote sensing satellites, as the observations are more meaningful when made under the same angle of illumination.

We shall see that the circle of orbit often has a great effect on spacecraft design.

ATTITUDE AND ORBIT CONTROL SYSTEM

Satellites do exist which need no control of attitude or orbit. The Echo balloons were examples, and so are the laser-ranging satellites Lageos and Starlette. In almost every other case though some control of the attitude, and sometimes the orbit as well, is required. There are, essentially, two ways to stabilise the attitude of a spacecraft. It can either be spun about one axis so that it possesses gyroscopic rigidity, or control can be applied to all three axes so that the spacecraft can point in any desired direction for as long as control is maintained.

The type of control used is fundamental to the design, and it often determines what kind of payload can be carried. A spinning satellite enables angular surveys to be carried out, by astronomical instruments and magnetospheric particle detectors. Three axis control is necessary for many earth-observational instruments.

For a spinning satellite to be stable, the spin axis must be the axis of maximum moment of inertia. These satellites tend to be symmetrical about the spin axis so that they are dynamically balanced, and are often drum shaped. Sometimes part of the spacecraft is attached to a motor rotating at the same speed as the spinning spacecraft, but in the opposite direction so that this part remains stationary. This is called a de-spun platform and the satellite is a dual-spin spacecraft. Examples of this technique are the Intelsat 4 and 4A communications satellites where the despun platform enables the antennas to point at the earth though the rest of the spacecraft is spinning.

Power for the spacecraft is normally provided by arrays of solar cells and it is often sufficient to simply cover the sides of the spacecraft, if spin stabilisation is chosen. As the spacecraft spins, most parts of its surface will face the sun at some time. The three-axis controlled spacecraft by contrast, normally carries its solar cells on flat panels which are movable so that they may follow the sun no matter which way the spacecraft is pointing. Already we see the interaction between subsystems, and the effect of this on overall configuration.

Control of the attitude implies that means are available to measure the spacecraft attitude. This may be an Inertial Reference Unit, containing gyroscopes to provide an "internal" measurement, or "external" measurements by sun-sensors, earth sensors or star-trackers. Usually a combination of these methods is used.

Attitude control also requires some means of moving the spacecraft about each axis, in a controlled way. Thrusters or gas-jets are the obvious method, but fine control is difficult to achieve. Accurately controlled attitude manoeuvres may be performed by using reaction wheels—these are essentially flywheels attached to electric motors. As the motor accelerates the wheel in one direction, the spacecraft as a whole spins in the opposite one, so that the overall angular momentum is conserved. Momentum wheels are similar devices except that they spin in their undisturbed state, so that they possess gyroscopic rigidity: they are momentum bias devices, and are commonly used on 3-axis stabilised spacecraft. Small torques may also be achieved by using a magnetorquer. This is a loop of wire through which an electric current may be passed, to produce a magnetic field. This then interacts with the Earth's magnetic field and can be used to rotate the spacecraft.

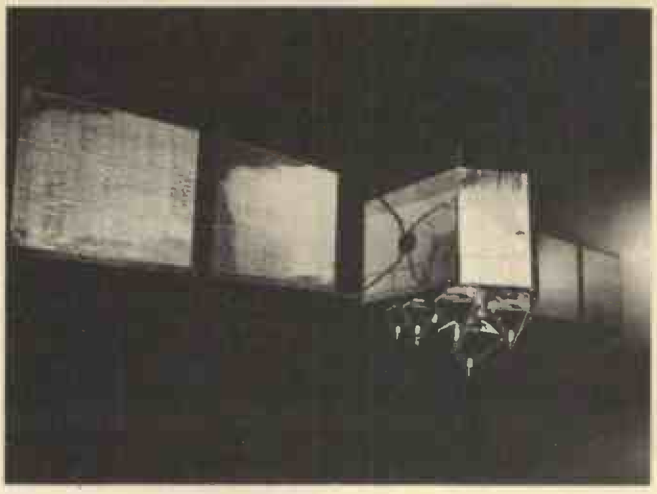
Some spacecraft also need to be able to adjust their orbit. Obvious examples are geostationary spacecraft; to maintain their geostationary condition under the perturbing influence of lunar and solar gravitational effects, substantial orbit control ability is required. This always has to be by means of thrusters—devices

SMMR. **Scanning Multichannel Microwave Radiometer, flown on the Seasat and Nimbus 7 satellites. The offset paraboloid antenna is 70cm across, and scans 25 degrees each side, driven by the mechanism which is visible. The central microwave horn is a very advanced 5-frequency device, and three calibration horns are also visible. The electronics are housed in the three bays beneath. Note the 12 inch ruler attached to the ground handling support.** *(By courtesy of Jet Propulsion Laboratories)* which merely spin the spacecraft cannot change the orbit. To achieve geostationary orbit an apogee boost motor is required. This is normally a fairly large solid fuel rocket engine. Orbital measurements are not carried out by the spacecraft, but are made on the ground. The on-board equipment which enables this to be done falls into the Telemetry, Tracking and Command System.

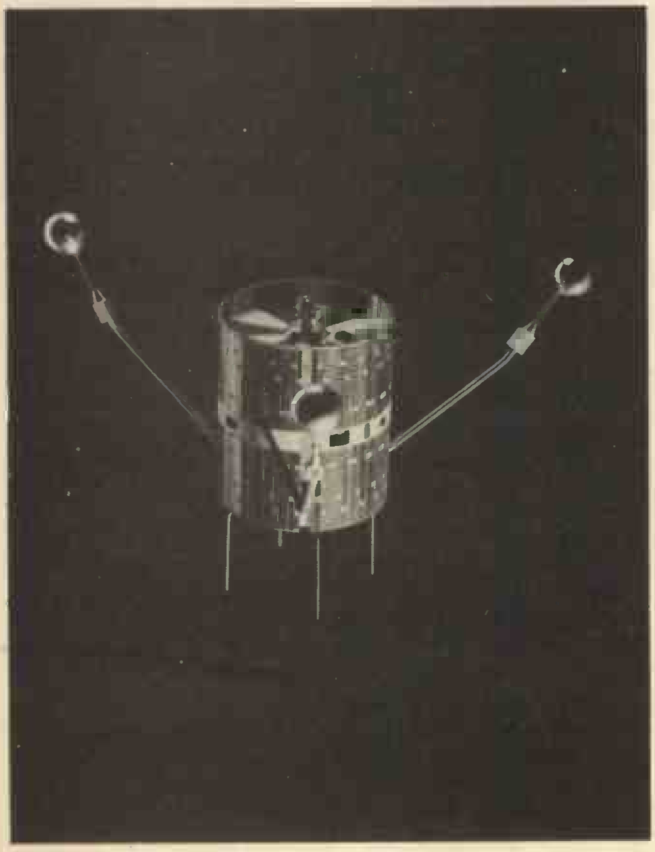
POWER SYSTEM

These days the main source of power for spacecraft is the sun. Occasionally some sort of nuclear power source is used, and the earliest spacecraft tended to use batteries, with no means of charging them up—their lifetimes were consequently rather low. The dominant feature of most spacecraft therefore are the arrays of solar cells. We have already seen that spin-stabilised spacecraft often have solar cells all around their surface, as a result of the constantly changing angle of illumination, while three-axis controlled spacecraft have solar panels which follow the sun.

A little thought will quickly show that the number of rotation axes such panels will require depends on the orbit. For example an equationally orbiting satellite only requires an axis of rotation for its arrays, normal to the plane of the orbit (we can ignore the seasonal variation in the sun's position—at $23\frac{1}{2}$ degrees each way it is not significant). OTS is such a spacecraft. Similarly a satellite in a sun-synchronous orbit only requires one axis, though the arrays may require to be tilted to this axis, depending on the angle the orbital plane makes to the sun. Sometimes however, two axes are required.



***OTS.* The Orbital Test Satellite is a forerunner to the European Communications Satellite programme. The 444kg, 3-axis controlled spacecraft was placed into geostationary orbit in 1977. This model shows some of the subsystems mentioned in the text. The solar cells are mounted on panels which turn about one axis, normal to the equatorial plane of the orbit to follow the sun as the antennas remain pointed at the earth. These antennas are not for TCC but form part of the payload; an experimental communications relay. The foil-like thermal blanketing and polished reflectors on the satellite's body, which are parts of the thermal control system, are visible; so too are the nozzles of two thrusters.** *(By courtesy of European Space Agency)*



***ESRO 4.* ESRO 4 was launched in 1972 into an elliptical 245 × 1173km orbit, Inclination 91 degrees. The 130kg satellite was spin-stabilised, with three deployable booms, and studied the ionosphere.** *(By courtesy of European Space Agency)*

The amount of power required for a spacecraft, and therefore the area devoted to solar cells, varies greatly. Fig. 1 shows a histogram of the solar array power capability for a representative selection of spacecraft of the late sixties and the seventies. The spacecraft range from small scientific satellites to large communications satellites, and include spin-stabilised and 3-axis controlled vehicles. Clearly arrays providing a few hundred watts are the commonest size, and with an efficiency of the order of 10 per cent this implies an area of about $1m^2$.

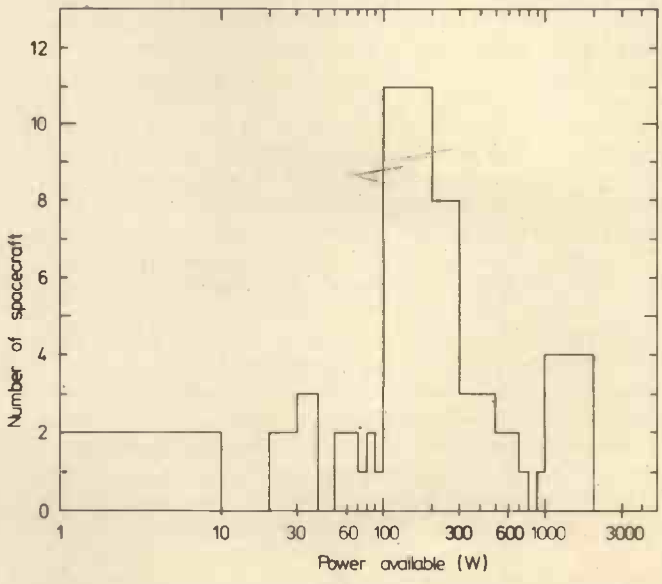
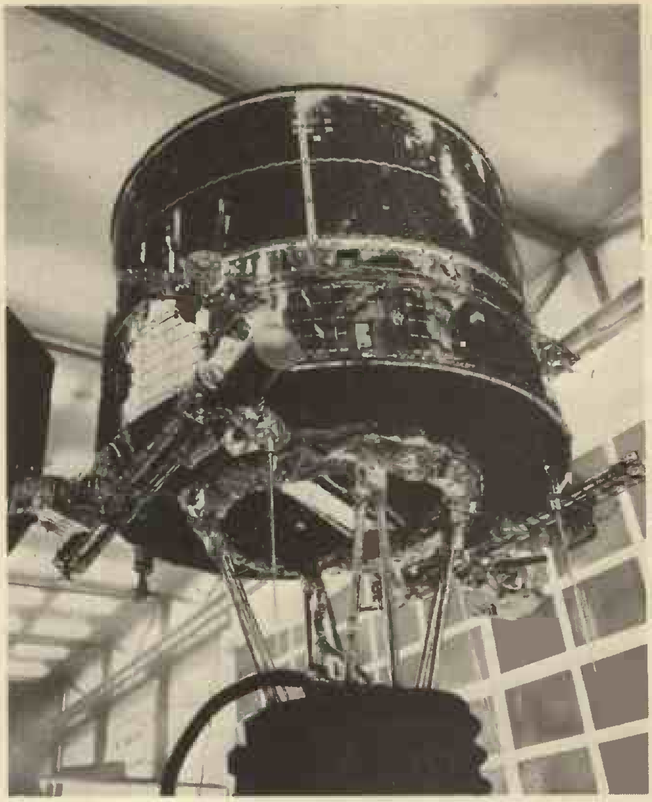


Fig. 1. A histogram of the power generated by the solar arrays of a random selection of 51 unmanned spacecraft

Geos. **The Geos structure is seen during the installation of the wiring harness. The thrust-tube and platform structure can be clearly seen. The apogee boost motor is placed inside the thrust-tube.** *(By courtesy of British Aerospace)*



Geos. **This view of Geos clearly shows the thermal blanketing applied to the satellite. Geos was a magnetospheric research satellite intended to be placed in geostationary orbit, but a launch malfunction in 1977 put the original Geos in an elliptical 38,498 × 213km orbit. A second vehicle, Geos 2, was launched in 1978 into the correct orbit. The 574kg satellite (including a 350kg apogee boost motor) is spin stabilised and has many deployable booms.** *(By courtesy of European Space Agency)*

Large arrays, delivering in excess of 1kW will become more common in the 1980's. The extreme case of this is the satellite whose sole purpose is to collect solar power, so that it may be beamed to suitable receivers on the earth in the form of microwave radiation. This is the Solar Power Satellite concept, and here the array will generate about 10,000MW; clearly it will have to be very large—several kilometres square (see *Spacewatch* PE August 1980).

Sometimes a nuclear power source is used. American spacecraft use a Radioisotope Thermoelectric Generator, an RTG, where heat generated in a quantity of radioactive isotope is converted to electricity by thermocouples. The isotope need not be capable of sustaining a chain reaction. When the Russian space-vehicle Cosmos 954 crashed in Canada in 1978 it became clear that here the nuclear energy source was a true reactor, where a critical mass of material which can maintain a chain reaction is used, again to raise heat which can be converted to electricity.

The RTG is characterised by a need to maintain one junction of its thermocouples as cool as possible, and it is therefore covered with radiating surfaces which are normally fins. Such power sources may be used instead of, or in addition to, solar cells. Obviously if nuclear energy replaces solar energy the constraints on configuration due to the solar arrays are removed but new ones are added by the RTG. It must be able to radiate its heat away efficiently, and, on a long mission accumulated radiation damage due to stray radiation from the device must be limited. These factors normally ensure that the RTG must be accommodated on a boom away from the rest of the structure. This of course raises its own problems.

The power system must contain, in addition to its primary energy source, secondary sources (i.e. rechargeable batteries) and regulating and distributing subsystems. A power dump is also required. This equipment does not have a great impact on the structure and configuration of the spacecraft.

