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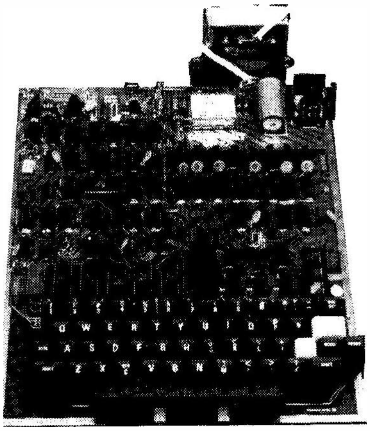

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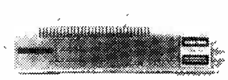

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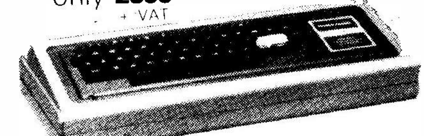

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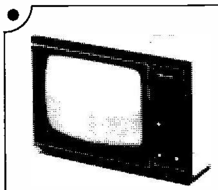

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VOLUME 16 No. 4 APRIL 1980

CONSTRUCTIONAL PROJECTS

GENERAL FEATURES

NEWS AND COMMENT

SPECIAL SUPPLEMENT

OUR MAY ISSUE WILL BE ON SALE FRIDAY, 11 APRIL 1980
(for details of contents see page 37)

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160V: 10nF, 12n, 39n, 100n, 150n, 220n **11p;** 330n, 470n **19p;** 680n, 1μF **22p;** 2·2μF **32p;** 4·7μF **36p.**
1000V: 10n, 15n **20p;** 22n **22p;** 47n **26p;** 100n **38p;** 470n **53p;** 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.**

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ELECTROLYTIC CAPACITORS: (Values are in μF).
500V: 10 **40p;** 47 **68p; 250V:** 100 **65p; 63V:** 0·47, 1·0, 1·5, 2·2, 2·5, 3·3, 4·7, 6·8, **8p;** 10, 15, 22 **10p;** 32, 47, 50 **12p;** 63, 100, **27p; 50V:** 50, 100, 220 **25p;** 470 **32p;** 1000 **60p; 40V:** 22, 33μF **8p;** 100 **12p;** 2200, 3300 **85p;** 4700 **98p; 35V:** 10, 33 **7p;** 330, 470 **32p;** 1000 **50p; 25V:** 10, 22, 47, 80, 100 **8p;** 160, 220, 250 **15p;** 470 **25p;** 640 1000 **35p;** 1500 **40p;** 2200 **45p;** 3300 **77p;** 4700 **85p; 16V:** 10, 40, 47 **7p;** 100, 125 **8p;** 220, 330 **14p;** 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:** 15,000 **399p;** 4700 **130p;** 4000 **92p;** 3300 **98p;** 2500, 2200 **90p;** 2000 + 2000 **120p; 30V:** 4700 **90p; 25V:** 15,000 **195p;** 6400 **120p;** 4700 **100p;** 3300 **85p;** 2200 **60p.**

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35V: 0·1μF, 0·22, 0·33, 0·47, 0·68, 1·0, 2·2μF, 3·3, 4·7, 6·8. **25V:** 1·5, 10. **20V:** 1·5μ. **16V:** 10μF **13p** each.
16V: 15μ, 22 **25p;** 47, 100, **50p;** 220 **70p; 10V:** 15μ, 22, 33 **20p;** 100 **35p; 6V:** 47μ, 68, 100 **25p; 3V:** 100 **20p.**

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ACY17	60	BC517	48	BRY39	39	TIP42A	64	2N2221A	23
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ACY20	53	BC549C	10	BSY95A	18	TIP121	90	2N2646	48
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AD162	42	BD121	78	MJ2955	90	TIS44	45	2N3053	20
AF114	60	BD123	98	MJE340	54	TIS45	45	2N3054	55
AF115	60	BD124	115	MJE370	58	TIS88A	35	2N3055	48
AF116	60	BD131	42	MJE371	54	TIS90	20	2N3442	140
AF117	70	BD132	42	MJE2955	105	TIS91	24	2N3504	55
AF118	75	BD133	50	MJE3055	70	ZTX107	11	2N3663	14
AF139	40	BD135	30	MPF102	66	ZTX108	11	2N3702	10
AF178	75	BD136	30	MPF103	36	ZTX109	11	2N3703	10
BC107	10	BD137	30	MPF104	36	ZTX212	28	2N3704	10
BC107B	12	BD138	35	MPF105	36	ZTX300	13	2N3705	10
BC108	10	BD139	30	MPF106	40	ZTX301	15	2N3706	10
BC108B	12	BD140	30	MPSA05	15	ZTX302	20	2N3707	10
BC108C	12	BD144	198	MPSA06	16	ZTX303	25	2N3708	11
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BC109B	12	BD205	110	MPSA55	22	ZTX314	24	2N3710	10
BC109C	12	BD245	50	MPSA56	22	ZTX320	30	2N3711	10
BC140	26	BD378	70	MPSU02	58	ZTX326	45	2N3771	179
BC142	26	BD434	32	MPSU05	50	ZTX341	20	2N3772	195
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BC147	9	BD695A	85	MPSU52	65	ZTX501	15	2N3819	20
BC147B	10	BD696A	85	MPSU55	55	ZTX502	17	2N3820	45
BC148	8	BDY56	170	MPSU56	60	ZTX503	15	2N3822	130
BC148B	10	BF115	26	OC23	170	ZTX504	25	2N3823	70
BC148C	10	BF167	30	OC26	170	ZTX531	25	2N3866	90
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BC149C	10	BF178	25	OC35	125	40250	85	2N3904	18
BC153	20	BF179	30	OC36	130	40251	97	2N3905	18
BC154	13	BF180	38	OC41	125	40311	60	2N3906	17
BC157	10	BF194	10	OC42	48	40313	125	2N4037	52
BC158	10	BF195	11	OC43	55	40315	55	2N4058	17
BC159	11	BF196	12	OC44	55	40316	85	2N4061	17
BC160	28	BF197	12	OC45	30	40317	52	2N4062	17
BC167A	11	BF198	16	OC70	35	40319	71	2N4069	45
BC168C	10	BF199	18	OC71	28	40320	56	2N4427	75
BC169C	10	BF200	29	OC72	35	40361	42	2N4829	65
BC170	15	BF256	50	OC74	50	40362	42	2N4859	65
BC171	11	BF244A	28	OC76	45	40406	65	2N4871	50
BC172	11	BF244B	29	OC81	35	40407	52	2N4922	55
BC173	11	BF245	24	OC82	50	40408	70	2N5135	42
BC177	15	BF256	45	OC83	48	40411	280	2N5136	42
BC178	14	BF257	30	OC84	45	40412	65	2N5138	20
BC179	15	BF258	28	OC140	110	40467	95	2N5172	25
BC181	10	BF259	28	OC170	85	40468	60	2N5179	60
BC182	10	BF274	38	OC171	45	40594	95	2N5180	80
BC183	10	BF336	35	OC200	48	40595	98	2N5191	70
BC184	10	BF594	30	TIP29	31	40603	90	2N5305	40
BC182L	10	BF595	30	TIP29A	44	40636	125	2N5457	32
BC183L	10	BF910	95	TIP29B	56	40673	67	2N5458	32
BC184L	10	BFR39	25	TIP29C	60	2N697	25	2N5459	32
BC187	22	BFR40	25	TIP30	32	2N698	40	2N5485	35
BC212	9	BFR41	24	TIP30A	50	2N699	30	2N5642	750
BC212L	9	BFR79	24	TIP30B	40	2N706A	19	2N5777	45
BC213	9	BFR80	24	TIP30C	43	2N708	19	2N6027	40
BC213L	9	BFR81	24	TIP31A	38	2N914	32	2N6109	50
BC214	10	BFR98	105	TIP31C	50	2N916	37	3N128	112
BC214L	10	BFX29	28	TIP32A	40	2N918	33	3N140	112
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AY-1-6721/6	195	LM379	375	SN76023ND	130
AY-3-1015	560	LM380	80	SN76033N	195
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CA3019	70	MC1303	88	TBA810S	95
CA3020	186	MC1304P	260	TBA820	70
CA3023	191	MC1310P	150	TBA920Q	260
CA3028A	80	MC1312PQ	195	TBA990Q	270
CA3035	235	MC1458	37	TCA965	120
CA3036	115	MC1495	350	TDA1004	290
CA3043	275	MC1496L	92	TDA1008	310
CA3045	365	MC1596	225	TDA1022	575
CA3046	210	MC1710	79	TDA1024	105
CA3048	214	MC3302	150	TDA2020	320
CA3075	213	MC3340P	120	TL061C	54
CA3080E	65	MC3360P	120	TL062CP	125
CA3081	190	MC3401	52	TL064CN	159
CA3089E	215	MC3405	150	TL071CP	45
CA3090AQ	375	MFC6040	97	TL072CP	90
CA3123	150	MK50398	635	TL074CN	140
CA3130	90	MM5303	635	TL081CP	42
CA3140	48	MM5307	1275	TL082CP	70
CA3160	95	MM57160	620	TL083CP	95
ICL7106	795	MSM5526	850	TL084CP	120
ICL7107	975	NE518	210	UAA170	150
ICL8038CC	340	NE543K	210	UAA180	150
ICM7205	1150	NE544	185	ZN414	80
ICM7215	1050	NE555	20	ZN424E	130
ICM7216A	1950	NE556DB	55	ZN425E	415
ICM7216B	1950	NE560	325	ZN1034	200
		NE561	395	ZN1040E	685
		NE562B	410		