TELEMETRY, TRACKING AND COMMAND

The name of this system is self-explanatory, and again much of the system is internal equipment; transmitters, receivers, multiplexers, A-to-D converters, tape recorders and so on. The only item which is significantly affected by the configuration is the antenna subsystems. Often spacecraft have a multiplicity of antennas. These include VHF omnidirectional antennas for commands and for low data rate telemetry (though the VHF network is now being phased out), and directional S- and X-band antennas (the latter are not yet common) for high rate telemetry. High resolution imagery from spacecraft may require data transmission rates in excess of 100Mbs^{-1}, so the S- or X-band antenna requires high gain, or a high power transmitter! (In spacecraft terms of course. The RF power output is almost always less than 100W.)

For spacecraft in earth orbit, even fairly distant orbits such as the geostationary orbit, telemetry antennas are small and insignificant. (Note that we are here considering that the large antennas of communications satellites are part of the payload.)

However, planetary probes, which must return data from millions of miles away, normally need a large directional antenna, so that transmitter power can be kept low, and the transmitted data-rate as high as possible. The Pioneer and Voyager probes to Jupiter (and beyond) were completely dominated by their high-gain antennas.

THERMAL CONTROL SYSTEM

In our British climate we are not always aware of the full heating effect of the sun. Yet we have all heard of eggs being fried on bare rocks in desert regions and should therefore be able to appreciate that in space, depending on their surface finish, exposed surfaces can become very hot. Similarly, the coldest night on earth is positively warm compared to the temperature to which a shadowed object in space can fall.

It is the task of the Thermal Control System to regulate the spacecraft temperature to preset limits. These vary from item to item in the equipment inventory, but may be, typically, −10°C to +40°C.

Solar heat inputs, and heat produced by onboard equipment, must be balanced against radiation losses to space, and the thermal inertia must be such that the temperature does not drop too far while the spacecraft is in shadow. Although some active devices are used, such as heaters and thermal louvres, much of the Thermal Control System lies in the surface finish of the spacecraft. Combinations of aluminised plastic film, polished metal surfaces and paint are used, to achieve the correct thermal properties.

This system therefore governs the final surface finish of the spacecraft: and explains why space vehicles often look as if they have been wrapped in cooking foil!

STRUCTURE

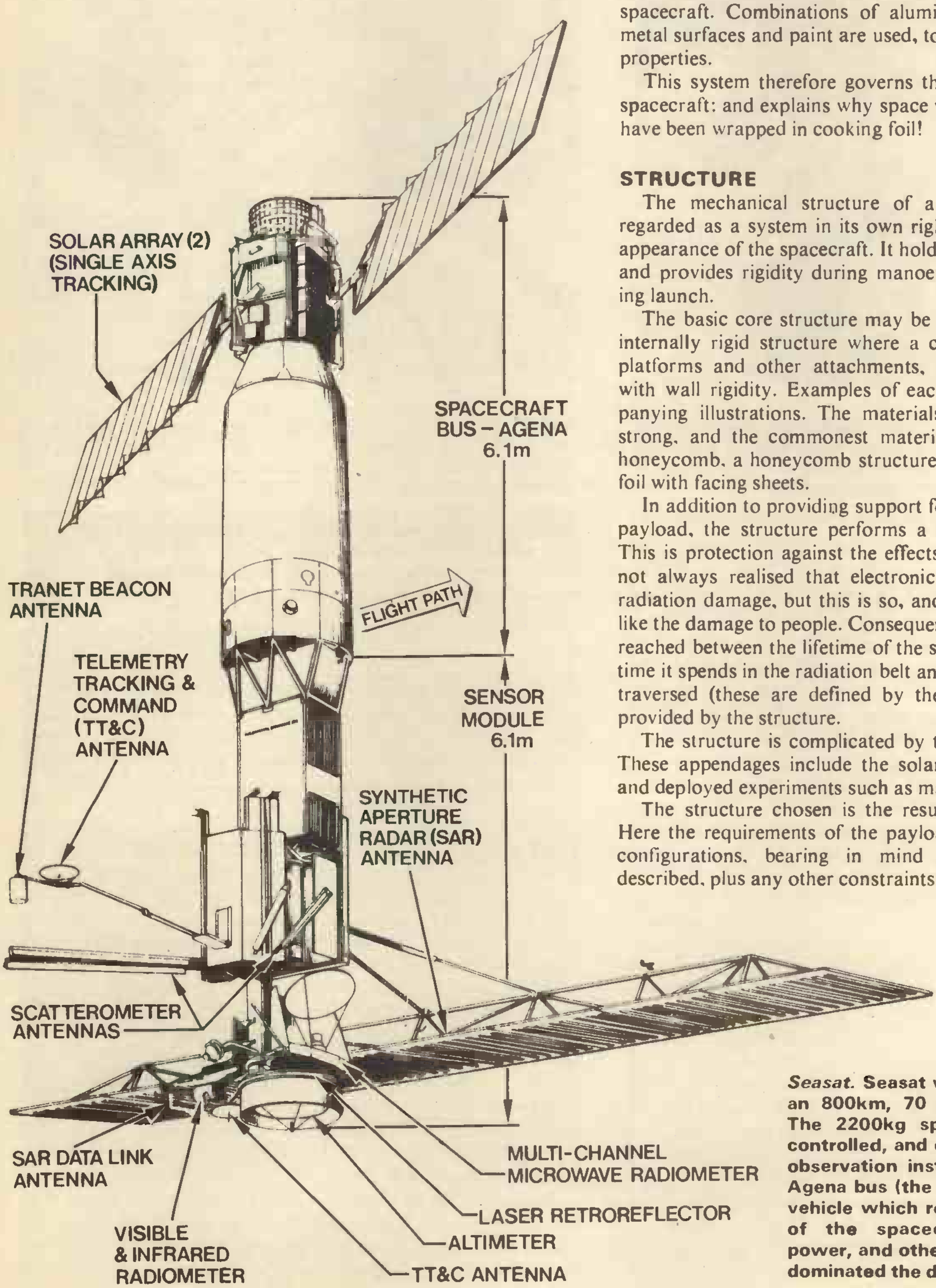
The mechanical structure of a space-vehicle is normally regarded as a system in its own right, and it really governs the appearance of the spacecraft. It holds all the other parts together and provides rigidity during manoeuvres, and particularly during launch.

The basic core structure may be of two types. These are the internally rigid structure where a central thrust tube supports platforms and other attachments, and the box-type structure with wall rigidity. Examples of each are shown in the accompanying illustrations. The materials used are lightweight and strong, and the commonest material for panels is aluminium honeycomb, a honeycomb structure made from thin aluminium foil with facing sheets.

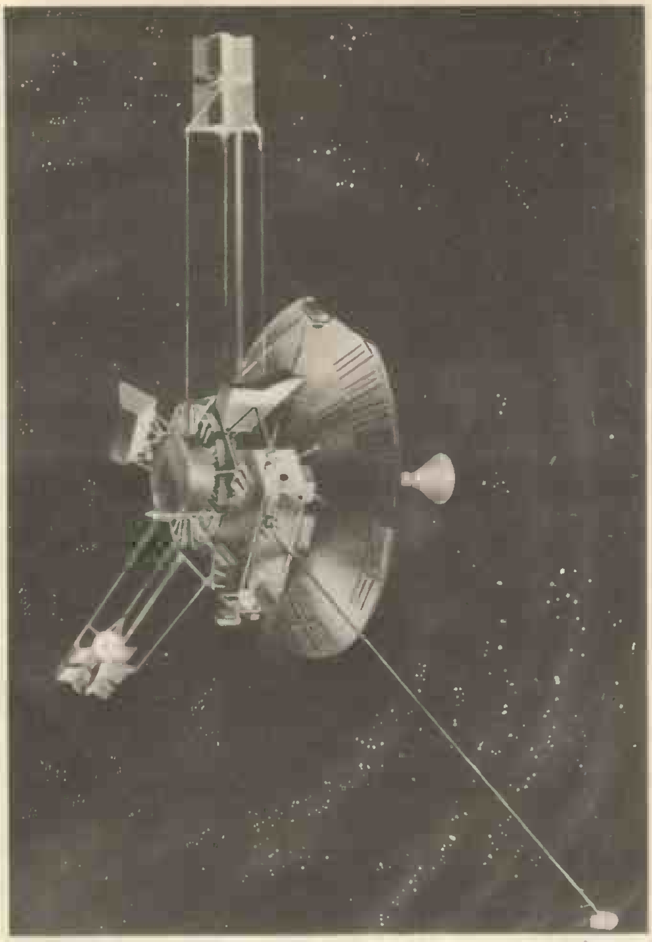
In addition to providing support for the other systems and the payload, the structure performs a further important function. This is protection against the effects of the radiation belts. It is not always realised that electronic devices are susceptible to radiation damage, but this is so, and it is a cumulative process, like the damage to people. Consequently a compromise has to be reached between the lifetime of the spacecraft, the fraction of its time it spends in the radiation belt and which part of the belts are traversed (these are defined by the orbit) and the protection provided by the structure.

The structure is complicated by the addition of appendages. These appendages include the solar arrays, various antennas, and deployed experiments such as magnetometers.

The structure chosen is the result of configuration studies. Here the requirements of the payload are matched to possible configurations, bearing in mind the constraints we have described, plus any other constraints which may exist.



***Seasat.* Seasat was launched in 1978 into an 800km, 70 degrees inclination orbit. The 2200kg spacecraft was three axis controlled, and carried a number of earth-observation instruments. The use of the Agena bus (the upper stage of the launch vehicle which remains as an integral part of the spacecraft, providing AOCS, power, and other functions) has obviously dominated the design**



***Pioneer 10/11*. These two spacecraft were precursors to the Voyager missions to the outer planets. Pioneer 11 flew past Saturn in September 1979, following its launch in April 1973 and Jupiter fly-by in 1974. Pioneer 11 was renamed Pioneer Saturn. The spacecraft has a large (2·74m diameter) antenna to maintain contact with Earth and is spin stabilised about the antenna axis. There are no solar cells, power is provided by two radiosotope thermoelectric generators**

LAUNCH

The launch imposes an inflexible set of constraints which every spacecraft must meet. The space inside launch vehicles is limited, and accelerations, vibrations and acoustic noise levels are high.

The available volume and mass which the launch vehicle allows are a strong design driver. Many spacecraft have obviously been designed to fit the cylindrical space within the launcher, and some even include the upper stage of the launcher as part of the spacecraft. Seasat is an example of this type. As a result of the limited space most appendages have to be deployed after launch, and this has given rise to many fascinating deployment mechanisms.

When the Space-Shuttle comes into service, it's primary purpose will be to launch satellites. It's huge cargo-bay will ease many of the launch constraints, though some new ones related to safety will appear.

Although the spacecraft will spend most of its life in a weightless environment, it must be designed for strength along the longitudinal axis to cope with the launch acceleration, and it must be able to stand strong vibrations in all directions.

The illustrations accompanying this article show a diverse range of spacecraft. The reason for some of this diversity should now be clear, though manned spacecraft and many planetary landers may look as inexplicable as ever. These, though, are a different story altogether. ★

125W AMPLIFIER...

THIS 125W module, which has been designed for high power audio applications is a compact single board unit suitable for pop groups, discos, hi-fi, PA systems, etc.

The module, including a loudspeaker coupling electrolytic can be built for under £12·00 (see components list).

CIRCUIT DESCRIPTION

The complete circuit diagram of the module is shown in Fig. 1. Transistors TR1 and TR2 form a differential input pair, the output of which is d.c. coupled to the pre-driver TR3. It's mid-point voltage is set by the resistors R2 and R3. The level of negative feedback is determined by C3 and R7. Increasing the value of R7 will result in an increase in the negative feedback which improves linearity and distortion. However, C3 should not exceed 50μF otherwise "clamping" will result. The capacitors C4, C7 and C11 ensure high frequency stability.

The collector load of TR3 is "boot strapped" to the mid point via C8. The output from the input stage is connected to a complimentary driver pair via the diode D4. Under normal conditions D4 is forward biased but in the event of a high voltage occurring at the emitters of the power transistors, due to a short circuit at the loudspeaker terminals, the sensing resistors R28, R29, R30 and R31 will trigger the appropriate protection transistors TR5, TR7, TR4 or TR6. The protection circuit reverse biases D4 and clamps the bases of the drivers, TR9, TR10 to the mid point. When the short is removed normal operating conditions are restored.

The bias condition, which sets the quiescent current of the output transistors is determined by the collector-emitter voltage of TR8. This voltage is set by VR1. A stable quiescent current is maintained throughout the working temperature range of the module by transistor TR8 being in thermal contact with the heatsink. Any rise in temperature reduces the collector-emitter voltage of TR8 thus compensating for the current rise in the drivers and output transistors.

The bias path via TR8 which also carries the a.c. signal to TR10 has the junction of R15 and R16 "bootstrapped" to the mid point. The diode D5 ensures maximum drive at high power levels.

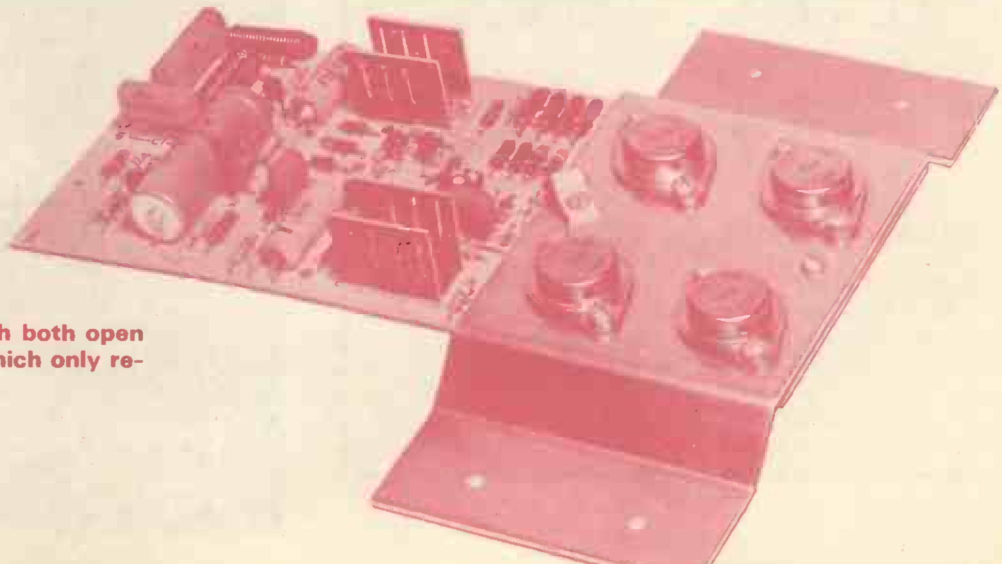
The output transistors TR11, TR13, TR12 and TR14 are parallel connected with independent emitter resistors. The diodes D2 and D3 limit the mid point swing to the level of the supply voltage as when an inductive load is connected without D2 and D3 the mid point voltage could become higher or lower than the supply voltage.

The output is shunted with a Zobel network (C9 and R14) and connects to the speaker via L1 and R8. This arrangement minimises the effect of the speaker's inductance and presents the speaker with as near a d.c. load as possible. The coil L1 also enables electrostatic speakers to

SPECIFICATION

Output Power	125W r.m.s. (not continuous sine wave) maximum into 4 ohms
Frequency Response	25Hz to 20kHz at 100W
T.H.D. 4 ohm lead	0·1% typical
at $\frac{1}{2}$ power 8 ohm lead	0·07% typical
Signal/noise	78dBs
Sensitivity for 100W	400mV
Input Impedance	47k

Short and open circuit protection.



A power amplifier module with both open and short circuit protection which only requires a p.s.u. for operation

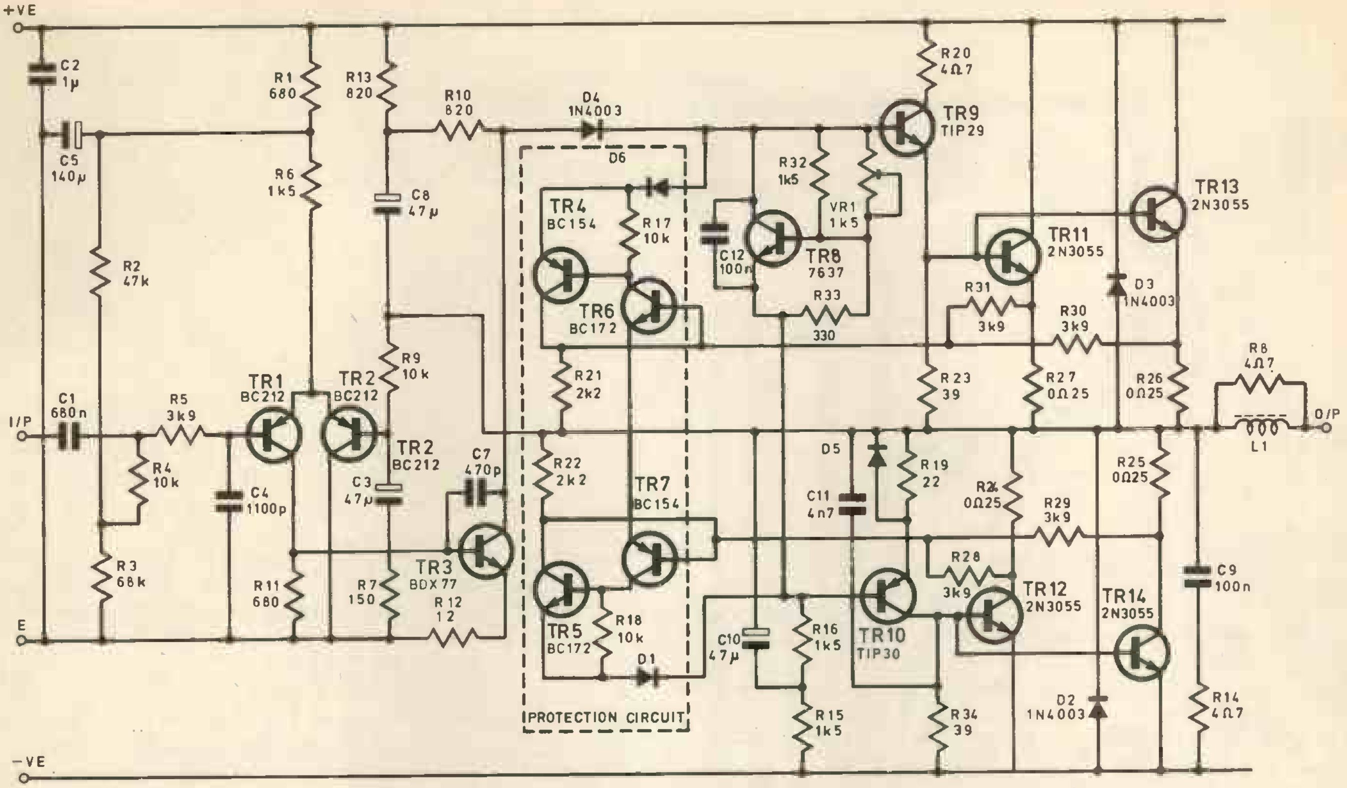


Fig. 1. Circuit diagram of the amplifier

be used. However, the shunt resistor R8 may require some adjustment but it should not be higher than 15 ohms otherwise severe ringing may occur.

PREMATURE LIMITING

Premature limiting may occur due to the spread in component values, particularly minor variations in the values of R24, R25, R26 and R27. The symptom of premature limiting is the break-up of sound at high power levels. Should this occur the value of R21 and R22 should be changed from 2k2 to 1k5.

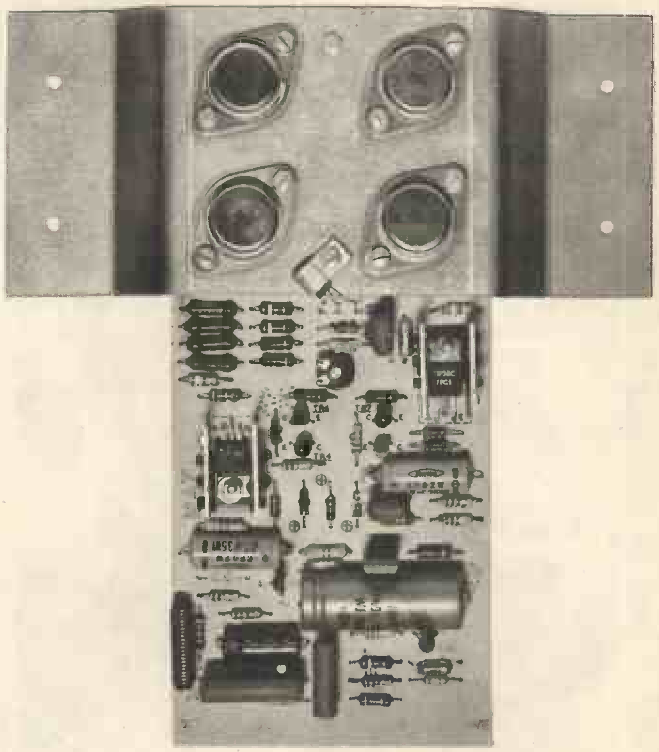
COUPLING CAPACITOR

The load coupling capacitor which should be connected with the positive lead to the module must be at least 470μF 60V for a 16Ω load, 1000μF 60V for an 8Ω load and 2200μF 60V for 4Ω loads. The voltage rating can be reduced with the supply voltage but should never be less than two thirds of the supply voltage.

An unregulated power supply capable of giving 80V at 2·5A is suitable for use with each module the current rating can be reduced to 0·5A if a 16Ω load at 50V is used. Hum generated as a result of supply line ripple will be the controlling factor in the smoothing of the power supply.

CONSTRUCTION

The p.c.b. which is supplied with the kit requires drilling. All the holes should be drilled first with the exception of the power transistor holes. Particular care should be taken to drill the two heatsink fixing screws accurately. The p.c.b. can then be fixed to the heatsink and using the heatsink as a template all the power transistor holes can then be drilled. Make sure that all the holes are drilled in the centre of the heatsink holes as no insulation bushes are used. The power transistors should be mounted into position using mica



washers and a silicon compound. The rest of the components can now be soldered. Note that TR9 and TR10 both have heatsinks fitted to them.

Carefully check all the soldered joints and using a multi-

Fig. 2. P.c.b. design

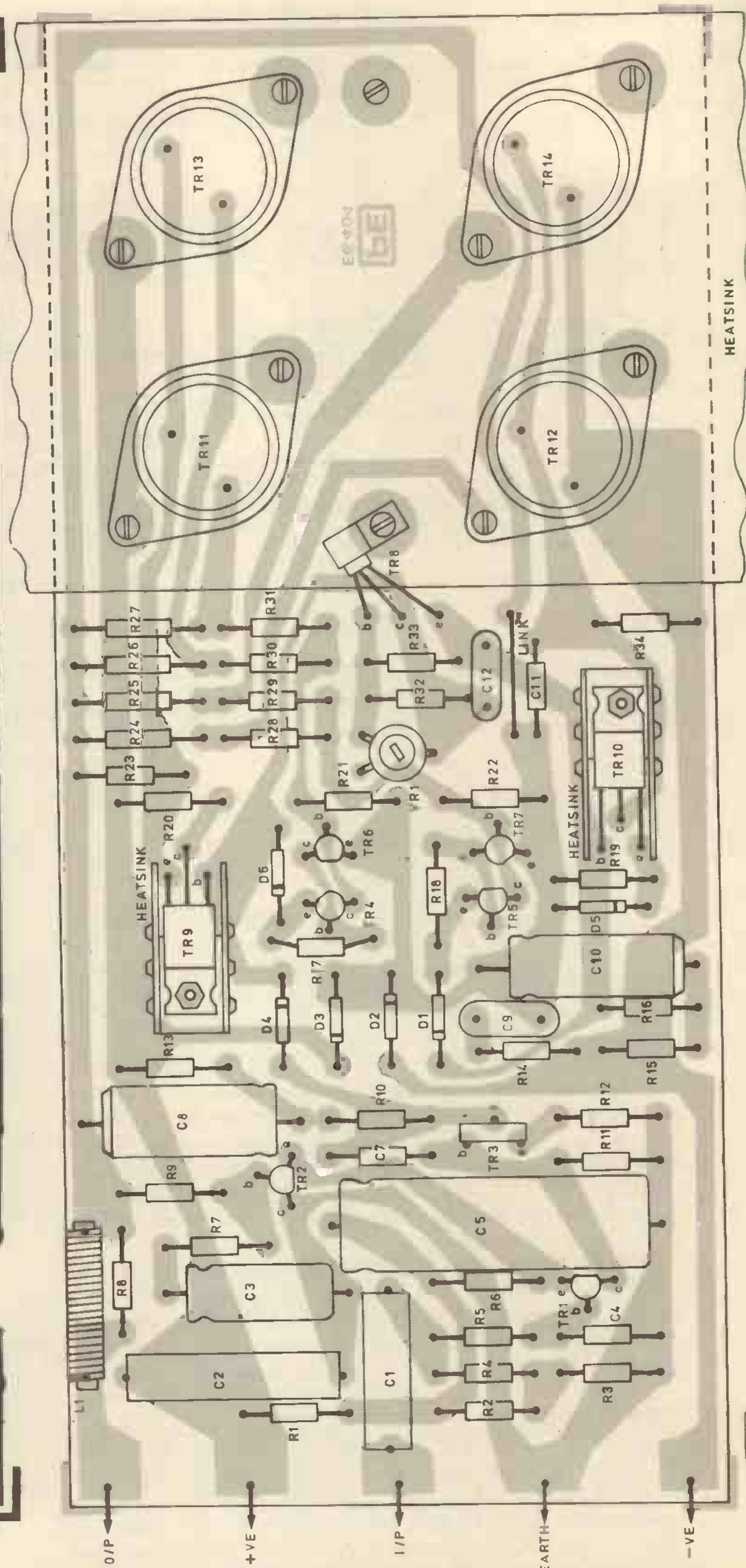


Fig. 3. Component layout for the amplifier
Note: C6 is not required

COMPONENTS . . .

Resistors

R1, R11	680 (2 off)
R2	47k 5%
R3	68k 5%
R4, R9, R17, R18	10k 5% (4 off)
R5, R28, R29, R30, R31	3k9 5% (5 off)
R6, R15, R16, R32	1k5 (4 off)
R7	150
R8, R14, R20	4Ω 7 (3 off)
R10, R13	820 $\frac{1}{2}$W (2 off)
R12	12
R19	22
R21, R22	2k2 5% (2 off)
R23, R34	39 (2 off)
R24, R25, R26, R27	0Ω 25 (4 off)
R33	330

All transistors $\frac{1}{4}$W 10% carbon except where otherwise stated.

Potentiometers

VR1	1k5 preset lin

Capacitors

C1	680n
C2	1µ
C3	47µ 63V elect
C4	1100p
C5	140µ 70V elect
C7	470p
C8, C10	47µ 35V elect (2 off)
C9, C12	100n (2 off)
C11	4n7

Semiconductors

D1	Germanium diode
D2, D3, D4	1N4003 (3 off)
D5, D6	Silicon diode (2 off)
TR1, TR2	BC212 (2 off)
TR3	BDX 77
TR4, TR7	BC154 (red spot) (2 off)
TR5, TR6	BC172 (white spot) (2 off)
TR8	7637
TR9	TIP29 (white spot TO220)
TR10	TIP30 (red spot TO220)
TR11, TR12, TR13, TR14	2N3055 (4 off)

Miscellaneous

P.c.b.
Heatsink
Mica washers (4 off)
Inductor

Constructor's Note

A complete kit of parts for the amplifier module is available from *Radio and TV Components, 21B High Street, Acton, London W3 6NG*. A suitable power supply unit kit for the amplifier is also available from RT-VC.

meter check there is no continuity between the cases of the output transistors and the heatsink.

The inter wiring should be kept as short as possible with screened leads used for the input connections. Each module should be earthed to a central earthing point only, as should the power supply—ve, mains, earth, etc. The main leads should be capable of carrying a continuous current of 2·5A. Generally speaking, the heavier the earth lead the better and 24/0·2mm conductor is recommended.

OUTPUT POWER

To obtain the maximum output from the module a power supply of 80V (the maximum allowable voltage) and a load of 4 ohms must be used. When the module is being operated at full power it should be mounted on an aluminium case or heatsink of at least 16 s.w.g. and with a surface area of 950 sq. cms.

With a 50V supply (minimum voltage) and a load of 16 ohms the output power will be approximately 16W and if an 8 ohm load is used, 32W.

With the module connected to a suitable p.s.u. and loudspeaker, and with no input signal applied, VR1 should be adjusted for a total current reading of 50mA. ★

News Briefs

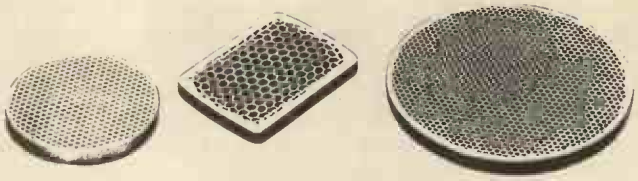
MAGIC ELEMENT

AN ENTIRELY new and intriguing type of heating element with *built-in* temperature control without the need for any external sensors or cutouts is now available from Salford Electrical Instruments Ltd. Known as PTC Honeycomb heaters, the new elements are available for use from 240V or 110V a.c. mains, and are ideally suited to use in domestic appliances and blown air applications in industry.