COMPUTER IC'S

2102-2	225
2111	195
2112-2N	250
2114-250ns	520
2114-450ns	439
2708	675
4116 16K	1025
4047	750
6502	995
6802	980
6810	350
6821	525
6850	470
74S00	60
74S04	73
74S132	350
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
8060	TBA
8085	TBA
81LS95	125
81LS96	125
81LS97	137
AY-5-2376	980
CP1610	920
MC1488	85
MC1489	90
MC14411	958
MC14412	1080
MK4027 4K	325
MK4027-2	470
MK4027-3	445
MK4027-4	350
MK4116-4	1025
MK4118-4	2099
RO-3-2513	650
TMS2716 (3 rails)	1750
TMS 4027-25	325
TMS 4035	250
TMS 4039	250
TMS 4045	1083
Z80 CPU2·5	990
Z80 4M	1099
Z80 P10	660
Z80 CTC	595

VDU IC'S

AY-3-1015	550
SFS80102	205
SN74265	63
SN74LS163	118
SN74S262	895
SN75450	120
SN75451	70
SN75452	70
SN75454	225
TMS6011	355

TTL 74 (TEXAS)

7400	11	7473	20	74164	50
7401	11	7474	20	74165	50
7402	11	7475	23	74166	60
7403	12	7476	22	74167	110
7404	12	7480	38	74170	59
7405	13	7481	69	74172	340
7406	23	7482	49	74173	65
7407	30	7483	41	74174	50
7408	15	7484	80	74175	75
7409	15	7485	52	74176	50
7410	12	7486	16	74177	45
7411	14	7489	120	74178	53
7412	18	7490	23	74180	45
7413	21	7491	27	74181	110
7414	32	7492	28	74182	35
7416	23	7493	22	74184	105
7417	26	7494	40	74185	80
7420	14	7495	30	74188	175
7421	25	7496	34	74190	45
7422	19	7497	98	74191	45
7423	17	74100	75	74192	45
7425	16	74104	65	74193	45
7426	19	74105	65	74194	42
7427	19	74107	30	74195	40
7428	19	74109	32	74196	47
7430	12	74110	38	74197	80
7432	15	74111	50	74198	150
7433	20	74112	68	74199	150
7437	17	74116	120	74221	132
7438	17	74118	56	74246	204
7440	11	74119	89	74247	204
7441	52	74120	79	74248	240
7442	35	74121	25	74249	204
7443	50	74122	32	74251	125
7444	52	74123	35	74265	63
7445	43	74125	33	74273	320
7446	45	74126	32	74278	220
7447	43	74128	60	74279	119
7448	45	74132	41	74367	90
7450	15	74136	55	74368	75
7451	15	74141	45	74390	120
7453	15	74142	160	74298	185
7454	15	74143	250	75108	350
7460	13	74144	250	75150	175
7470	23	74145	50	75491	92
7472	23	74147	90	75492	92
		74148	80		
		74150	50		
		74151	37		
		74153	37		
		74154	59		
		74155	36		
		74156	36		
		74157	36		
		74159	120		
		74160	45		
		74161	45		
		74162	45		
		74163	45		

74L (TEXAS)

74L00	65
74L30	70
74L47	599
74L75	298
74L85	525
74L121	150
74L123	495

74LS

LS00	11	LS132	95	LS290	128
LS01	11	LS136	55	LS293	128
LS02	12	LS138	85	LS295	185
LS03	12	LS139	85	LS298	68
LS04	12	LS145	108	LS299	468
LS05	23	LS147	170	LS300	175
LS08	22	LS148	173	LS302	175
LS09	22	LS151	96	LS323	468
LS10	20	LS153	76	LS324	240
LS11	22	LS155	96	LS325	290
LS12	23	LS156	96	LS326	294
LS13	38	LS157	76	LS327	286
LS14	75	LS158	96	LS327	286
LS15	30	LS160	128	LS346	185
LS20	20	LS161	98	LS347	206
LS21	22	LS162	138	LS348	186
LS22	22	LS163	102	LS352	228
LS26	48	LS164	114	LS353	228
LS27	28	LS165	75	LS365	65
LS28	48	LS166	226	LS366	65
LS30	22	LS168	155	LS367	65
LS32	27	LS169	150	LS368	66
LS33	39	LS170	288	LS373	180
LS37	39	LS173	105	LS374	165
LS38	39	LS174	106	LS377	212
LS40	28	LS175	110	LS378	184
LS42	98	LS181	398	LS379	215
LS47	63	LS183	298	LS384	86
LS48	120	LS189	348	LS385	155
LS49	120	LS190	140	LS386	86
LS51	24	LS191	140	LS390	230
LS54	28	LS192	132	LS393	230
LS55	30	LS193	130	LS395	218
LS63	150	LS194	166	LS396	215
LS73	46	LS195	136	LS398	276
LS74	41	LS196	100	LS399	230
LS75	48	LS197	140	LS445	150
LS76	40	LS202	345	LS447	144
LS78	40	LS221	96	LS490	180
LS83	115	LS240	236	LS668	182
LS85	118	LS241	231	LS669	182
LS86	43	LS242	232	LS670	248
LS90	38	LS243	232	LS673	1050
LS91	104	LS244	155	LS674	1450
LS92	89	LS245	270	LS677	1050
LS93	89	LS247	190		
LS95	116	LS248	190		
LS96	116	LS249	190		
LS107	44	LS251	134		
LS109	55	LS253	142		
LS112	55	LS257	110		
LS113	50	LS258	110		
LS114	50	LS259	160		
LS122	70	LS261	450		
LS123	70	LS266	52		
LS124	180	LS273	244		
LS125	60	LS275	250		
LS126	60	LS279	66		
		LS280	250		

CMOS

4000	14	4014	80
4001	16	4015	82
4002	15	4016	45
4006	87	4017	79
4007	18	4018	87
4008	82	4019	48
4009	38	4020	99
4010	38	4021	105
4011	26	4022	95
4012	18	4023	22
4013	42	4024	66
		4025	19
		4026	180
		4027	45
		4028	81
		4029	99
		4030	58
		4031	205
		4032	100
		4033	145
		4034	216
		4035	111
		4036	335
		4037	100
		4038	108
		4039	320
		4040	105
		4041	80
		4042	75
		4043	94
		4044	95
		4045	145
		4046	128
		4047	87
		4048	58
		4049	48
		4050	48
		4051	72
		4052	73
		4053	72
		4054	110
		4055	128
		4056	135
		4057	1950
		4059	480
		4060	115
		4061	1425
		4062	995
		4063	110
		4066	58
		4067	380
		4068	22
		4069	20
		4070	32
		4071	21
		4072	21
		4073	21
		4075	23
		4076	85
		4077	40
		4078	21

CMOS (CONT.)

4081	20
4082	21
4085	74
4086	73
4089	150
4093	78
4094	190
4095	105
4096	105
4097	372
4098	110
4099	145
4160	109
4161	109
4162	109
4163	109
4174	110
4175	99
4194	108
4408	720
4409	720
4410	720
4411	958
4412V	1380
4415F	795
4415V	795
4419	280
4422	545
4433	995
4435	825
4440	1275
4450	295
4451	295
4452	
4490F	695
4490V	525
4501	19
4502	120
4503	69
4535	75
4506	51
4507	55
4508	298
4510	99
4511	150
4512	98
4513	206
4514	265
4515	299
4516	120
4517	382
4518	102
4519	55
4520	108
4521	228
4522	149
4526	149
4527	152
4528	99
4529	145
4530	85
4531	135
4532	115
4534	575
4536	365
4538	142
4539	105
4541	135
4543	155
4549	375
4550	398
4554	150
4556	72
4557	451
4558	105
4559	375
4560	210
4561	65
4562	533
4566	155
4568	268
4569	280
4572	26
4580	594
4581	297
4582	130
4583	75
4584	63
4585	105
40106	95

WATFORD ELECTRONICS

(Continued from opposite side)

DIODES

AA119	15
AA129	25
AAZ15	15
BA100	10
8A102	15
8Y100	24
BY126	12
8Y127	12
CRO33	157
OA9	75
OA47	12
OA70	12
OA79	12
OA81	15
OA85	12
OA90	6
OA91	6
OA95	8
OA200	9
OA202	8
IN914	4
IN916	5
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 6A/200V	30
0 8A30V	28
0·8A100V	30
0 8A200V	35
1A600V	70
5A300V	35
5A600V	43
8A300V	48
8A600V	85
12A300V	59
12A500V	92
12A800V	150
15A700V	195
8T106	150
8T116	150
C106D	38
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

MVAM115	140
BA102	25
BB104	40
BB105B	40
8B106	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
25A/400V	160
25A/800V	295
T2800D	120

DIAC

ST2 20

SPEAKERS

8Ω 0·3W	
2", 2½"	75
2·5; 3"	75
40Ω 2·5"	88
64 Ω 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
4×2¾×1½"	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