The heaters depend for their operation on the thermal properties of doped barium titanate, a semiconductor ceramic whose resistance increase sharply above a certain temperature, known as the switching temperature. The elements are available in round or rectangular shapes, with a "honeycomb" structure of hexagonal holes to ensure easy air flow over as large a surface as possible.

The low initial resistance of the elements means that warm-up is achieved very rapidly after switching on, but once the switching temperature is reached equilibrium occurs, with heat losses from the element balancing the input power. Passing air through the heater results in a new, lower equilibrium temperature, which in turn causes the resistance to drop and hence increases the input power. The result is that the overall temperature of the block remains nearly constant at around the switching temperature, and heating power can be varied merely by controlling the flow of air.

An important feature of the elements is their inherent safety; if the air flow stops for any reason, the current flow into the device becomes self-limiting and the heater remains at the switching temperature. Other advantages include minimal temperature fluctuations, with no "dead spots" within the heater block.



Self-regulating heater elements

PE

TELETEXT

with INFRA-RED REMOTE CONTROL

David Shortland

PART 3... VIDEO SUMMER BOARD & P.S.U.

THE circuit diagram of the Video Summer Unit is shown in Fig. 3.1. In addition to the R, G and B signals from the character generator, the TEA1002 requires a number of timing signals. These are all derived from signals available in the teletext decoder. The PAL switch input (pin 12) is a square wave at half line frequency which changes the colour burst phase on alternate lines to provide correct PAL encoding. It is generated by taking the $\overline{GLR}$ signal and dividing it by two with a binary counter. The counter is negative edge triggered to ensure that the timing of the PAL switch is correct. $\overline{GLR}$ is also used to generate the Colour Burst Flag (CBF) input to the TEA1002. It is gated with F1 in the 4528 monostable (IC16) to provide a 2·2μs pulse which enables the colour burst encoder in the TEA1002 at the correct time. AHS is used as the composite sync input to the TEA1002 and also to trigger the second monostable of IC16. This generates a 4·5μs pulse which is adjustable to enclose the whole of the colour burst on the TV video signal. This output is then inverted and fed to the burst gate input of IC17. This enables IC17 to frequency lock its 8·8MHz oscillator to the frequency of the incoming burst. The oscillator output is then buffered and connected to the oscillator input of the TEA1002. The Picture On input from the teletext board is used to kill the oscillator whenever TV display is selected since there would otherwise be an ambiguity in the colours of the displayed text. This means that news flashes and subtitles are displayed in black and white only.

Pin 11 on the TEA1002 has a chroma band limiting filter connected to it to reduce the harmonics present in the TEA1002 chroma signals. This considerably improves the quality of the display but necessitates the use of a delay line in the luminance path between pins 6 and 7. A delay of 270ns effectively compensates for the delays introduced by the filter in the chroma path.

Pin 9 on the TEA1002 is used to select two different colour bar standards. For teletext use, it is grounded to give colours based on the BBC 95 per cent colour bar standard. If it is taken to the 5V supply, colours based on the EBU 75 per cent colour bars are produced which are more suitable for TV games.

The remainder of the circuit consists of a black level clamp which clamps the TV video black level to that of the TEA1002 video output, and an analogue switch to select either the TV video information or the encoded teletext display. The output of the switch is buffered and provide a signal suitable for driving the REMO 200 modulator directly.

The composite video output from the TEA1002 is shifted in d.c. level and reduced in amplitude to give a 1 volt signal on the input to the analogue switch and on one side of the long tailed pair. When the CBF signal is high, current flows in the long tailed pair and the p.n.p. transistor conducts to charge the 1μF clamping capacitor until the two bases of the pair are at the same potential.

The TV signal which is nominally 2·4V peak to peak is reduced in amplitude and buffered to provide a 1V signal at the output of the clamp.

IC19 is an analogue switch and when the blanking signal is low, the Y_0 input is connected to the output giving a TV picture display. If the blanking signal is high as in teletext mode or during boxed information on news flash and subtitle pages, then the Y_1 input is connected to the output giving a text display.

CONSTRUCTION

The Video Summer Circuit, sound amplifier and modulator are all mounted on the p.c.b. shown in Figs. 3.2. and 3.3. The through-board links shown by the square pads in Fig. 3.3. should be soldered first. Before soldering the rest of the components carefully check the links for continuity with a multimeter. It is recommended that i.c. holders are used for

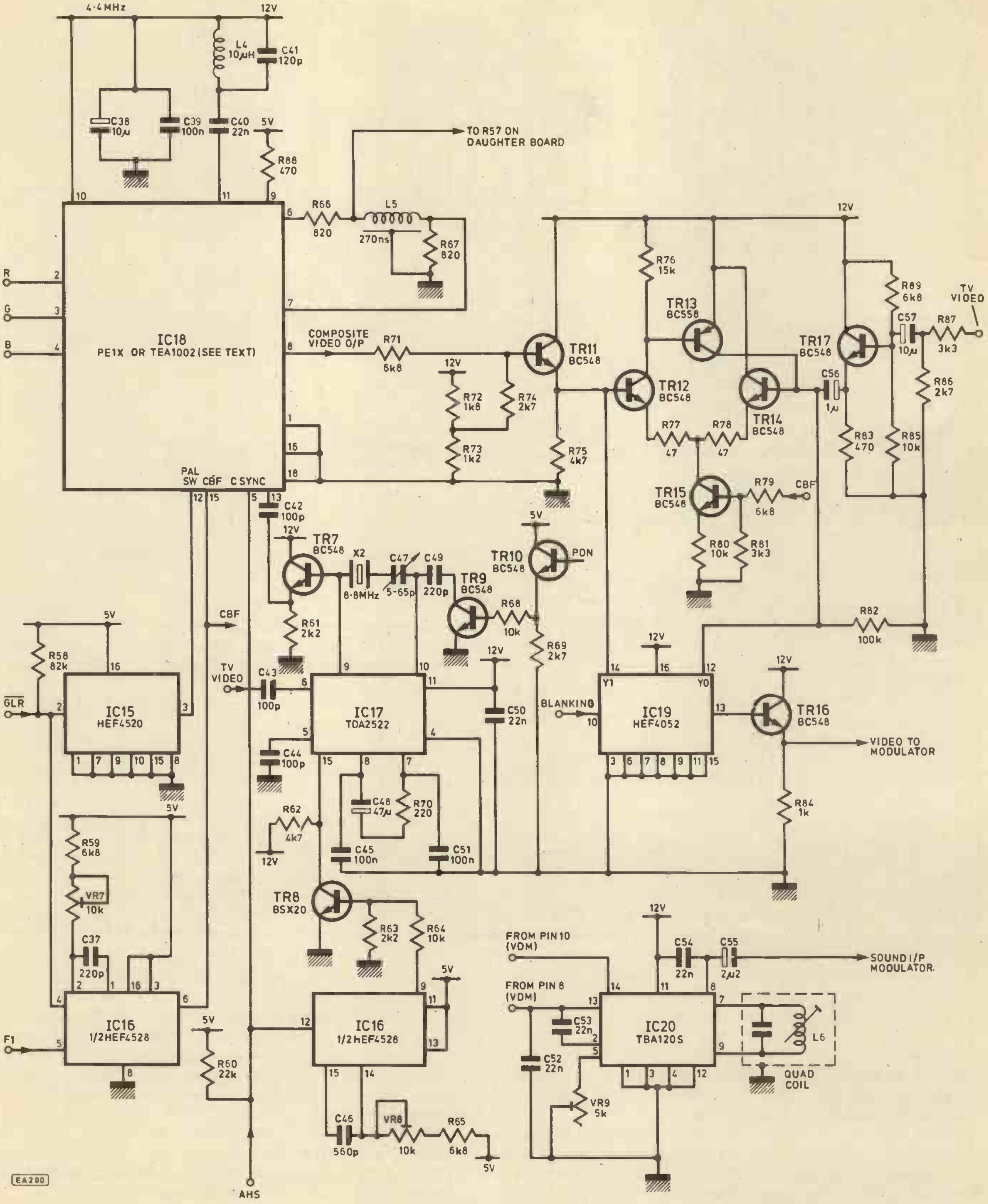


Fig. 3.1. Circuit diagram of the Video Summer Unit

COMPONENTS . . .

VIDEO SUMMER BOARD

Resistors

R58	82k
R59, R65, R71, R79, R89	6k8 (5 off)
R60	22k
R61, R63	2k2 (2 off)
R62, R75	4k7 (2 off)
R64, R68, R80, R85	10k (4 off)
R66, R67	820 (2 off)
R69, R74, R86	2k7 (3 off)
R70	220
R72	1k8
R73	1k2
R76	15k
R77, R78	47 (2 off)
R81, R87	3k3 (2 off)
R82	100k
R83, R88	470 (2 off)
R84	1k

Potentiometers

VR7, VR8	10k (2 off)
VR9	5k

Capacitors

C37, C49	220p (2 off)
C38, C57	10µ 16V elect (2 off)
C39, C45, C51	100n (2 off)
C40, C50, C52, C53, C54	22n (5 off)
C41	120p
C42, C43, C44	100p (3 off)
C46	560p
C47	5–65p
C48	47µ 16V elect
C55	2µ2 16V elect
C56	1µ 16V elect

Semiconductors

TR7, TR9, TR10, TR11 TR12, TR14, TR15, TR16, TR17	BC548 (9 off)
TR8	BSX20
TR13	BC558
IC15	4520
IC16	4528
IC17	TDA 2522
*IC18	PE1X or TEA 1002
IC19	4052
IC20	TBA120S

Miscellaneous

p.c.b.
Holders for i.c.s. (6 off)
Modulator REMO 200
X28·8MHz crystal
L4 inductor 10µH
L5 delay line 270ns
L6 Quad coil

* See text.

POWER SUPPLY UNIT

Capacitors

C58, C59, C63	220n
C60	4700µ 25V elect
C61	2200µ 25V elect
C62	220µ 160V elect

Semiconductors

D20, D21	1N4001 (2 off)
D22	BZY88 47V zener
BR1	1 Amp bridge rectifier WO1
IC21	LM340T-5
IC22	LM340T-12
IC23	LM78L24 CH

Miscellaneous

S1 single pole switch
LP1 neon lamp
T1 mains transformer (30–0–30, 0–5A; 8–0–8, 0–2A)
Fuse holder
Case RB6
UHF panel mounted sockets (2 off)
UHF plugs (4 off)

the chips and care should be taken with the orientation of the transistors. Double check the correct types have been used.

SETTING UP

All the adjustments on the board can be carried out using an oscilloscope, a standard TV receiver and a source of broadcast video including teletext data.

First the CBF pulse on pin 6 of the IC16 should be adjusted to be 2·2µs wide. Then the pulse at pin 15 of the IC17 should be adjusted to just enclose the colour burst on the incoming TV video signal. Check that it is correct for all channels. It is now necessary to adjust the frequency of the reference oscillator (IC17). For this, it is necessary to display both TV video and coloured teletext simultaneously. To do this, select a newsflash or subtitle page which contains coloured information, then open-circuit the PON input (TR10 base). This allows the reference oscillator in IC17 to continue oscillating to give a colour display of the newsflash. Now short circuit together pins 7 and 8 of IC17 to allow the oscillator to free run, and adjust the crystal trimmer capacitor for the minimum beat of the colours in the displayed text. The oscillator is now correctly tuned, and the shorting link can be removed and PON reconnected.

Finally, the coil in the chroma filter on pin 11 of the TEA1002 should be adjusted for maximum colour burst amplitude at the TEA1002 output. This should correspond to minimum patterning on the teletext display.

PE1X MODIFICATION

Supplies of the TEA1002 are at present very limited. However, the PE1X can be used in place of the TEA1002.

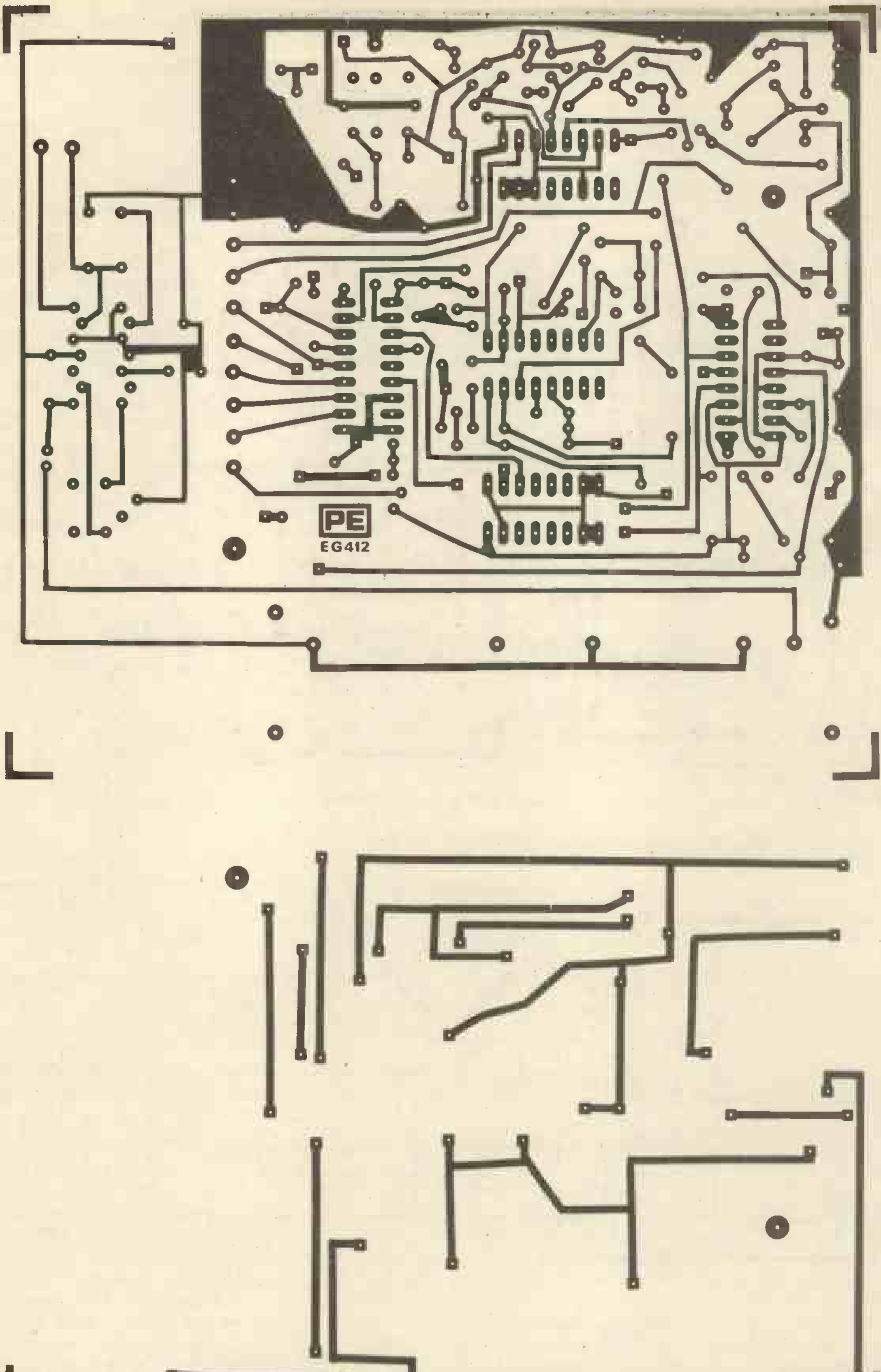


Fig. 3.2. Video Summer p.c.b. design

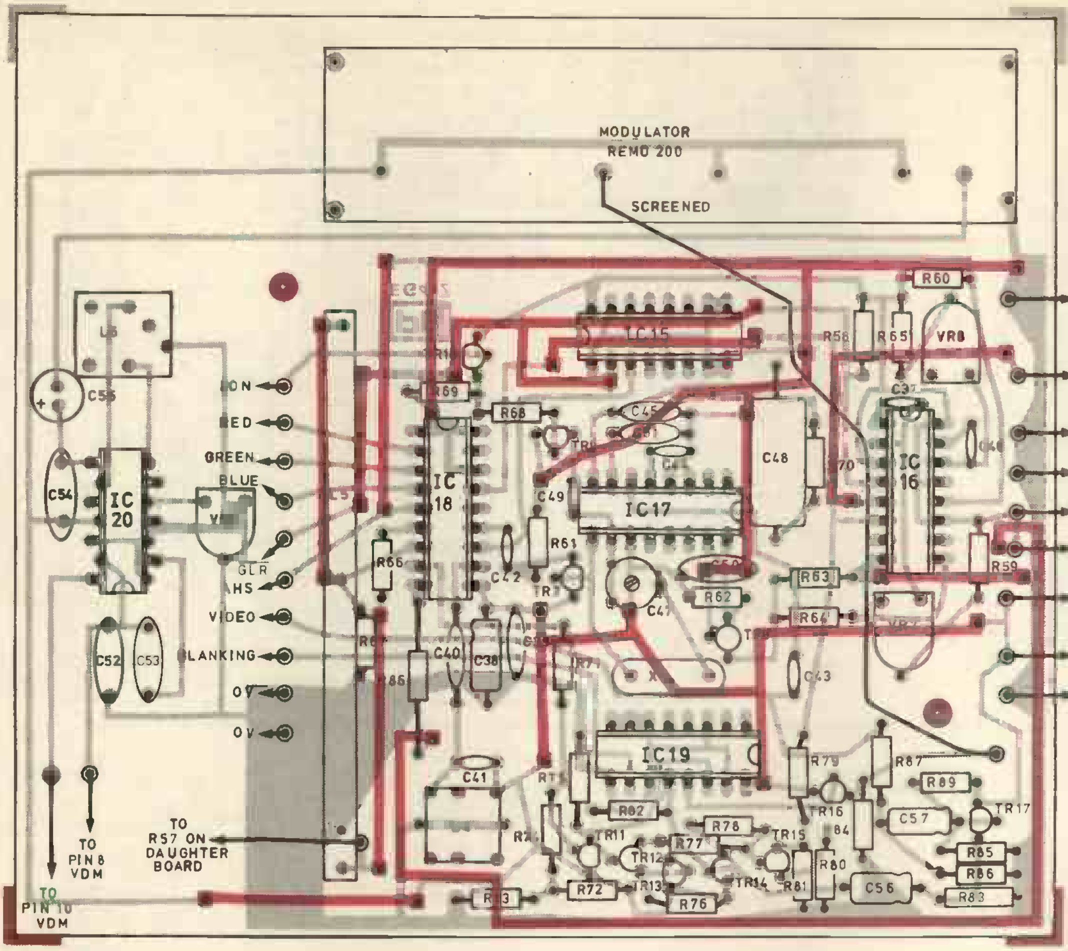


Fig. 3.3. Component layout

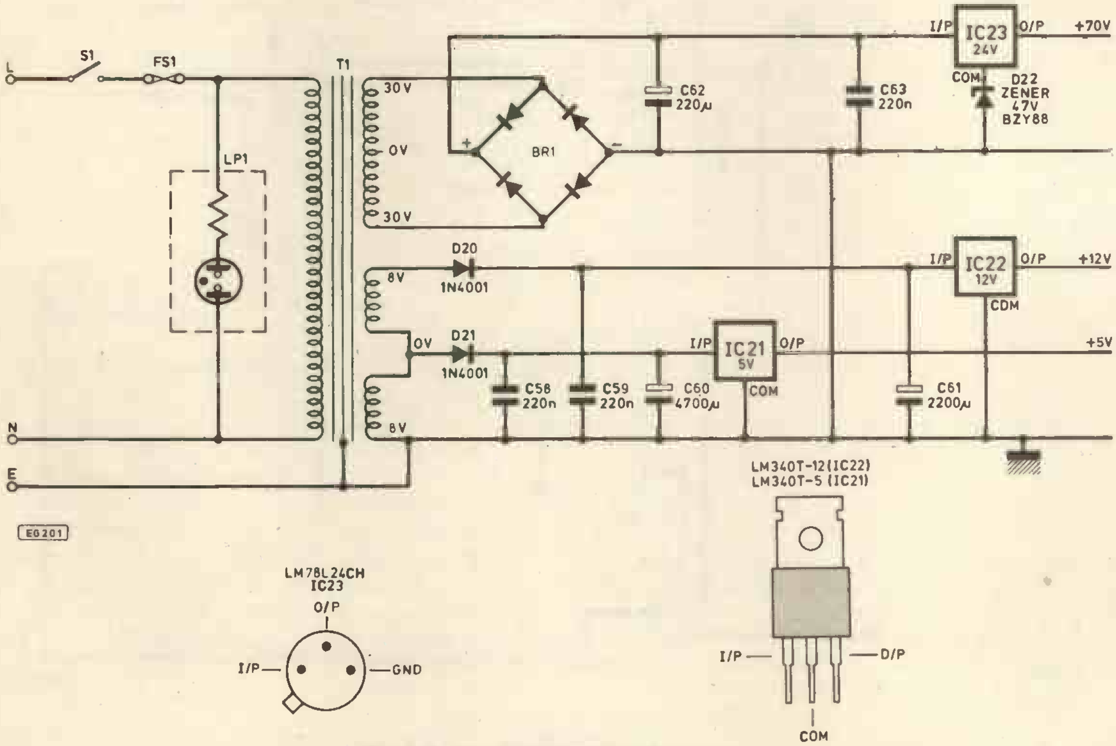
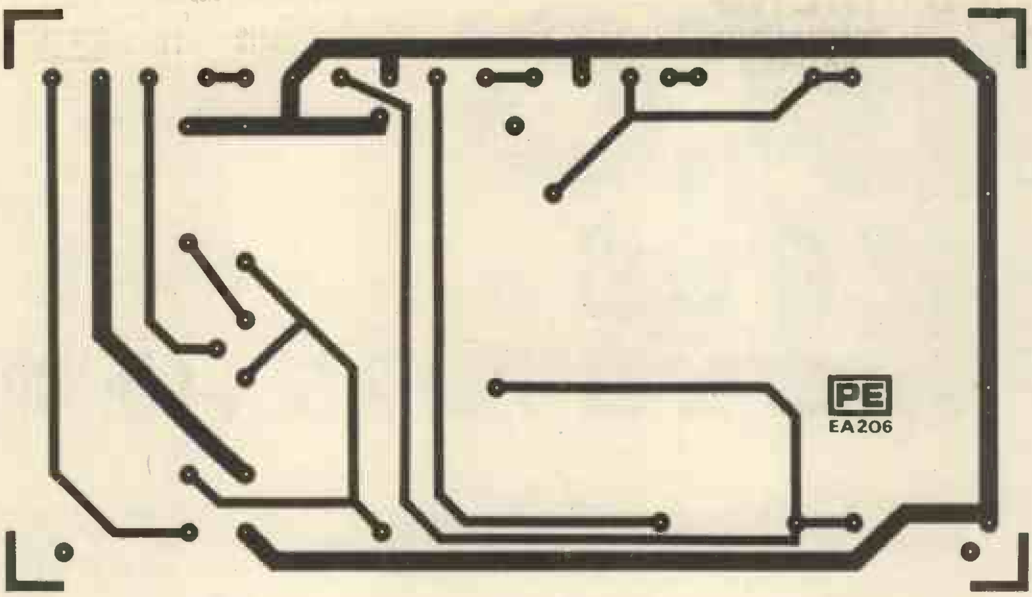


Fig. 3.4. Circuit diagram of the p.s.u.



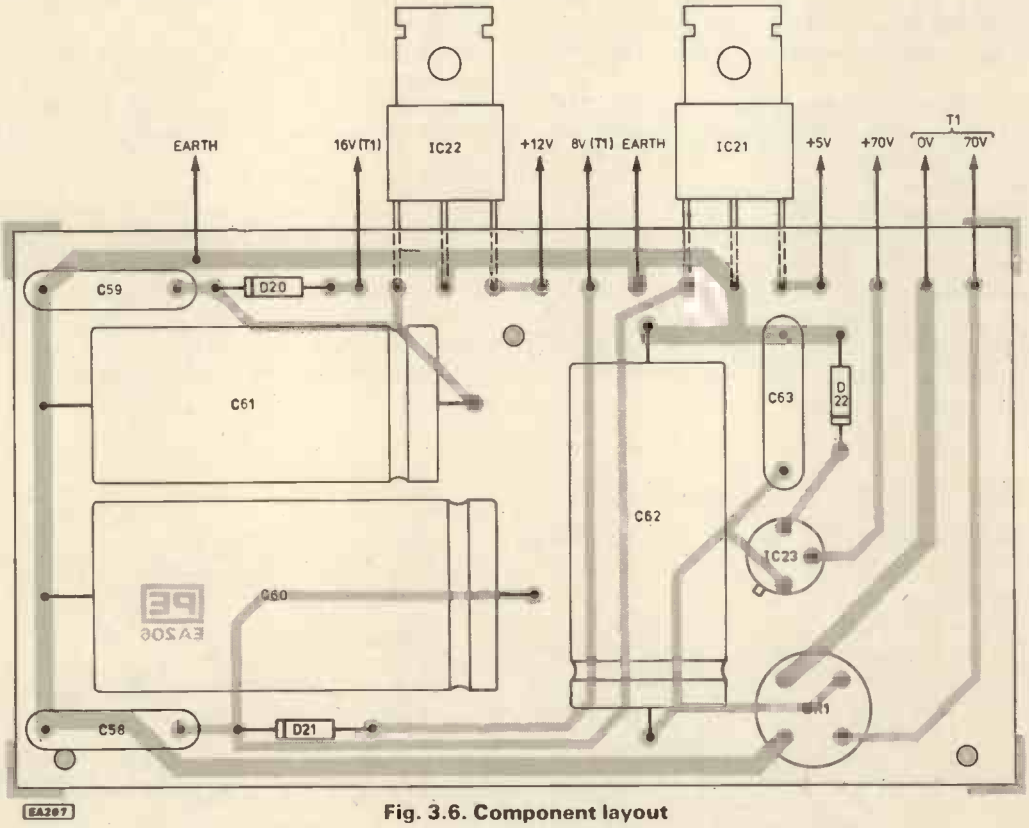


Fig. 3.6. Component layout

The PE1X which is similar to the TEA1002 although it does not have the BBC colour bar option. If the PE1X is used, then additional components are required to simulate the BBC colour bars provided by the TEA1002. This is done by ORing together the R, G and B signals with diodes and using this signal to inject an extra current into the lumminence channel at the delay line input. In addition, the PE1X has a 470Ω series resistor to pin 9.

The circuit diagram and the p.c.b. are shown for PE1X operation. If a TEA1002 is to be used then the series resistor R88 should be removed and pin 9 should be linked to 0V instead of 5V and the diodes D14 to D18 and resistor R57 should be removed from the daughter board.

POWER SUPPLY UNIT

The circuit diagram of the p.s.u. is shown in Fig. 3.4. Three output voltages are required by the decoder; +70V for the tuning voltage, with +12V and +5V for the TTL and CMOS.

The p.c.b. design is shown in Fig. 3.5 with the component layout in Fig. 3.6. The two voltage regulators (IC21, IC22) are mounted on the copper side of the board and their leads should be kept as long as possible. The p.c.b. is mounted at the rear of the case with the regulators bolted to the case.

Before connecting the p.s.u. to the system, carefully check the output voltage of each rail.

NEXT MONTH: WIRING AND TESTING

DISCO DESK Part 2 BEN DUNCAN

IN this part the circuits of cards 2 and 3 and the assembly of the former will be dealt with.

CARD 2

Fig. 6 includes the panel mounted components and the interwiring that lies between Cards 1 and 2. The panel mounted components, however, will be dealt with in greater detail later.

S1 and S2 are the source switches, S3 is the monitor PFL selector and VR1 is the crossfader. IC1 raises the disc or line input signal to line level and provides RIAA bass boost. A degree of rumble filtering is provided by C11, which causes the gain of the stage to fall below 20Hz. The output of IC1 feeds the tone control stage and also the Sound-to-Light output via a mixer. C17 and C23 control the degree of midrange variation; to reduce the midrange boost and cut, a lower value, typically 2n7 should be substituted. C25 provides d.c. isolation thereby ensuring that the tone controls are quiet in action. Instead, the d.c. bias current flows through R25.