OPTO ELECTRONICS

LEDS Plus. Clip

TIL209 Red 125"	13
TIL211 Grn 125"	18
TIL212 Yellow	22
TIL2200 2" Red	15
0 2" Yellow, green and Amber	18
Rectangular LEDS. Red, Green and Yellow	36
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 (Red Displays)

TIL312 & 313 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
FND357	120
XAN351 .3" Green C.A.	150
Bargraph 10 seg. Red	225

Liquid Crystal Display
3½ digit **875p;** 4 digit **975p**

VEROBOARD

	Pitch 0·1 (copper clad)	0·15 (copper clad)	0·1 (plain)	0·15 (plain)
2½×3¾"	46p	39p	31p	24p
2½×5"	55p	50p	—	31p
3¾×3¾"	55p	50p	—	—
3¾×5"	62p	67p	50p	43p
3¾×17"	218p	180p	141p	120
4¾×17"	280p	—	—	183p

Pkt of 36 pins **20p** VQ board **129p**
Spot face cutter **105p** DIP board **290p**
Pin insertion tool **140p** Veroblock **324p**

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

FERRIC CHLORIDE
1 lb bag Anhydrous
95p + 35p P&P

EURO BREADBOARD
£5.20

DALO ETCH RESIST
Pen + Spare tip 75p

BIMBOARDS
£8.58

COPPER CLAD BOARDS

Fibre Glass	Single-sided	Double-sided	SRBP
6"×6"	75p	90p	9·5"×8·5" 80p
6"×12"	130p	175p	

SOLDERCON PINS
100 pins **50p:** 500 pins **200p**

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	65p		7905	75p
12V	7812	65p		7912	75p
15V	7815	65p		7915	75p
18V	7818	65p		7918	75p
24V	7824	65p			
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:**

SWITCHES

SLIDE 250V

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

PUSH BUTTON
Spring loaded
Latching

SPST on off	60
SPDT C/over	65
DPDT 6 Tag	85

TOGGLE 2A 250V

SPST	28
DPST	34
DPDT	38
4 pole on off	54

SUB-MIN TOGGLE

SP changeover	59
SPST on off	54
SPST 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**
Push to change cover momentary **85p**

ROCKER: 5A, 250V, SPST **30p**

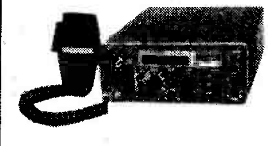
ROCKER: (white) 5A 250V SP change-over centre off **50p**

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

ROTARY: "Make-A-Switch" Make your own multiway Switch as required. Shafting assembly has adjustable stop.
Accommodates up to 6 Wafers **78p**
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 **54p**
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 **41**

ROTARY: Mains 250V AC, 4 Amp **50**



Freq: 144.000MHz to 144.995.
Chanl: 800 (5KHz step)
Ant. Imp: 50Ω unbalanced
Power Source: 13.6V DC (11.5 to 16V) 6A, —ve ground.
Transmitter: PPL controlled
Automatic Voltage Reg.
RF Output: 25 High, 5W Low.

Freq. Stab: 0.0005%
Deviation: ±5KHz (max.) Var reactance system.
Off-set Freq: ±600KHz for repeater
Tone burst freq: 1750Hz
Comm. System: Simplex & semiduplex
Dim: 185 x 285 x 75mm.
Receiver has monolithic ceramic filter & variable squelch control.
Circuit: Double Superheterodyne
Inter. Freq: 1st 10.7MHz, 2nd 455KHz
Sensitivity: Better than −6db for 20db NQ
Freq. Stab: 0.0005%
A.F. Output Power: More than 2W
Dynamic microphone has curly lead.
Price: only **£210.** (£1 P&P).

CRYSTALS

		6·5536MHz	200p
100kHz	323p	7·680MHz	323p
455kHz	385p	8 867MHz	323p
1MHz	323p	9·375MHz	323p
1·008MHz	323p	10MHz	323p
1·80MHz	385p	10·7MHz	323p
1·832MHz	362p	12MHz	392p
1·6MHz	395p	14·318118M	300p
3·2768MHz	323p	18MHz	323p
4MHz	290p	18·432M	392p
4·032MHz	323p	20MHz	362p
4·433619M	135p	27·648MHz	350p
5·0MHz	355p	48MHz	323p
26 69MHz	390p	100MHz	300p

UHF Modulator **250p**
Wide Bandwidth Modulator Special for Computers **450p**
Power Supplies, Readybuilt:
+6V + 0.5A **£14.95**
±12V + 0.25A **£14.95**

KEYPADS, 4 × 4 matrix, Reed switch assembly **350p**
Full ASCII Keyboard
Model 756 **£39.95**

DIL PLUGS (Headers)
14 pin **35p** 24 pin **85p**
16 pin **39p** 40 pin

DIL PLUGS (Headers)
14 pin **35p;** 24 pin **85p**
16 pin **39p;** 40 pin —

'D' CONNECTORS
(Cannon type)
(Special introductory prices)

	Plugs	Sockets	Covers plastic
9 way	70p	90p	—
15 way	95p	125p	114p
25 way	140p	198p	128p
37 way	210p	295p	135p

DIL switches (SPST)
4 way **110p**
6 way **120p**
8 way **145p**

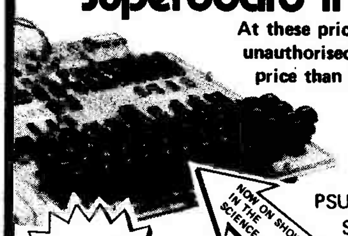
EDGE CONNECTORS double type

	·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	120p
2×36 way	194p	—
2×40 way	210p	160p
2×43 way	232p	160p

TRANSFORMERS (mains Prim. 220-240V)
6-0-6V 100mA; 9-0-9V 75mA, 12-0-12V 75mA **95p.**
8VA type: 6V-·5A 6V-·5A; 9V-·4A 9V-·4A; 12V-·3A 12V-·3A; 15V-·25A 15V-·25A **195p.**
12VA: 4·5-1·3A 4 5V-1·3A; 6V-1·2A 6V-1·2A 12V-·5A 12V-·5A **235p** (20p 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 **290p** (45p 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** (50p 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** (60p p&p)
(N.B. P&P charge to be added above our normal postal charge.)

PE PROJECTS: Rhythm Generator, Diamatics modem, Temp. Controller, etc. Send SAE for list.

Superboard II



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610 Expansion Board 8k RAM **ONLY £149.95** + VAT
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Plastic Case, Beige **ONLY £26**+VAT
Challenger IP-Metal Cased, Superboard, PSU modulator **ONLY £188**+VAT

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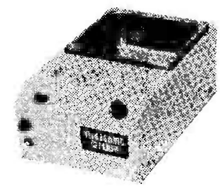

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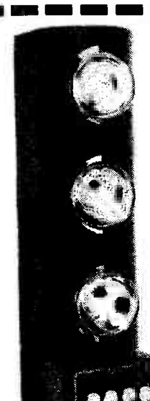

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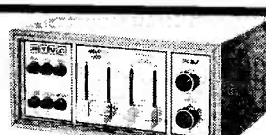

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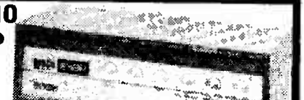

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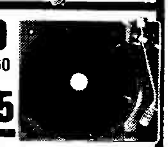

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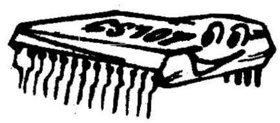

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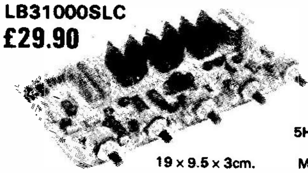

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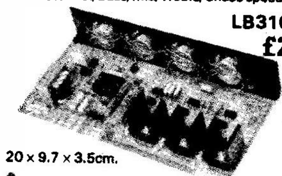

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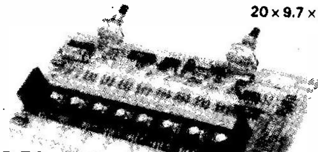

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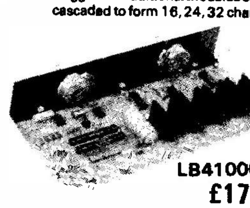

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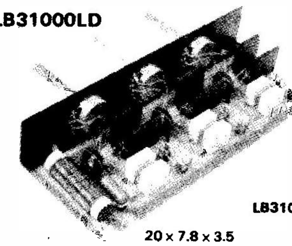

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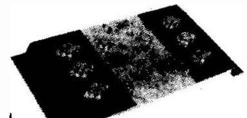

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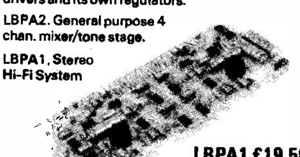

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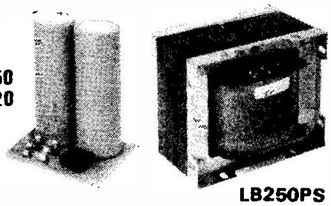

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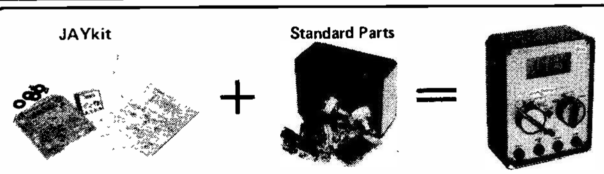