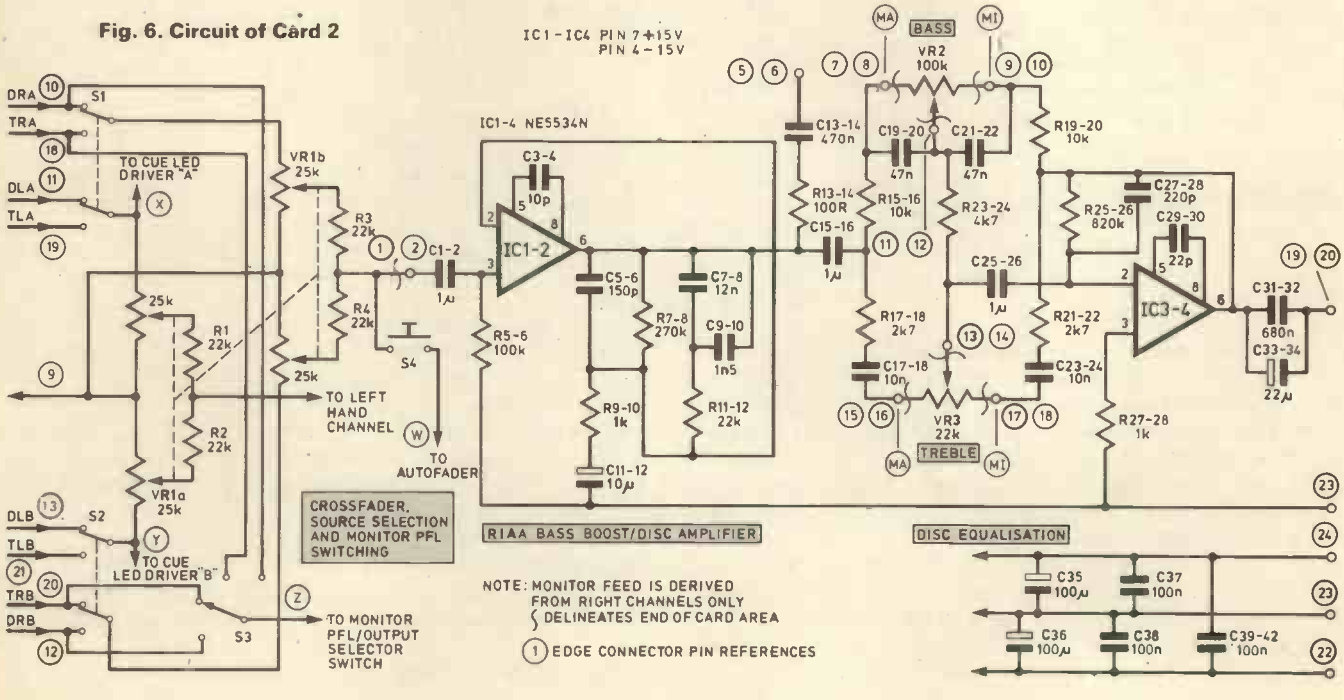
C27 provides lead compensation in order to achieve stability even when the wires leading to the tone controls are quite long. The value given is typical, and generally, for good performance it must be as small as possible. The precise value of C27 can only be determined when the completed unit is tested.

When wiring the board, keep the 'MA', 'CEN' and 'MI' tone control connection wires away from each other, and make the wiring as direct as possible. Again, use 16/0·2 wire for the 0V connection and screened cable for the inputs.

CARD 3 CIRCUIT

The microphone input stage shown in Fig. 8 is intended for high output unbalanced capacitor microphones with a typical output of 1·5mV/μBar. A 47V line is needed to power the integral preamplifier in most capacitor microphones, and this voltage appears at the input socket. For this reason, the rarely encountered 4 pin XLR is used to lessen the chance of accidental connection of other circuits or microphones to the 47V supply.

Fig. 6. Circuit of Card 2



CARD 2

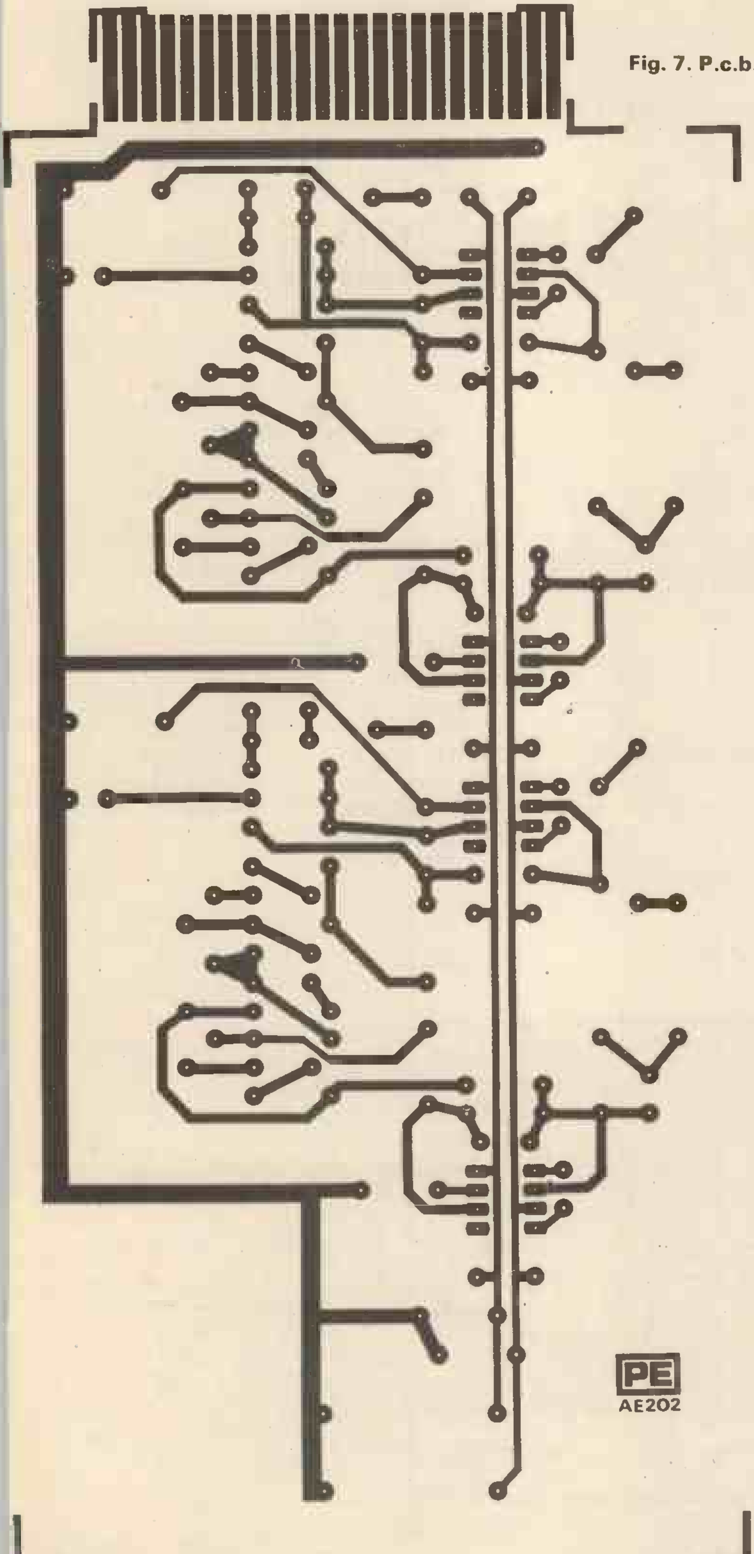
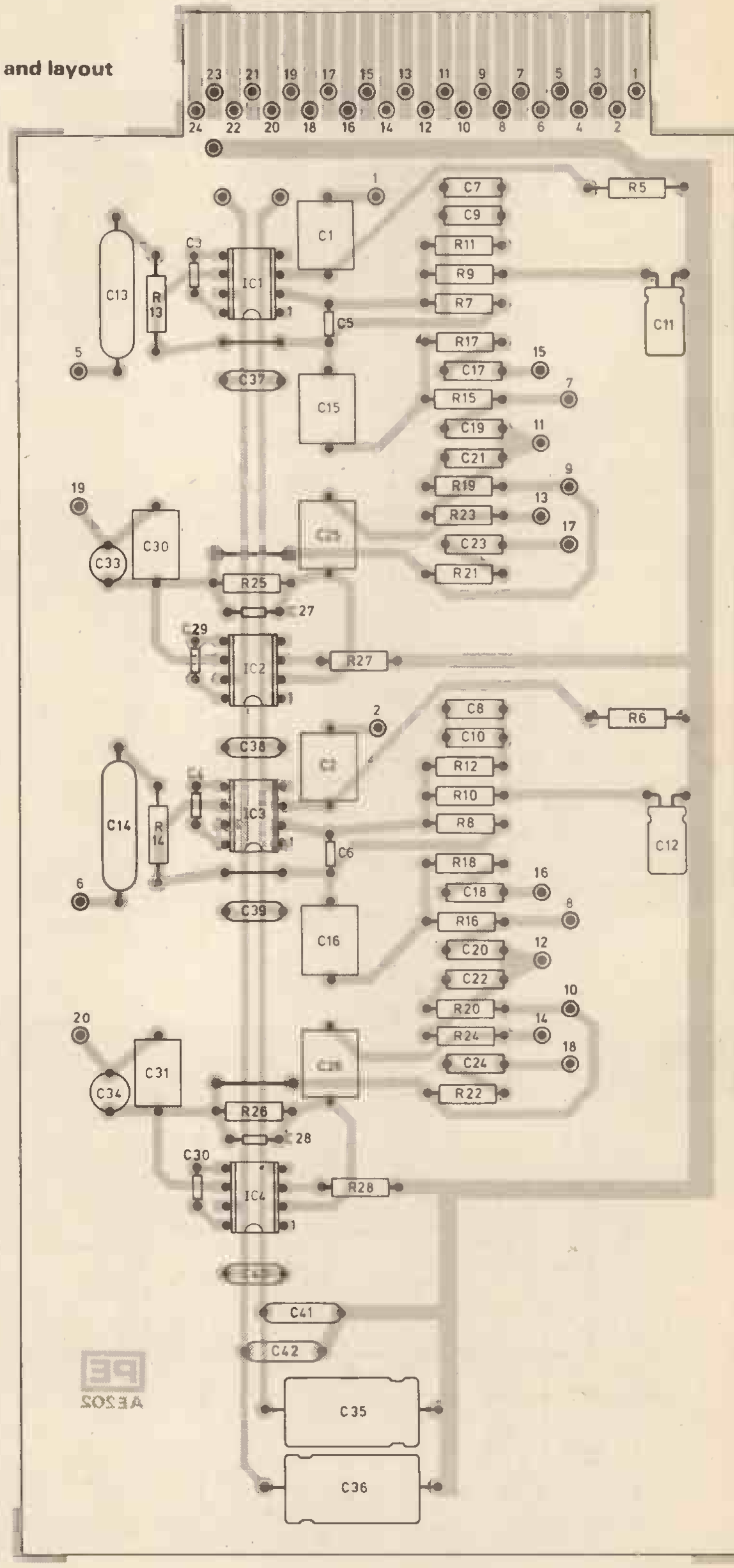


Fig. 7. P.c.b. and layout



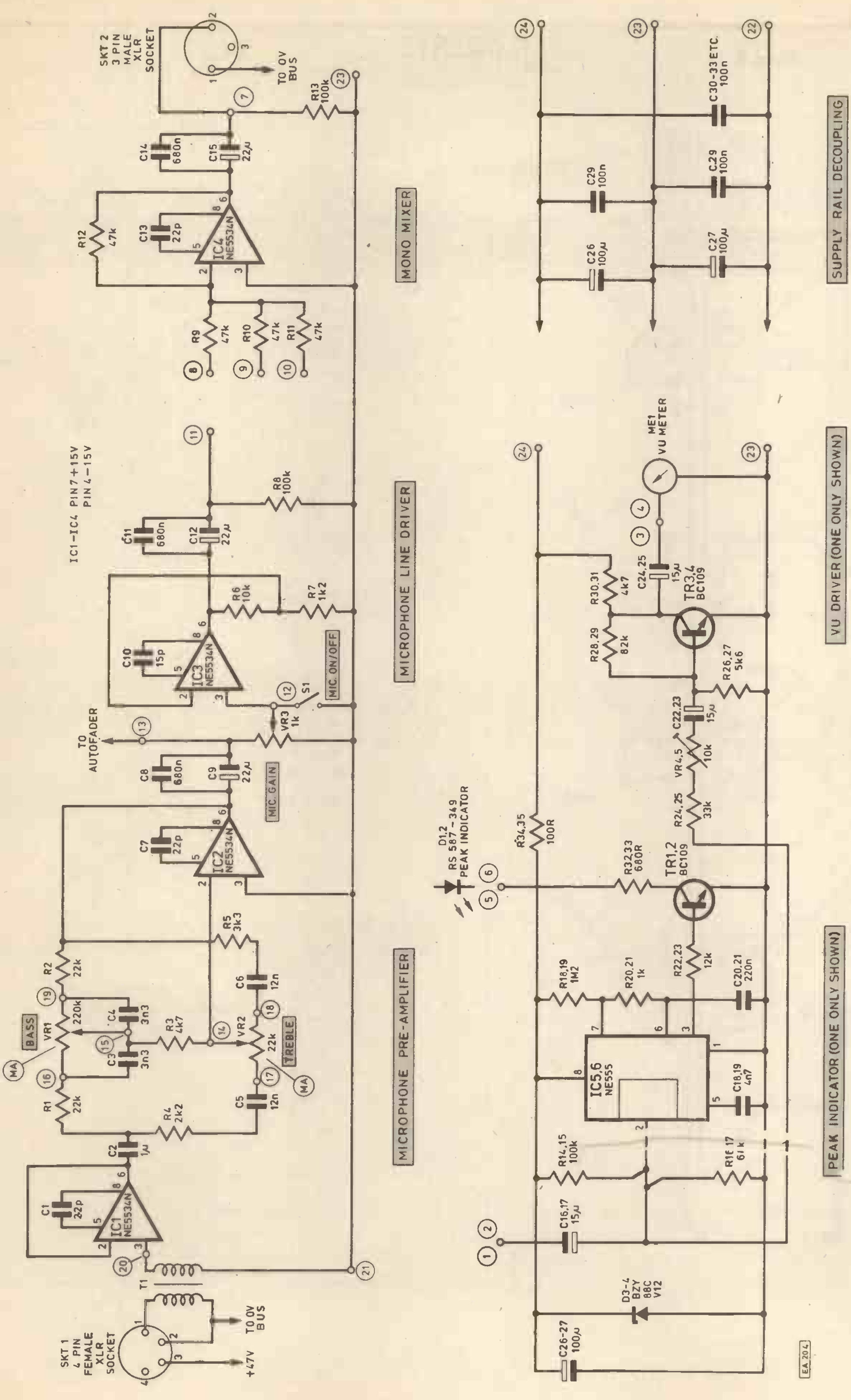


Fig. 8. Circuit of Card 3

COMPONENTS

Card 2

Resistors

R1—4	22k	Metal oxide, ½ watt, 2%
R5—6	100k	Metal oxide, ½ watt, 2%
R7, 8	270k	
R9, 10	1k	
R11, 12	22k	
R13, 14	100R	
R15, 16	10k	
R17, 18	2k7	
R19, 20	10k	
R21, 22	2k7	
R23, 24	4k7	
R25, 26	820k	
R27, 28	1k	

All ¼ watt, 5% unless otherwise specified

Potentiometers

VR1—25k quad slider pot with log/antilog tracks (Rivlin)
VR2—100k lin dual slider pot (Maplin type FX80B)
VR3—22k lin dual slider pot (Maplin type FX78K)

Capacitors

C1, 2	1µ polycarbonate
C3, 4	10p ceramic
C5, 6	150p ceramic or polystyrene
C7, 8	12n polycarbonate
C9, 10	1n5 polycarbonate
C11, 12	10µ, 25V PC electrolytic
C13, 14	470n polyester, C280AE series
C15, 16	1µ polycarbonate
C17, 18	10n polycarbonate
C19, 20	47n polycarbonate
C21, 22	47n polycarbonate
C23, 24	10n polycarbonate
C25, 26	1µ polycarbonate
C27, 28	220p ceramic (see text)
C29, 30	22p ceramic
C31, 32	680n polycarbonate
C33, 34	22µ, 25V p.c. electrolytic
C35, 36	100µ, 40V axial electrolytic
C37—42	100n polyester, C280AE series

Semiconductors

IC1—4	NE5534N

Miscellaneous

S1—2	'Min maka switch' with 3-way, 4-pole wafer (RS components, types 327—311 and 327—377)
S3	Min. rotary switch, 4-way, 3-pole
S4	Pushbutton illuminated switch with red lens and shield (RS 339—358, 339—409, 339—415), one each of these required

4 x 8 pin d.i.l. sockets
Pointer type collet knobs to suit above switches
Crossfader knob (Maplin type RX27E)
P.c.b.—RS type 434-150

Card 3

Resistors

R1—2	22k
R3	4k7
R4	2k2
R5	3k3
R6	10k
R7	1k2
R8	100k
R9—R12	47k
R13	47k
R14—15	100k
R16—17	68k
R18—19	1M2
R20—21	1k
R22—23	12k
R24—25	33k
R26—27	5k6
R28—29	82k
R30—31	4k7
R32—33	680R 1W
R34—35	100R 1W

All ¼W, 5% carbon unless otherwise stated

Capacitors

C1	22p ceramic
C2	1µ polycarbonate
C3, 4	3n3 polycarbonate
C5, 6	12n polycarbonate
C7	22p ceramic
C8	680n polycarbonate
C9	22µ, 25V PC electrolytic
C10	15p ceramic
C11	680n polycarbonate
C12	22µ, 25V PC electrolytic
C13	22p ceramic
C14	680n polycarbonate
C15	22µ, 25V PC electrolytic
C16, 17	15µ, 40V electrolytic, axial
C18, 19	4n7 polycarbonate
C20, 21	220n polycarbonate
C22, 23	15µ, 40V, axial electrolytic
C24, 25	15µ, 40V, axial electrolytic
C26, 27,	100µ, 40V, axial electrolytic
C28—33	100n polyester, C280AE series

Potentiometers

VR1	220k lin dual slide pot (Maplin type FX81C)
VR2	22k lin dual slide pot (Maplin type FX78K)
VR3	1k log dual slide pot (Maplin type HB00A)
VR4—5	10k enclosed cermet preset (RS components type 186-182)

Semiconductors

IC1—4	NE5534N
IC5—6	NE555
TR1—2	BC109
D1—2	Flush panel l.e.d. red (RS type 576-327)
D3—4	BZY88C-V12

Miscellaneous

SKT1	4 pin female XLR socket (see text)
SKT2	3 pin male XLR socket (Maplin type BW92A)
T1	Sowter microphone transformer (see text)

4 x 8 pin d.i.l. sockets
Kobs to suit slide pots (Maplin type F)
P.c.b.—RS type 434-150
VU meters—Maplin type RX53H (see text)
S1—Push-button illuminated switch, orange lens and shield (RS 339-358, 339-409, 339-415) see text (one each of the above required)

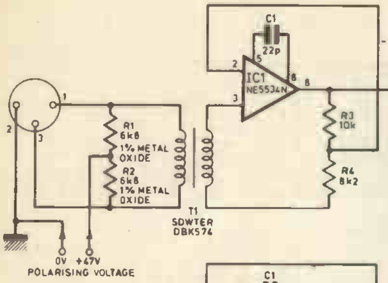


Fig. 9(a). For phantom powered capacitor microphones e.g. Calrec 1051C. Sensitivity 0·8mV/μBar

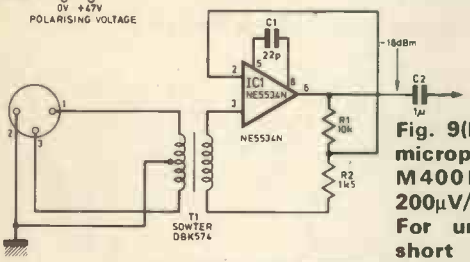


Fig. 9(b). For moving coil microphones e.g. Beyer M400NC. Sensitivity 200μV/μBar.
For unbalanced working short pins 2 and 3 on socket

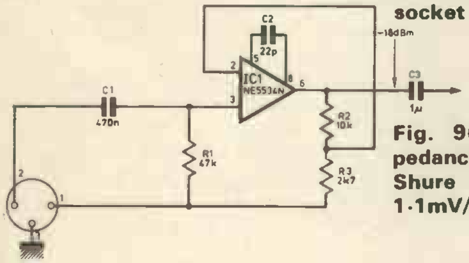


Fig. 9(c). For high impedance microphone e.g. Shure 515SA. Sensitivity 1·1mV/μBar

Card 2—Edge connector details

Pin No.	Connection	
1	Right input	from crossfader
2	Left input	
3	No connection	
4	No connection	
5	Right output to SLM mixer (8 on card 4)	
6	Left output to SLM mixer (7 on card 4)	
7	B.MA (R)	Tone controls, bass
8	B.MA (L)	
9	B.MI (R)	
10	B.MI (L)	
11	B.CEN (R)	
12	B.CEN (L)	
13	T.CEN (R)	Tone controls, treble
14	T.CEN (L)	
15	T.MA (R)	
16	T.MA (L)	
17	T.MI (R)	
18	T.MI (L)	
19	Right output to volume control	
20	Left output to volume control	
21	No connection	
22	−ve, 15V	To p.s.u busbar
23	0V	
24	+ve, 15V	

Abbreviations for tone control connection:
CEN—Centre (slider)
MA—Max boost position
MI—Min (cut) position
T—Treble pot
B—Bass pot

Fig. 9 shows alternative input circuit arrangements which will accommodate the vast majority of moving coil and phantom powered capacitor microphones. Phantom powering keeps the polarising voltage out of harm's way and thus the common 3 pin XLR socket can be used. All the circuits shown in Fig. 9 provide similar performance to the input stage in Fig. 8, and the output voltage for the quoted microphone sensitivities is identical.

To achieve a good overload margin, the signal is not brought to line level immediately. Instead, it passes through the equalisation stage (IC2 and associated components) and the gain control (VR3).

The tone control potentiometers are not isolated from the input bias current of IC2, as in Card 2, because they are usually preset before a performance. If this is not the case, then the arrangement shown in Fig. 6 can be applied, i.e., a 1μ isolating capacitor and an 820k resistor to derive the bias current from pin 6 on the op.amp.

IC3 is a line driver, providing amplification to line level and a low output impedance. The microphone signal passes to the send-return switch and socket (shown later) and then to the mono mixer (IC4), together with the stereo lines. R8 and R13 prevent switch clicks, etc., by holding the voltage on the output capacitors at ground potential, regardless of any offset voltages that may be present.

Also on Card 3 are the peak indicator l.e.d. and VU meter drivers. The 555 timer (IC5) is powered from the +15V rail because there are insufficient pins on the edge connector to provide a +12V rail.

This device can readily introduce noise on the supply rail when switching; C26 and R35 are provided to decouple switching noise generated by this device. IC5 operates in the monostable mode; R15 and R17 are set so that a signal in excess of 500mV applied to pin 2 causes triggering. Other signal levels can be accommodated by slight adjustments to the values of these resistors. Once triggered, IC5 turns TR1 and its associated l.e.d. on until C20 has charged (about 300ms), whence it returns to its stable state. The time delay provided by C20 allows the shortest transient peaks to be seen clearly.

Like the 555 timer, the peak indicator l.e.d.s can introduce noise on the supply rails, but in this case, because they are panel mounted, they can be fed from the auxiliary 12 volt supply. This supply does not feed any audio circuitry, apart from the monitor amplifier, thus noise levels on this rail are largely immaterial.

Professional VU meters have rigidly defined ballistics, frequency response and impedance and are designed to bridge 600 ohm lines directly. Panel space limitations prevented the use of such a meter, and a miniature meter with a VU scale was used. The genuine article is designed such that 0VU occurs at +4dBm, but the non-standard 0VU=0dBm was considered to be more useful. A VU driver was required to bring the level derived from stereo lines up to +4dBm, and cause 0VU deflection in the meter. TR3 provides such amplification and VR4 allows accurate calibration.

Test the circuit as before, connecting all inputs to 0V. Also connect pins 15 and 19 together to bias IC2 in the absence of VR1. To test the peak indicator, connect a l.e.d. to the +15V rail and pin 5. Although only the +15V rail is required to test this circuit, *both* rails must be connected, otherwise the op-amps will saturate and damage may result. Apply a 1kHz signal to pin 1 on the edge connector and raise the input level until the l.e.d. lights. Trimming of R15 and R17 may be necessary to achieve the desired indication level accurately. The VU driver is tested in a similar manner; in this case, a 776mV r.m.s. input signal should cause an 0VU reading.

Next Month: More circuits and boards.

PATENTS REVIEW...

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

HI-FI FILMING

New British patent application 2 031 690 from Polaroid Corporation of Cambridge, Massachusetts (filed under the New Laws and dating back to September 1978) describes a complex, but interesting microphone system for a home movie camera. The aim is to facilitate direct sound recording with an integrated camera, recorder and microphone system. Home movie cameras which record sound direct onto the magnetic stripe of conventional (but pre-striped) Super 8 film are already available and the patent application may mean that Polaroid intends to launch a sound version of the Polaroid instant movie system. This is called Polavision and uses a modified form of Super 8 colour film which is automatically developed in a table-top player with a back projection screen. So far Polavision has been only a silent system.

Home movie cameras produce a considerable amount of noise i.e. motor and claw whirr which spreads from 100Hz to 6000Hz with a peak at around 2000 Hz. As this peak is in the centre of the speech frequencies any camera noise recorded on the film soundtrack is a considerable nuisance. Polaroid suggest a microphone system capable of efficiently rejecting sound at a chosen frequency and angle of incidence. Figure 1 shows camera 17 with microphone 13 mounted on a boom and connected to a processing circuit 15. Figure 2 shows a design for circuit 15 which can be tuned to reject a selected sound spectrum in a solid cone angle marked by chain lines 22 in figure 1.

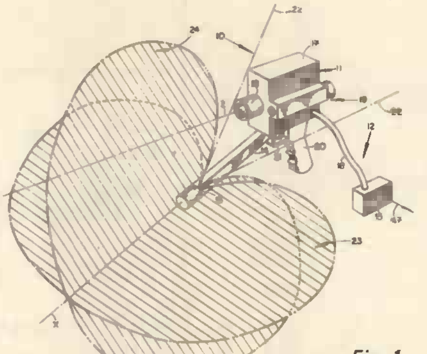
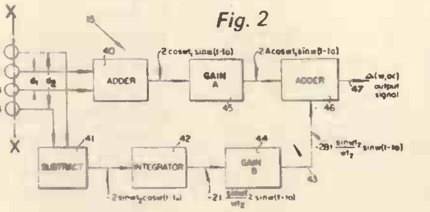


Fig. 1

Microphone 13 is in fact a linear ray of four omni-directional microphone elements M1, M2, M3 and M4, spaced apart (by distances D1, D2). An arriving sound wave thus produces four identical, but mutually phase shifted, output signals. In figure 2 summing channel 40 adds the signals from elements M2, M3 and subtractor 41 differences the signals from M1, M4. The output of subtractor 41 is integrated with respect to time, at 42 and combining means 46 adds the outputs from the summing and integrated channels. A gain control 44, 45 in each channel allows adjustment of the relative channel levels. The overall output, which appears on line 47, is recorded and can be reduced to zero at any desired frequency and angle of incidence by suitable selection of the relative gain at 44, 45 and the spacing D1, D2 between the elements. Extensive formulae are given in the patent to enable necessary calculations to be made.

Fig. 2



A three microphone stereo system, with filtering to reduce wind noise, is also described, (Figure 3). A means of adding and subtracting microphone inputs by mechanical rather than electrical means is suggested (Fig. 4). Two microphones 126, 128, are arranged with their diaphragm axis mutually at right angles. When the output of microphone 128 is integrated and added to the output of microphone 126, the response pattern obtained is similar to that obtained with the circuit of Figure 2.