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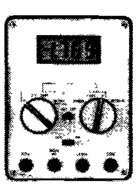

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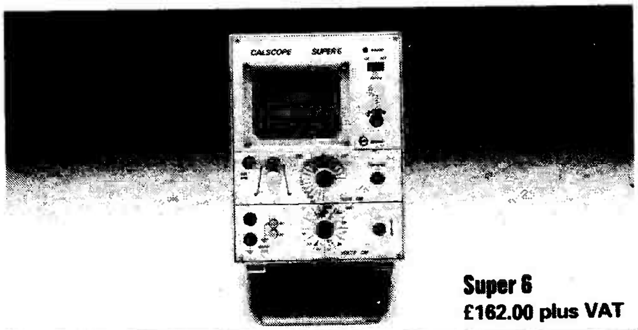

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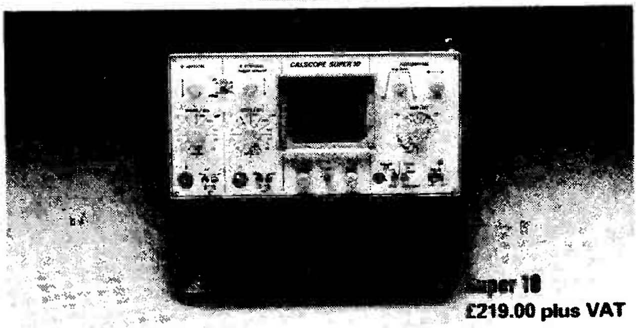

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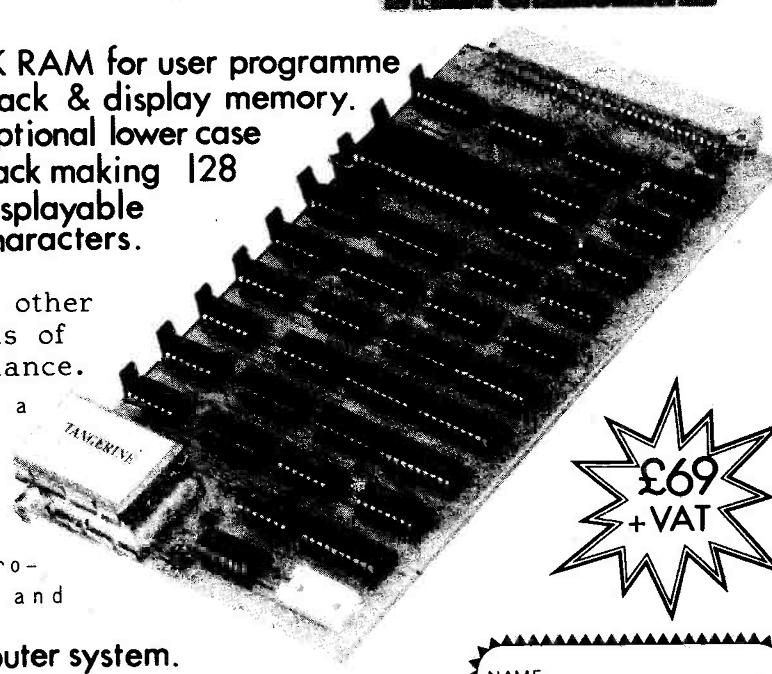

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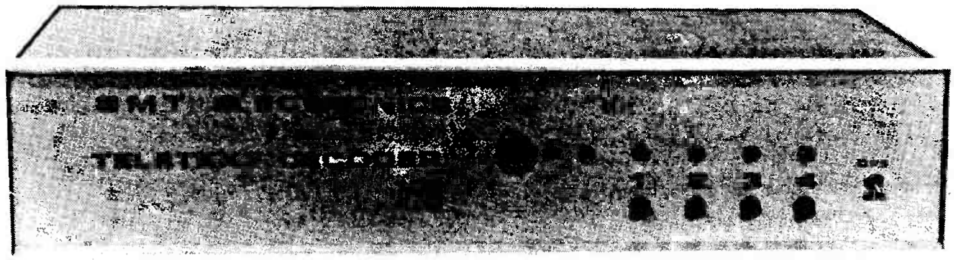

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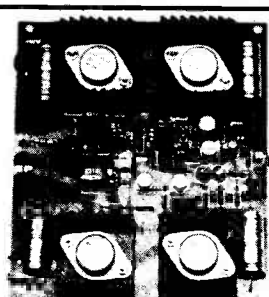
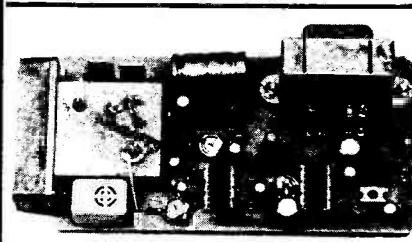


Bring your HI-FI up to date. Available now is a 100 watt audio amplifier using POWERMOSFETS. The POWER MOSFET has several advantages over bipolar transistors. It has good frequency response, no carrier storage delay, thermal stability, no secondary breakdown, and high input impedance.
The MOSFET Amplifier has been designed to deliver a continuous power output of 100 watts with full heatsinking into 8 ohms from 5 Hz to 100 kHz with no more than 0.01% total harmonic distortion, which is about a tenfold improvement on ordinary bipolar techniques. The high output impedance and thermal stability of the MOSFET reduces the size of the total circuit by about 30%. The kit does not include a case.

POWER MOSFET AMPLIFIER MODULE **£27.50**

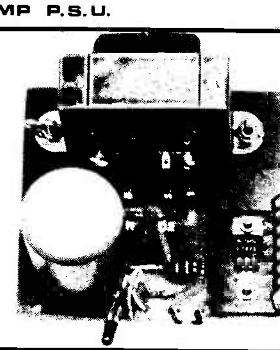
DOPPLER RADAR ALARM



Do your goodies need protecting? No need to run miles of wire, and hack window and door frames to pieces. Just build a Doppler Radar Alarm kit. It can be mains or battery operated (external battery required), and is triggered by any movement in its detection area. It incorporates an arming delay - to enable you to leave its detection field safely, and a trigger delay (0 to 45 seconds), so you can catch the thief red handed without a prior warning having been given.
The unit provides a 12 volt output, normally high (low on alarm), to supply an external remote relay, which is not supplied. The unit has an integral buzzer to give an indication when the unit is being armed, and when triggering is complete.
The unit comes complete with a suitable case.

DOPPLER RADAR ALARM **£39.50**

1 AMP P.S.U.

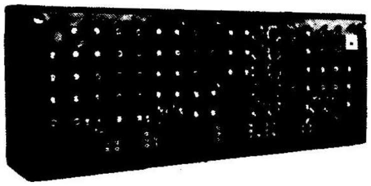


Need a one amp power supply at five volts or twelve volts? Fed up with lash ups? Here is a basic 'no frills' 1 amp P.S.U. kit, based on the well known ua7800 series three terminal regulators. When assembled, all components, including the transformer are mounted on the printed circuit board.
Use the module as a bench power supply, or as part of a piece of equipment.

1 AMP PSU - 5 VOLTS **£6.00**

1 AMP PSU - 12 VOLTS **£7.50**

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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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.

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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 component kits, PCBs and layout charts — KIT 86-5 — **£27.99**
Set text photocopies — **£1.84**

P.E. STRING ENSEMBLE

A multivoiced polyphonic string instrument synthesiser.

Set of basic component kits, PCBs & layout charts — KIT 77-8 — **£92.89**

P.E. JOANNA PLUS ORGAN VOICING

A modified version of the P.E. 5-octave piano that retains all the original facilities and includes switchable organ voicing circuitry.

Set of basic component kits, PCBs & layout charts — KIT71-7 — **£119.87**
"Sound Design" booklet — **£1.00**

ELEKTOR ELECTRONIC PIANO

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 components and PCBs (as published) — KIT 80-9 — **£136.41**
Additional 3-octave extension and basic parts and PCBs (as published) — KIT 80-10 — **£54.62**
Set of text photocopies — **£1.81**

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 — **£76.92**
"Sound Design" booklet — **£1.00**

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.

Main Unit basic component kits, PCBs & layout charts — KIT 23-31 — **£101.43**
Keyboard Unit basic component kits, PCBs & layout charts — KIT 23-32 — **£60.47**
Main Unit set of text photocopies — **£5.91**
Keyboard Unit set of text photocopies — **£2.30**

ELEKTOR FORMANT SYNTHESISER

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

Set of basic component kits, PCBs (as published) — KIT 66-14 — **£247.60**
Set of text photocopies — **£7.83**

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 parts with foot switches, PCB & layout chart — KIT 42-3 — **£10.02**
Text photocopy — **28p**

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 component kit and PCB (as published) — KIT 78-3 — **£53.68**
Extension unit basic component kit and PCB (as published) — KIT 78-4 — **£48.85**
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 — **£4.31**
Text photocopy — **67p**

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 component kits, PCBs & layout charts — KIT 85-5 — **£54.37**
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 — **£10.14**
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 components, PCB & layout chart — KIT 70-2 — **£21.67**
Text photocopy — **67p**

P.E. PHASING UNIT

A simple but effective manually controlled phasing unit.

Basic components, PCB & chart — KIT 25-1 — **£3.52**
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PHASING CONTROL UNIT

For use with Phasing Kit 25 to automatically control rate of phasing.

Basic components, PCB & chart — KIT 36-1 — **£5.21**
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P.E. SWITCHED TONE TREBLE BOOST

Provides switched selection of 4 preset tonal responses.

Basic components, PCB & chart — KIT 89-1 — **£3.82**
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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 — **£2.76**

ELEKTOR RESONANCE FILTER

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

Set of basic components & PCB (as published) — KIT 82-2 — **£19.90**
Text photocopy — **57p**

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.

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P.E. SMOOTH FUZZ

Basic components, PCB & chart — KIT 91-1 — **£5.01**
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TREMOLO UNIT

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

Basic components, PCB & chart — KIT 54-1 — **£3.23**

GUITAR FREQUENCY DOUBLER

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

Basic components, PCB & chart — KIT 74-1 — **£4.97**
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P.E. GUITAR SUSTAIN

Maintains the natural attack whilst extending note duration.

Basic components, PCB & chart — KIT 75-1 — **£5.64**
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P.E. WAH-WAH UNIT

Can be controlled manually or by integral automatic control.

Basic components, PCB & chart — KIT 51-1 — **£3.99**

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Automatically gives Wah or Swell sounds with each note played.

Basic components, PCB & chart — KIT 58-1 — **£8.43**
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P.E. V.C.F.

A voltage controlled filter extracted from P.E. Minisonic project.

Basic components, PCB & chart — KIT-65-1 — **£7.88**

P.E. RING MODULATOR

Extracted from P.E. Minisonic project.

Basic components, PCB & chart — KIT 59-1 — **£6.05**

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

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A slightly modified version of the original P.E. unit.
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Extracted from P.E. 6-channel mixer.
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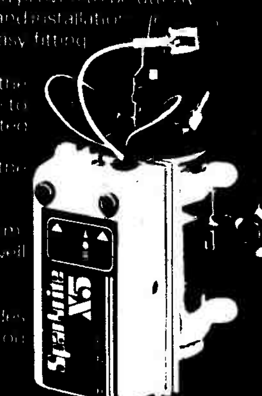

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AC134	£0.23
AC137	£0.23
AC141	£0.25
AC141K	£0.35
AC142	£0.23
AC176	£0.21
AC176K	£0.30
AC178	£0.29
AC179	£0.29
AC180	£0.23
AC180K	£0.32
AC181	£0.23
AC181K	£0.32
AC187	£0.21
AC187K	£0.32
AC188	£0.21
AC188K	£0.32
AD140	£0.69
AD142	£0.98
AD143	£0.86
AD149	£0.69
AD161	£0.40
AD162	£0.40
AD161/162MP	£0.81
AF124	£0.35
AF125	£0.35
AF126	£0.35
AF127	£0.37
AF139	£0.40
AF186	£0.58
AF239	£0.47
AL102	£1.38
AL103	£1.36
AU104	£1.61
AU110	£1.61
AU113	£1.61
BC107A	£0.09
BC107B	£0.10
BC107C	£0.12
BC108A	£0.09
BC108B	£0.11
BC108C	£0.12
BC109A	£0.09
BC109B	£0.10
BC109C	£0.12
BC147	£0.08

Type	Price
BC148	£0.08
BC149	£0.08
BC157	£0.12
BC158	£0.12
BC159	£0.12
BC167	£0.14
BC168	£0.14
BC169	£0.10
BC169C	£0.12
BC170	£0.10
BC171	£0.10
BC172	£0.10
BC173	£0.10
BC177	£0.18
BC178	£0.18
BC179	£0.18
BC180	£0.29
BC181	£0.10
BC182L	£0.10
BC183	£0.10
BC183L	£0.10
BC184	£0.10
BC207	£0.13
BC208	£0.13
BC209	£0.14
BC212	£0.10
BC212L	£0.10
BC213	£0.10
BC213L	£0.10
BC214	£0.10
BC214L	£0.10
BC227	£0.18
BC238	£0.10
BC251	£0.17
BC251A	£0.18
BC301	£0.32
BC302	£0.33
BC303	£0.32
BC304	£0.44
BC327	£0.18
BC328	£0.17
BC337	£0.17
BC338	£0.17
BC440	£0.35
BC441	£0.35
BC460	£0.44
BC461	£0.44
BC477	£0.23
BC478	£0.23
BC479	£0.29
BC547	£0.12
BC548	£0.12

Type	Price
BC549	£0.12
BC550	£0.16
BC556	£0.16
BC557	£0.15
BC558	£0.14
BC559	£0.16
BD115	£0.58
BD116	£0.92
BD121	£0.75
BD124	£0.81
BD131	£0.40
BD132	£0.40
BD133	£0.46
BD135	£0.44
BD136	£0.40
BD137	£0.40
BD138	£0.41
BD139	£0.41
BD140	£0.41
BD155	£0.92
BD175	£0.69
BD176	£0.69
BD177	£0.78
BD178	£0.78
BD179	£0.86
BD203	£0.92
BD204	£0.92
BDY20	£0.92
BF457	£0.43
BF458	£0.43
BF459	£0.44
BF594	£0.35
BF596	£0.32
BFR39	£0.28
BFR40	£0.29
BFR79	£0.28
BFR80	£0.32
BFX29	£0.25
BFX30	£0.35
BFX84	£0.25
BFX85	£0.28
BFX86	£0.29
BFX87	£0.25
BFX88	£0.25
BFY50	£0.20
BFY51	£0.20
BFY52	£0.20
BIP19	£0.44
BIP20	£0.44
BIP19/20MP	£0.92
BRY39	£0.51

Type	Price
BU105	£1.84
BU105/02	£2.24
BU204	£1.61
BU205	£1.61
BU208/02	£2.58
MJE2955	£1.04
MJE3055	£0.69
MJE3440	£0.60
MPF102	£0.40
MPF104	£0.40
MPF105	£0.40
MPSA05	£0.23
MPSA06	£0.23
MPSA55	£0.23
MPSA56	£0.23
OC22	£1.73
OC23	£1.73
OC24	£1.55
OC25	£1.15
OC26	£1.15
OC28	£0.92
OC29	£1.09
OC35	£1.03
OC36	£1.03
OC70	£0.27
OC71	£0.17
TIC44	£0.33
TIC45	£0.40
TIP29A	£0.46
TIP29B	£0.48
TIP29C	£0.51
TIP30A	£0.46
TIP30B	£0.48
TIP30C	£0.50
TIP31A	£0.46
TIP31B	£0.48
TIP31C	£0.50
TIP32A	£0.46
TIP32B	£0.48
TIP32C	£0.50
TIP41A	£0.50
TIP41B	£0.52
TIP41C	£0.55
TIP42A	£0.50
TIP42B	£0.52
TIP42C	£0.55
TIP2955	£0.69
TIS43	£0.25
TIS90	£0.20
UT46	£0.23
ZTX107	£0.11

Type	Price
ZTX108	£0.11
ZTX109	£0.11
ZTX300	£0.13
ZTX500	£0.14
2N1613	£0.23
2N1711	£0.23
2N1889	£0.51
2N1890	£0.51
2N1893	£0.35
2N2147	£0.86
2N2148	£0.81
2N2160	£1.15
2N2192	£0.44
2N2193	£0.44
2N2194	£0.44
2N2217	£0.25
2N2218	£0.25
2N2218A	£0.23
2N2219	£0.23
2N2219A	£0.25
2N2904	£0.23
2N2904A	£0.24
2N2905	£0.20
2N2905A	£0.23
2N2906	£0.18
2N2906A	£0.21
2N2907	£0.23
2N2907A	£0.25
2N2926G	£0.10
2N2926Y	£0.09
2N29260	£0.09
2N2926R	£0.09
2N2926B	£0.09
2N3053	£0.20
2N3054	£0.46
2N3055	£0.46
2N3614	£1.15
2N3615	£1.21
2N3616	£1.21
2N3646	£0.10
2N3702	£0.09
2N3703	£0.09
2N3704	£0.08
2N3705	£0.08
2N3706	£0.09
2N3707	£0.09
2N3708	£0.08
2N3709	£0.08
2N3710	£0.08
2N3711	£0.08
2N3819	£0.21
2N3820	£0.40

74 SERIES TTL

Type	Price	Type	Price	Type	Price	Type	Price	Type	Price
7400	£0.10	7427	£0.27	7472	£0.23	74105	£0.43	74163	£0.71
7401	£0.12	7428	£0.29	7473	£0.28	74107	£0.27	74164	£0.78
7402	£0.12	7430	£0.12	7474	£0.28	74110	£0.41	74165	£0.78
7403	£0.12	7432	£0.25	7475	£0.33	74111	£0.66	74166	£0.89
7404	£0.12	7433	£0.34	7476	£0.28	74118	£0.92	74174	£0.74
7405	£0.12	7437	£0.25	7480	£0.50	74119	£1.35	74175	£0.71
7406	£0.25	7438	£0.24	7481	£0.97	74121	£0.27	74176	£0.66
7407	£0.25	7440	£0.13	7482	£0.78	74122	£0.44	74177	£0.66
7408	£0.14	7441	£0.57	7483	£0.66	74123	£0.46	74180	£1.72
7409	£0.14	7442	£0.46	7484	£1.01	74136	£0.59	74181	£0.66
7410	£0.12	7443	£0.80	7485	£0.78	74141	£0.63	74182	£0.80
7411	£0.19	7444	£0.80	7486	£0.25	74145	£0.63	74184	£0.80
7412	£0.17	7445	£0.74	7489	£1.95	74150	£0.78	74190	£0.78
7413	£0.27	7446	£0.69	7490	£0.36	74151	£0.55	74191	£0.71
7414	£0.57	7447	£0.55	7491	£0.73	74153	£0.55	74192	£0.69
7416	£0.26	7448	£0.64	7492	£0.40	74154	£0.94	74193	£0.66
7417	£0.26	7450	£0.12	7493	£0.34	74155	£0.57	74194	£0.71
7420	£0.12	7451	£0.12	7494	£0.86	74156	£0.57	74195	£0.69
7421	£0.23	7453	£0.12	7495	£0.57	74157	£0.57	74196	£1.20
7422	£0.18	7454	£0.12	7496	£0.57	74160	£0.66	74197	£1.20
7423	£0.24	7460	£0.12	74100	£0.97	74161	£0.71	74198	£2.12
7425	£0.21	7470	£0.28	74104	£0.44	74162	£0.71	74199	£2.12
7426	£0.26								