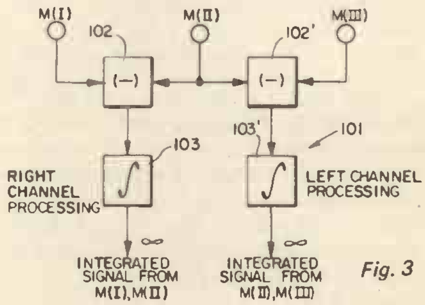


Fig. 3

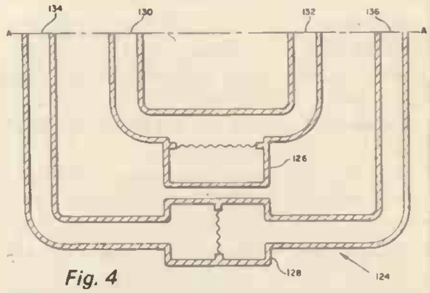


Fig. 4

POINTS ARISING

MICROPROMPT *(July 1980)*

Don't try running this as a program, it will not work. These lines contain corrections to the "LE PASSE-TEMPS" program. Our apologies for these errors.

```
  40  DIMS(44), T(11): POKE 53Ø, 1 : PRINT : GOTO 6Ø
  8Ø  E = Ø : F = Ø : G = Ø : FOR A = 1 TO 42 : S(A) = Ø :
        NEXT
 7Ø5  FOR A = Ø : TO 11 : T(A) = Ø : NEXT A
 73Ø  T(I) = T(I) + S(U)
 83Ø  FOR D = Ø TO 3 : T(I) = T(I) + S(N) : N = N + 6 :
        NEXT D : I = I + 1
 85Ø  FOR H = Ø TO I : D = T(H) : IF D = 4 THEN E = 1
 95Ø  FOR A = 1 TO 7 : IF S(A) = Ø THEN 97Ø
 98Ø  PRINT TAB (22—LEN (M$)/2) M$ ; CHR$ (13) ;
1Ø1Ø  IF MM = Ø THEN 1Ø4Ø
1Ø7Ø  IF G THEN G = Ø : S3 = S3 + 1 : GOTO 5Ø
```

Countdown

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

EMIX (Electronic Measuring Instruments Exhibition) Sept. 30, Oct. 1-2. Post House Hotel, Southampton. **I**
BEX (Business Equipment Exhibition) Oct. 1-2. The Guildhall, Plymouth. **K**
EMIX Oct. 7-8. Centre Hotel, Newcastle. **I**
Fire Alarms and Emergency Lighting — Some Modern Developments (IEETE event) Oct. 14. Thompson Arms, Sackville St., Manchester, at 7.15 p.m. **B3**
D.C. Servo Motors (IEETE event) Oct. 14. SSEB, 75 Waterloo Street, Glasgow, at 7 p.m. **B3**
EMIX Oct 14-15. Guildhall, Cambridge. **I**
Drive Electric Oct. 14-17. Wembley Conf. Centre, London. Organiser ☎ 01-834 2333.
Mailing Efficiency Exhibition Oct. 14-17. Cunard International Hotel, London. **Z**
BEX Oct. 15-16. Assembly Rooms, Edinburgh. **K**
Engineering Ireland Oct. 15-18. Leopardstown Exhibition Centre. **V**
Testmex (exhibition and conference) Oct. 28-30. Wembley Conf. Centre. **T**
Viewdata Exhibition for Professional & Business People Oct. 29-31. West Centre Hotel, London. **Z1**
Compec Nov. 4-6. Olympia. **Z1**
BEX Nov. 5-6. Sophia Gardens, Cardiff. **K**
London Business Equipment Exhibition Nov. 11-14. Cunard International Hotel, London. **Z**
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 Mar. 25–26. Metropole, Brighton. **K**
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**
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 Internation Exhibitions ☎ 0822 4671
V SDL Exhibitions, 68 Fitzwilliam Square, Dublin, Ireland
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
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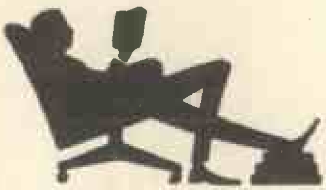

BOOK REVIEWS

THE PERSONAL COMPUTER BOOK
By Robin Bradbeer
Published by Input Two-Nine and distributed by MCB Publications Ltd., Bradford 499821.
220 pages. 147 × 210 mm. Price £5·25.

ANYONE who has had even the briefest encounter with the world of personal computers and its literature will probably have come across the name Robin Bradbeer. Few would be better placed to put a book of this nature together. A freelance writer on personal computing, senior lecturer at the Polytechnic of North London, and founder of the North London Computer Club, the author has produced an excellent book, packed with photographs and illustrations. This is truly a beginners' book, explaining the whole concept and meaning of the microcomputer revolution in simple terms. It goes on to explain languages, software and hardware, and most important of all—what you can do with a home computer once you have one!

The Personal Computer Book's greatest strength is probably the appendices, which are as follows: (a) Binary Arithmetic; Octal; Hexadecimal; ASCII Code; (b) Bus Standards, (c) Manufacturers and Distributors in the UK, (d) Computer Clubs in the UK, (e) Magazines in English, (f) Bibliography of Selected Computer Books, (g) Glossary, (h) Some Hints on Kit-Build Systems.

Having served as a thorough introduction to the subject of microcomputers, therefore, the work should continue to serve as a most handy source of reference.

News Briefs

CLUB NEWS

THE SCOTTISH Amateur Computer Society meet on the first Wednesday of every month in the Claremont Hotel, Claremont Crescent, Edinburgh, at 7.30 pm.

Details of the next meeting, and a copy of the latest newsletter may be obtained from:
Alastair Macpherson (Secretary)
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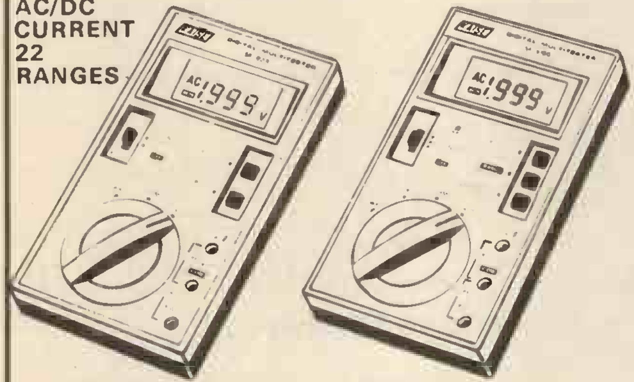

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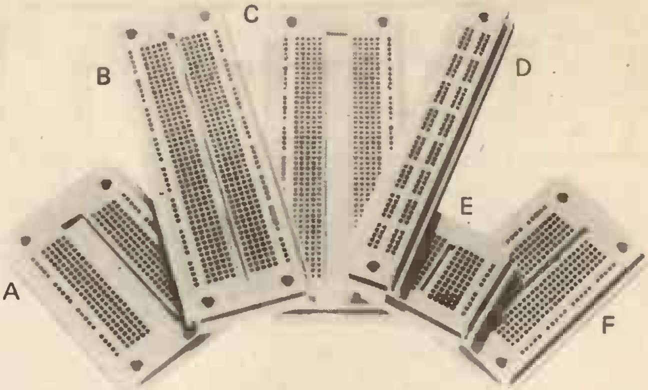

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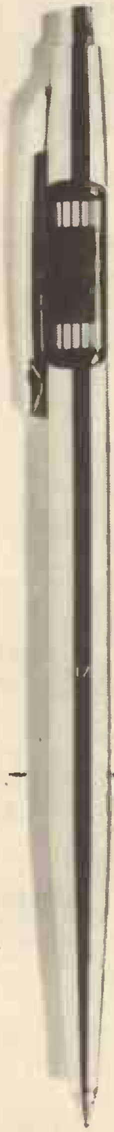


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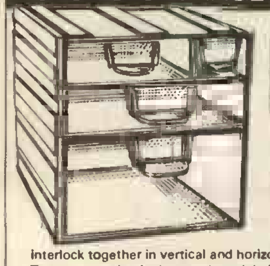

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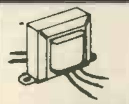

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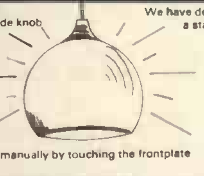
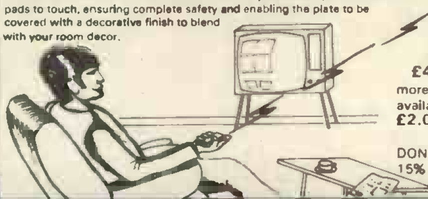


Two years ago TK Electronics launched a touchdimmer kit, the TD300K, which made knob controlled dimmers obsolete. This was such a great success that many magazines and more retailers soon produced similar designs. SO THAT OTHERS MAY FOLLOW. TK have designed a touch dimmer kit with an Infra Red Remote 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.

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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

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2X011		9+9	2.77			
2X012		12+12	2.08			
2X013		15+15	1.66			
2X014		18+18	1.38			
2X015		22+22	1.13			
2X016		25+25	1.00			
3X010	80	6+6	6.64	90×30mm	1.0	EACH £5.76 +£1.20 P&P +£1.04 VAT
3X011		9+9	4.44			
3X012		12+12	3.33			
3X013		15+15	2.66			
3X014		18+18	2.22			
3X015		22+22	1.81			
3X016		25+25	1.60			
3X028		110V	0.72			
3X029		220V	0.36			
3X030		240V	0.33			
4X010	120	6+6	10.00	90×40mm	1.2	EACH £6.72 +£1.30 P&P +£1.20 VAT
4X011		9+9	6.66			
4X012		12+12	5.00			
4X013		15+15	4.00			
4X014		18+18	3.33			
4X015		22+22	2.72			
4X016		25+25	2.40			
4X028		110V	1.09			
4X029		220V	0.54			
4X030		240V	0.50			
5X016	160	25+25	3.20	110×40mm	1.8	EACH £8.88 +£1.40 P&P +£1.54 VAT
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5X028		110V	1.45			
5X029		220V	0.72			
5X030		240V	0.66			
6X016	300	25+25	6.00	110×50mm	2.6	£12.27 +£2.50 P&P +£2.07 VAT
6X017		30+30	5.00			
6X018		35 + 35	4.28			
6X026		40 + 40	3.75			
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6X029		220V	1.36			
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For 220V Primary please insert 1 in place of X in type number. Example 120VA 240V 15 + 15V, 4A = 42013

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MINIATURE MAINS TRANSFORMERS. ALL 240VAC PRIMARY. 6-0-6 100mA, 9-0-9 75mA, 12-0-12 50mA all **75p** each. 12V 200mA **75p.** 6V 500mA **£1.10p** 0-6V-0-6V 280mA **£1.30.**

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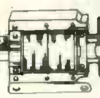

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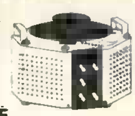

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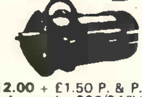
28rpm WYNSCALE motors approx. 20lb inch
71rpm WYNSCALE motor approx. 10lb inch
Above four motors are designed for 110V. A.C. supplied with auto transformer 240V. A.C. operation. **£9.25** p. & p. 75p. Total incl. VAT **£11.50.** N.M.S.

19 rpm FHP 220/240V. a.c. reversible, torque 14.5kg. Gear ratio 144-1. Brand new including capacitors. mf. CITENCO. Price: **£14.25** + £1.25 P. & P. (**£17.83** inclus. VAT). N.M.S.

30 rpm. 230/240V. a.c. 50lb. in. mf. **PARVALUX.** Price: **£15.00** + £1.50 P. & P. (**£18.98** inclus. VAT). N.M.S.

56 rpm. 240V. a.c. 50lb. in. 50Hz 0.7 amp. Shaft length 35mm. Dia. 16mm. Wt. 6kg. 600g. mf. **FRACMO.** Price: **£15.00** + £1.50 P. & P. (**£18.98** inclus. VAT). N.M.S.



100 rpm. 110V. a.c. 115lb. in., 50Hz. 2.8 amp. single phase split capacitor. Immense power.
Totally enclosed. In-line gearbox. Length 250mm. Dia. 135mm. Spindle dia. 15.5mm, length 145mm. Tested. Price: **£12.00** + £1.50 P. & P. (**£15.53** inclus. VAT). R. & T. Suitable Transformer for 230/240V operation. Price **£8.00** + 75p. P. & P. (**£10.06** inc. VAT).

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** inclus. tricity Board specification. Price **£9.50.**

230V a.c. FAN ASSEMBLY.

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 ali. 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**).

24V. D.C. REVERSIBLE MOTOR

Parvalux type SD12L, 24 D.C. shunt wound Motor, either 133 rpm 65lbs in Gearbox ratio 30:1. Current 6.8 amp. Rating continuous. Will operate on reduced power and speed at 9V D.C. or less. Size Dia. 16mm, Width 150mm, Shaft dia. 16mm. Price **£16.00** + £2.00 p. & p. (**£20.70** incl. VAT). N.M.S. or 60 rpm 100lb in rating. Price as above. N.M.S.
100W Rheostat 1 ohm speed control available **£6.90** (**£7.94** incl. VAT).

ROTARY CARBON VANE VACUUM & COMPRESSOR.

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.
Suitable transformer for 240V. op. **£10.00** P. & P. £2.00 (**£13.80** incl. VAT). N.M.S.

COMPRESSOR

Precision built USA. Horizontally opposed twin head diaphragm type producing 20lbs. approx. P.S.I. per head. 3.5 plus C.F.M. Output virtually pulse free. Powered by 110V A.C. motor size 30×23×15cm. Weight 7 kilos. Price **£25.00** + £2.00 P. & P. (Total Incl. VAT **£31.05**). N.M.S.
Suitable transformer for 240V op. **£8.00** P. & P. £1.50 (**£10.93** inc. VAT).

VERY EXCEPTIONAL OFFER REDUCTION DRIVE GEAR BOX.

Ratio 72:1. Input spindle ¼ x ½ in. Output spindle ⅜ x 3 in. long. Overall size approx: 120 x 98 x 68 mm. All metal construction. Ex-equip. tested. Price: **£2.00** + 50p. (incl VAT **£2.88**).

A.C. Wkg. TUBULAR CAPACITORS.

Fraction of makers price. Motor start etc.

1.5 mfd. 440V. A.C.	**60p**	7.5 mfd.	200V. A.C.	**£1.00**
2 mfd. 250V. A.C.	**60p**	10 mfd.	250V. A.C.	**£1.00**
2 mfd. 450V. A.C.	**75p**	10 mfd.	400V. A.C.	**£1.75**
2.2 mfd. 440V. A.C.	**75p**	14 mfd.	400V. A.C.	**£3.00**
3 mfd. 440V. A.C.	**£1.00**	15 mfd.	250V	
4.1 mfd. 440V. A.C.	**£1.00**	(Block)		**£1.50**
5 mfd. 400V. A.C.	**£1.25**	19 mfd.	280V. A.C.	**£2.00**
5.3 mfd. 160V. A.C.	**60p**	20 mfd.	250V. A.C.	**£2.25**
5.4 mfd. 280V. A.C.	**75p**	50 mfd.	370V.	**£5.00**
6.5 mfd. 280V. A.C.	**£1.00**		(Block)	

P. & P., up to 2.5 mfd. 25p. 3 mfd tp 20 mfd. 50p. 50 mfd. £1.50. All plus V.A.T. N.M.S.

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ERD Time switch 200/250V a.c. 30 amp contact 2 on/2 off every 24 hrs. at any manually pre-set time. 36 hour Spring Reserve and day omitting device. Built to highest Electricity Board specification. Price **£9.00.** P. & P. 75p (**£11.79**). R. & T.

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Type S251 200/250V. a.c 2 on/2 off every 24 hours. 20 amps contacts with override switch dia. 4 x 3 price **£8.50** P & P 50p inc. VAT **£10.35.** Also available with Solar dial. R. & T.

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