CMOS ICs

Type	Price	Type	Price	Type	Price	Type	Price	Type	Price
CD4000	£0.16	CD4015	£0.87	CD4026	£1.38	CD4043	£1.01	CD4070	£0.19
CD4001	£0.22	CD4016	£0.48	CD4027	£0.57	CD4044	£0.94	CD4071	£0.19
CD4002	£0.18	CD4017	£0.86	CD4028	£0.78	CD4045	£1.61	CD4072	£0.19
CD4006	£1.05	CD4018	£0.97	CD4029	£0.97	CD4046	£1.49	CD4081	£0.19
CD4007	£0.19	CD4019	£0.48	CD4030	£0.55	CD4047	£1.00	CD4082	£0.19
CD4008	£1.05	CD4020	£1.03	CD4031	£2.30	CD4049	£0.48	CD4510	£1.13
CD4009	£0.51	CD4021	£0.94	CD4035	£1.15	CD4050	£0.48	CD4511	£1.09
CD4010	£0.55	CD4022	£0.94	CD4037	£1.09	CD4054	£1.26	CD4516	£1.15
CD4011	£0.22	CD4023	£0.17	CD4040	£1.01	CD4055	£1.15	CD4518	£1.15
CD4012	£0.18	CD4024	£0.74	CD4041	£0.87	CD4056	£1.55	CD4520	£1.15
CD4013	£0.48	CD4025	£0.17	CD4042	£0.82	CD4069	£0.19	CD4014	£0.92

LINEAR

Type	Price	Type	Price	Type	Price	Type	Price	Type	Price
CA3011	£0.92	CA3130	£1.06	MC1496	£1.03	72711	£0.36	SL414A	£2.24
CA3014	£1.55	CA3140	£0.80	NE536	£3.05	UA723C	£0.52	TAA550B	£0.40
CA3018	£0.74	CA3065E	£0.95	NE550	£1.09	72723	£0.52	TAA621A	£2.30
CA3020	£1.95	LM301	£0.33	NE555	£0.23	UA741C	£0.27	TAA621B	£2.87
CA3028	£0.92	LM304	£1.84	NE556	£0.69	72741	£0.27	TAA661	£1.72
CA3035	£1.61	LM308	£1.15	NE565	£1.38	741P	£0.20	TAO100	£1.49
CA3036	£1.15	LM309	£1.72	NE566	£1.38	UA7447C	£0.69	TBA540	£2.41
CA3042	£1.72	LM380	£0.97	NE567	£1.95	72747	£0.69	TBA810S	£0.86
CA3043	£2.12	LM381	£1.66	UA702C	£0.52	UA748	£0.40	TBA810	£1.12
CA3046	£0.80	LM3900	£0.66	72702	£0.52	72748	£0.40	TBA820	£0.80
CA3052	£1.84	MC1303L	£0.97	UA703	£0.28	748P	£0.40	TBA9200	£2.87
CA3054	£1.26	MC1304	£2.18	UA709	£0.28	SN76013N	£2.01	TCA270S	£2.30
CA3075	£1.72	MC1310	£1.09	72709	£0.52	SN76023	£2.01	TBA800	£0.92
CA3081	£1.72	MC1312	£2.18	709P	£0.28	SN76110	£1.72	TBA120	£0.60
CA3089	£2.30	MC1350	£1.38	UA710C	£0.46	SN76115	£2.18	TBA641A	£1.84
CA3090	£4.14	MC1352	£1.61	72710	£0.34	SN762260N	£0.95	TBA642B	£2.53
CA3123	£2.18	MC1469	£3.39	UA711C	£0.36	SN76660	£0.86	ZN414	£1.15

THYRISTORS

Volts No.	Price
10 THY600ma/10v	£0.17
20 THY600ma/20v	£0.18
30 THY600ma/30v	£0.23
50 THY600ma/50v	£0.25
100 THY600ma/100v	£0.29
200 THY600ma/200v	£0.44
400 THY600ma/400v	£0.51

Volts No.	Price
50 THY1A/50	£0.29
100 THY1A/100	£0.32
200 THY1A/200	£0.36
400 THY1A/400	£0.43
600 THY1A/600	£0.51
800 THY1A/800	£0.66

Volts No.	Price
50 THY3A/50	£0.32
100 THY3A/100	£0.34
200 THY3A/200	£0.37
400 THY3A/400	£0.48
600 THY3A/600	£0.57
800 THY3A/800	£0.74

Volts No.	Price
50 THY5A/50	£0.41
100 THY5A/100	£0.51
200 THY5A/200	£0.57
400 THY5A/400	£0.65
600 THY5A/600	£0.79
800 THY5A/800	£0.93

Volts No.	Price
50 THY7A/50	£0.55
100 THY7A/100	£0.58
200 THY7A/200	£0.65
400 THY7A/400	£0.71
600 THY7A/600	£0.89
800 THY7A/800	£1.05

Volts No.	Price
50 THY10A/50	£0.58
100 THY10A/100	£0.65
200 THY10A/200	£0.71
400 THY10A/400	£0.80
600 THY10A/600	£1.13
800 THY10A/800	£1.40

Volts No.	Price
50 THY16A/50	£0.62
100 THY16A/100	£0.66
200 THY16A/200	£0.71
400 THY16A/400	£0.88
600 THY16A/600	£1.03
800 THY16A/800	£1.59

Volts No.	Price
50 THY30A/50v	£1.36
100 THY30A/100v	£1.64
200 THY30A/200v	£1.87
400 THY30A/400v	£2.06
600 THY30A/600v	£4.03

BT101/500R **£0.92.** BT102/500R **£0.92.** BT106 **£1.44.** BT107 **£1.07.** BT108 **£1.13.** 2N3228 **£0.81.** 2N3525 **£0.89.** BTX30/50L **£0.38.** BTX30/400L **£0.54.** BT116 **£1.73.** C106/4 **£0.69.**

SILICON RECTIFIERS

200mA	
IS920 50V	£0.07
IS921 100V	£0.08
IS922 150V	£0.09
IS923 200V	£0.10
IS924 300V	£0.11
1 Amp	
IN4001 50V	£0.05
IN4002 100V	£0.05
IN4003 200V	£0.07
IN4004 400V	£0.08
IN4005 600V	£0.09
IN4006 800V	£0.10
IN4007 1000V	£0.11
1.5 Amp	
IS015 50V	£0.10
IS020 100V	£0.11
IS021 200V	£0.12
IS023 400V	£0.14
IS025 600V	£0.16
IS027 800V	£0.18
IS029 1000V	£0.23
IS031 1200V	£0.28
3 Amp	
IN5400 50V	£0.16
IN5401 100V	£0.17
IN5402 200V	£0.18
IN5404 400V	£0.19
IN5406 600V	£0.24

IN5407 800V	£0.28
IN5408 1000V	£0.34
10 Amp	
IS10/50 50V	£0.21
IS10/100 100V	£0.24
IS10/200 200V	£0.26
IS10/400 400V	£0.40
IS10/600 600V	£0.48
IS10/800 800V	£0.58
IS10/1000 1000V	£0.69
IS10/1200 1200V	£0.79
30 Amp	
IS30/50 50V	£0.64
IS30/100 100V	£0.79
IS30/200 200V	£1.06
IS30/400 400V	£1.43
IS30/600 600V	£2.02
IS30/800 800V	£2.23
IS30/1000 1000V	£2.65
IS30/1200 1200V	£3.31
60 Amp	
IS70/50 50V	£0.86
IS70/100 100V	£0.96
IS70/200 200V	£1.38
IS70/400 400V	£2.01
IS70/600 600V	£2.58
IS70/800 800V	£2.87
IS70/1000 1000V	£3.45

TRIACS & DIACS

2 amp TO5 case

volts	No.	Price
100	TR12A/100	£0·36
200	TR12A/200	£0·59
400	TR12A/400	£0·82

6 amp

volts	No.	Price
100	TR16A/100	£0·59
200	TR16A/200	£0·70
400	TR16A/400	£0·88

10 amp

volts	No.	Price
100	TR110A/100	£0·88
200	TR110A/200	£1·06
400	TR110A/400	£1·29

10 amp

volts	No.	Price
400	TR110A/400P	£1·29

DIACS
BR100 **£0·23** D32 **£0·23**

BRIDGE RECTIFIERS

SILICON 1 amp

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

SILICON 10amp

Type	No.	Price
50v RMS	BR10/50	£1.50
200v RMS	BR10/200	£1.70

SILICON 2 amp

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

SILICON 25 amp

Type	No.	Price
50v RMS	BR25/50	£1.90
200v RMS	BR25/200	£2.20

DIODES

Type	Price	Type	Price	Type	Price	Type	Price
AA110	£0.09	BY100	£0.25	BYZ11	£0.52	OA90	£0.11
AA120	£0.09	BY101	£0.25	BYZ12	£0.46	OA91	£0.11
AA129	£0.09	BY105	£0.25	BYZ13		OA95	£0.11
AAY30	£0.10	BY114	£0.25	BYZ16	£0.47	OA182	£0.15
AAZ13	£0.17	BY124	£0.25	BYZ17	£0.41	OA200	£0.09
BA100	£0.11	BY126	£0.17	BYZ18	£0.41	OA202	£0.09
BA102	£0.37	BY127	£0.18	BYZ19	£0.41	SD10	£0.07
BA148	£0.17	BY128	£0.18	OA5	£0.69	SD19	£0.07
BA154	£0.14	BY130	£0.19	OA10	£0.40	IN34	£0.08
BA155	£0.16	BY133	£0.24	OA47	£0.09	IN34A	£0.08
BA173	£0.17	BY164	£0.58	OA70	£0.09	IN914	£0.07
BB104	£0.17	BY176	£0.86	OA79	£0.11	IN916	£0.07
BAX13	£0.08	BY206	£0.34	OA81	£0.11	IN4148	£0.08
BAX16	£0.09	BYZ10	£0.51	OA85	£0.11	IS44	£0.06
						IS920	£0.07

LEDS

O/no.	Size	Colour	
1501	125	RED	£0.10
1502	125	GREEN	£0.16
1503	125	YELLOW	£0.16
1504	2	RED	£0.10
1505	2	GREEN	£0.16
1506	2	YELLOW	£0.16
1509	2	CLEAR (Ill Red)	£0.12
SUPER 'Hi-Brite' Type			
1521	125	RED	£0.11
1522	2	RED	£0.11
1514	ORP 12 Light dependent resistor		£0.70
1520	OCP 71 Photo transistor		£0.40

CLIPS

1508/125 pack of 5 125 clips	£0.17
1508/2 pack of 5 2 clips	£0.20

DISPLAYS

DL703. 7 segment D.P. left (30" height) common anode single digit O/NO 1523 **£0.80**

DL707 RED 7 segment D.P. left (0.3" height) common anode single digit O/NO 1510 **£0.92**

DL527 RED 7 segment D.P. left (50" height) common anode. Two digit reflector O/NO 1524 **£1.95**

DL727 RED 7 segment D.P. right (510" height) common anode. Two-digit light pipe O/NO 1521 **£2.53**

DL747 RED 7 segment D.P. left (630" height) common anode Single-digit light pipe O/NO 1511 **£1.72**

OPTO-ISOLATORS

Isolation Breakdown – voltage 1500 – continuous two current 100mA

CIL74 Single-channel 6 pin DIP standard type – optically coupled pair with infra red LED emitter and NPN silicon photo transistor O/ND 1497 **£0.57**

CILO74 Multi-channel 8 pin DIP two isolated channels O/NO 1498 **£1.15**

CILQ74 Multi-channel 16 pin DIP four isolated channels O/NO 1499 **£2.53**

SECOND GRADE LED PACK

A pack of 10 standard sizes and colours which fail to perform to their very rigid specification, but which are ideal for amateurs who do not rquire the full spec O/NO 1507 **£1.04**

SOCKETS

1611	8 pin DIL	£0.09	1615	28 pin DIL	£0.26
1612	14 pin DIL	£0.11	1723	40 pin DIL	£0.34
1613	16 pin DIL	£0.12	1616	TO18 transistor	£0.13
1720	18 pin DIL	£0.18	1617	TO3 transistor	£0.37
1721	20 pin DIL	£0.20	16117	TO5 transistor	£0.13
1722	22 pin DIL	£0.22	1724	14 pin DIL Wire wrap gold plated Cambion	£0.26
1614	24 pin DIL	£0.24			

G.P. SILICON DIODES

300mW 40PIV (min) sub min FULLY TESTED ideal for Organ builders.
30 for **57p** – 100 for **£1.72** – 500 for **£5.75** – 1,000 for **£10.35.**

G.P. SWITCHING TRANSISTORS

TO 18sim to 2N706/8 BSY27 28, 95A ALL useable devices no open and shorts ALSO available in PNP sim to 2N290 BCY70.
20 for **57p;** 50 for **£1.15;** 100 for **£2.07;** 500 for **£9.20;** 1,000 for **£16.10;** when ordering state NPN/PNP.

VOLTAGE REGULATORS

Positive Case	Price
uA7805 TO220	£0.85
uA7812 TO220	£0.85
uA7815 TO220	£0.85
uA7824 TO220	£0.85
uA7818 TO220	£0.85

Negative Case	Price
uA7905 TO220	£0.92
uA7912 TO220	£0.92

uA7915 TO220	£0.92
uA7924 TO220	£0.92
uA7818 TO220	£0.92
72723 14 pin DN	£0.52
uA723C TO99	£0.52
LM309K TO3	£1.72
ZTK 33B	£0.12

ZENER DIODES

400 mw (Bzy88) D007. Glass encapsulated range of voltages available. 1.3v, 2.2v, 2.7v, 3.3v, 3.9v, 4.3v, 4.7v, 5.1v, 5.6v, 6.2v, 6.8v, 7.5v, 8.2v, 9.1v, 10v, 11v, 12v, 13v, 15v, 16v, 18v, 20v, 22v, 24v, 27v, 30v, 33v, 39v. **No. Z4 10p**

1w-1.5w Plastic and metal encapsulated. Range of voltages available. 1.3v, 2.2v, 2.7v, 3.3v, 3.9v, 4.3v, 4.7v, 5.1v, 5.6v, 6.2v, 6.8v, 7.5v, 8.2v, 9.1v, 10v, 11v, 12v, 13v, 15v, 16v, 18v, 20v, 22v, 24v, 27v, 30v, 33v, 43v, 47v, 51v, 68v, 72v, 75v, 82v, 91v, 100v. **No. Z13 18p**

10w metal stud type SO10 case. Range of voltages available as above. **No. Z10. 44p**

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Add 35p postage per order

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VISIT OUR SHOP AT: 3 BALDOCK ST, WARE, HERTS.
TEL: 0920 3182. TELEX: 817861

FUSE HOLDERS AND FUSES

Description	No.	Price
20mm × 5mm chassis mounting	506	£0·18
1¼in. × 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 **60** each

NUTS AND BOLTS

BA BOLTS—packs of 8A threaded cadmium plated screws slotted cheese head. Supplied in multiples of 50.

Type	No.	Price	Type	No.	Price
1in. OBA	839	£1·38	½in. 4BA	846	£0·37
½in. OBA	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	£0·20
1in. 4BA	845	£0·51			

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

Type	No.	Price	Type	No.	Price
OBA	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
OBA	859	£0·16	4BA	861	£0·14
OBA	B60	£0·14	6BA	862	£0·14

SOLDER TAGS—Hot tinned supplied in multiples of 50.

Type	No.	Price	Type	No.	Price
OBA	851	£0·46	4BA	853	£0·25
2BA	B52	£0·32	6BA	854	£0·25

TRANSFORMERS

MINIATURE MAINS Primary 240V

No.	Secondary	Price
2021	6V–0–6V 100mA	£1·04
2022	9V–0–9V 100mA	£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	£2·00	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. 4, 7, 8, 10, 14, 15, 17, 19, 25, 31, 33, 40, 25–0–25V

No.	Rating	Price	
2031	½ amp	£3·91	P & P 85p
2032	1 amp	£5·06	P & P 85p
2033	2 amp	£6·27	P & P £1
2035	240V Primary 0–55V @ 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 B6p

SPECIAL OFFERS

MINIDRILL 12v hand held battery-operated mini drill. 7,500 r.p.m. Collet chuck. Ideal for drilling printed circuits or model making. No.1402. **£7·79**

TRANSFORMER 240v Primary 0-20v @ 2A Secondary. By removing 5 turns for each volt from the secondary winding, any voltage up to 20v @ 2A is obtainable. Ideal for the experimenter. No.2042. **£1·50** + 86p. P & P

ANTEX MLX Soldering Iron. Sturdy 25 watt iron complete with 4½ metres of 2-core cable. Works off a 12 volt battery. Ideal for Car, Boat, Caravan. No.1724. **£5·29**

TANTALUM CAPACITORS

3137	1MFD	35V	£0·13	3142	4.4MFD	35V	£0·21
3138	22MFD	35V	£0·13	3157	3.3MFD	25V	£0·21
3139	47MFD	35V	£0·13	3143	10MFD	35V	£0·25
3140	1.0MFD	35V	£0·13	3144	22MFD	16V	£0·25
3141	2.2MFD	35V	£0·14	3145	47MFD	6.3V	
				3156	33MFD	35V	£0·13

ELECTROLYTIC CAPACITORS

3185	1,000uF	25V	£0.32				
3186	1,000uF	63V	£1.27	3190	4700uF	25V	£0.92
3187	2200uF	25V	£0.69	3191	4700uF	63V	£2.42
3188	2200uF	40V	£0.69	3192	2200uF	100V	£2.88
3189	3300uF	100V	£3.61	3196	100uF	100V	£0.09

POTENTIOMETERS

CARBON POTS (Linear Track)
Single gang with wire and terminations, 6mm × 50mm plastic shaft 10mm bushes supplied with shake proof washer and nut. Tolerance 20% of resistance.

1831 1k ohms	1835 22k ohms	1839 470k ohms
1832 2k2 ohms	1836 47k ohms	1840 1 Meg
1833 4k7 ohms	1837 100k ohms	1841 2M2
1834 10k ohms	1838 220k ohms	**All at 30p each**

CARBON POTS (Log Track)

1842 4k7 ohms	1846 100k ohms	1850 2M2
1843 10k ohms	1847 220k ohms	**All at**
1844 22k ohms	1848 470k ohms	**30p each**
1845 47k ohms	1849 1 Meg	

Designed to fit 2 54mm pitch board. All tracks are linear law.
VC7

1816 100 ohms	1822 10k ohms	1828 1 Meg ohms
1817 220 ohms	1823 22k ohms	1829 2M2 ohms
1818 470 ohms	1824 47k ohms	1830 4M7 ohms
1819 1k ohms	1825 100k ohms	**All at**
1820 2k2 ohms	1826 220k ohms	**10p each**
1821 4k7 ohms	1827 470k ohms	

DUAL CARBON POTS (Log Law)

1860 4k7 ohms	1864 100k ohms	1868 2M2
1861 10k ohms	1865 220k ohms	**All at**
1862 22k ohms	1866 470k ohms	**99p each**
1863 47k ohms	1867 1 Meg	

SINGLE GANG SWITCHED (Lin Law)
These potentiometers are fitted with double pole on-off switches. The switch is incorporated within the rotary action of the pot. Specification of pot is as VC1. Switch rating 1.5 amps at 250v AC.

1870 4k7 ohms	1874 100k ohms	1878 2M2
1871 10k ohms	1875 220k ohms	**All at**
1872 22k ohms	1876 470k ohms	**75p each**
1873 47k ohms	1877 1 Meg	

DUAL GANG LONG-ANTI-LOG POT
1888 Track specification as dual gang pots VC3, but tracks mounted to log-anti-log action 100k ohms **£0.86.**

SPECIAL VOLUME CONTROLS
A miniature 16mm type replacement volume control, incorporating single pole on-off switch. Resistance value 5k ohms. Tolerance 20% 1/8 watt rating.
1889 **£0.31** VC8

MINIATURE ROTARY VOLUME CONTROL
5k ohms log law with on-off switch. 20mm grooved spindle. Tag connections 17mm dia. Supplied with fixing nut. Used mainly for replacement.
1890 **£0.62** VC9

WIRE WOUND POTS
A range of wire wound single gang pots with linear tracks of 1 watt rating, fitted with 10mm bush and supplied with shakeproof washer and nut.
VC6

1891 10 ohms	1895 220 ohms	1899 4k7 ohms
1892 22 ohms	1896 470 ohms	**All at**
1893 47 ohms	1897 1k ohms	**92p each**
1894 20 ohms	1898 2k2 ohms	

SWITCHED POT (Log Track)
Specification as VC2 but track having (log) law.

1879 4k7 ohms	1883 100k ohms	1887 2M2
1880 10k ohms	1884 220k ohms	**All at**
1881 22k ohms	1885 470k ohms	**75p each**
1882 47k ohms	1886 1 Meg	

PRE-SET POTS HORIZONTAL MOUNTING
Miniature type for transistor circuits. The wiper of the preset is provided with a slot for screw driver adjustment. The tags of the preset will fit printed wiring boards with a pitch of 2.54mm. All tracks are linear law.
VC7

1801 100 ohms	1807 10k ohms	1813 1M ohms
1802 220 ohms	1808 22k ohms	1814 2M2 ohms
1803 470 ohms	1809 47k ohms	1815 4M7 ohms
1804 1k ohms	1810 100k ohms	**All at**
1805 2k2 ohms	1811 220k ohms	**10p each**
1806 4k7 ohms	1812 470k ohms	

PRE-SET POTS VERTICAL MOUNTING
Miniature type for transistor circuits. Wiper adjustment is made by a screw driver slot.

ANTEX IRONS

1943	15 watt high quality soldering iron totally enclosed element in a ceramic shaft fitted with 3/32" bit	£4.83
1947	Replacement element for 1943 iron.	£2.19
1944	Iron coated bit 3/32" for 1943 iron.	£0.53
1945	Iron coated bit ⅛" for 1943 iron.	£0.53
1946	Iron coated bit 3/16" for 1943 iron.	£0.53
1948	General purpose 18 watt iron fitted with iron coated bit.	£4.54
1952	Replacement element for 1948 iron.	£2.19
1949	Iron coated bit 3/32" for 1948 iron.	£0.53
1950	Iron coated bit ⅛" for 1948 iron.	£0.53
1951	Iron coated bit 3/16" for 1948 iron.	£0.53
1931	Highly popular ×25 25 watt quality soldering 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.	£4.83
1935	Replacement element for 1931 iron.	£1.84
1932	Iron coated bit ⅛" for 1931 iron.	£0.58
1933	Iron coated bit 2/16" for 1931 iron.	£0.58
1934	Iron coated bit 3/32" for 1931 iron.	£0.58
1953	SK1 soldering kit – This kit contains 15 watt soldering iron fitted with a 3/16" bit plus two spare bits, a reel of solder, heat-sink and a booklet 'How to solder.' In presentation display box.	£6.38
1939	ST3 soldering iron stand. Stand made from high grade bakelite material chromium plated strong steel spring suitable for all models, includes accommodation for six spare bits and two sponges which serve to keep the soldering iron bits clean.	£1.73

BIB HI-FI ACCESSORIES

O/No	Ref		Price
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' automatic, 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 fast hand tape winder	£1.50

VEROBOARD

2201	2.5"×5" .1 Copper	£0.71	2211	2.5"×3.75" .15 Copper	£0.53
2202	2.5"×3.75" .1 Copper	£0.61	2212	3.75"×17" .15 Copper	£2.39
2203	2.5"×17" .1 Copper	£2.14	2213	3.75"×5" .15 Copper	£0.90
2205	3.75"×3.75" .1 Copper	£0.71	2217	3.75"×17.9" .1 Plain	£1.79
2206	3.75"×17" .1 Copper	£2.76	2218	3.75"×2.5" .1 Plain	£0.44
2207	4.75"×17.9" .1 Copper	£3.61	2219	5"×3.75" .1 Plain	£0.68
2208	2.5"×1", 5 in pack	£0.85	2223	2.5"×5" .15 Plain	£0.37
2204	3.75"×5" .1 Copper	£0.79	2225	5"×3.75" .15 Plain	£0.56
2210	2.5"×5" .15 Copper	£0.64			

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	£1·72
156	11in	6in	3in	£2·92
157	6in	4¾in	1¾in	£1·79
158	9in	5¼in	2½in	£2·43

ALUMINIUM BOXES made from bright alli, 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	£1·82
167	6in	4in	2in	£1·18

SLOPE front aluminium boxes with black vinyl base and sides & aluminium back, top & front – strong construction easily accessable.

169	2⅛in	5⅜in	2¾in	12in	3½in	8in	£5·45
168	2⅝in	7¼in	4in	16in	4½in	11in	£8·21

VERO plastic case box. These boxes consist of top and bottom sections which include fixings points for horizontal mounting PC boards/chassis plates, the two sections are held together by four screws which enter through the base and are concealed by plastic feet.

No.	Length	Width	Height	Price
170	140mm	40mm	205mm	£4·14
171	140mm	75mm	205mm	£4·62
172	140mm	110mm	205mm	£6·00

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·mm 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 insulaed 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 Coiled Guitar Lead Mono Jack plug to Mono Jack plug Black	£1·72
124	3 pin DIN plug to 3 pin DIN plug. Length 1·5m	£0·85
125	5 pin DIN plug to 5 pin DIN plug. Length 1·5m	£0·85
126	5 pin DIN plug to Tinned open end. Length 1·5m	£0·85
127	5 pin DIN plug to 4 Phono Plugs. All colour coded. Length 1·5m	£1·49
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	£0·96
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	Coiled stereo headphone extension lead. Black, length 6m	£2·01
178	AC mains lead for calculators, etc	£0·52

SWITCHES

Description	No.	Price
DPDT miniature slide	1973	£0·16
DPDT standard slide	1974	£0·17
Toggle switch SPST 12 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
A range of rocker switches SPST–moulded in high insulation material available in a choice of colours ideal for small apparatus

Colour	No.	Price
RED	1980	£0·35
BLACK	1981	£0·35
WHITE	1982	£0·35
BLUE	1983	£0·35
YELLOW	1984	£0·35
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	£0·91
Miniature DPDT toggle centre off 2 amp 250V ac	1961	£1·07
Push-button SPST 2 amp 250V ac	1962	£1·04
Push-button SPST 2 amp 250V ac	1963	£1·09
Push-button DPDY 2 amp 250V ac	1964	£1·34

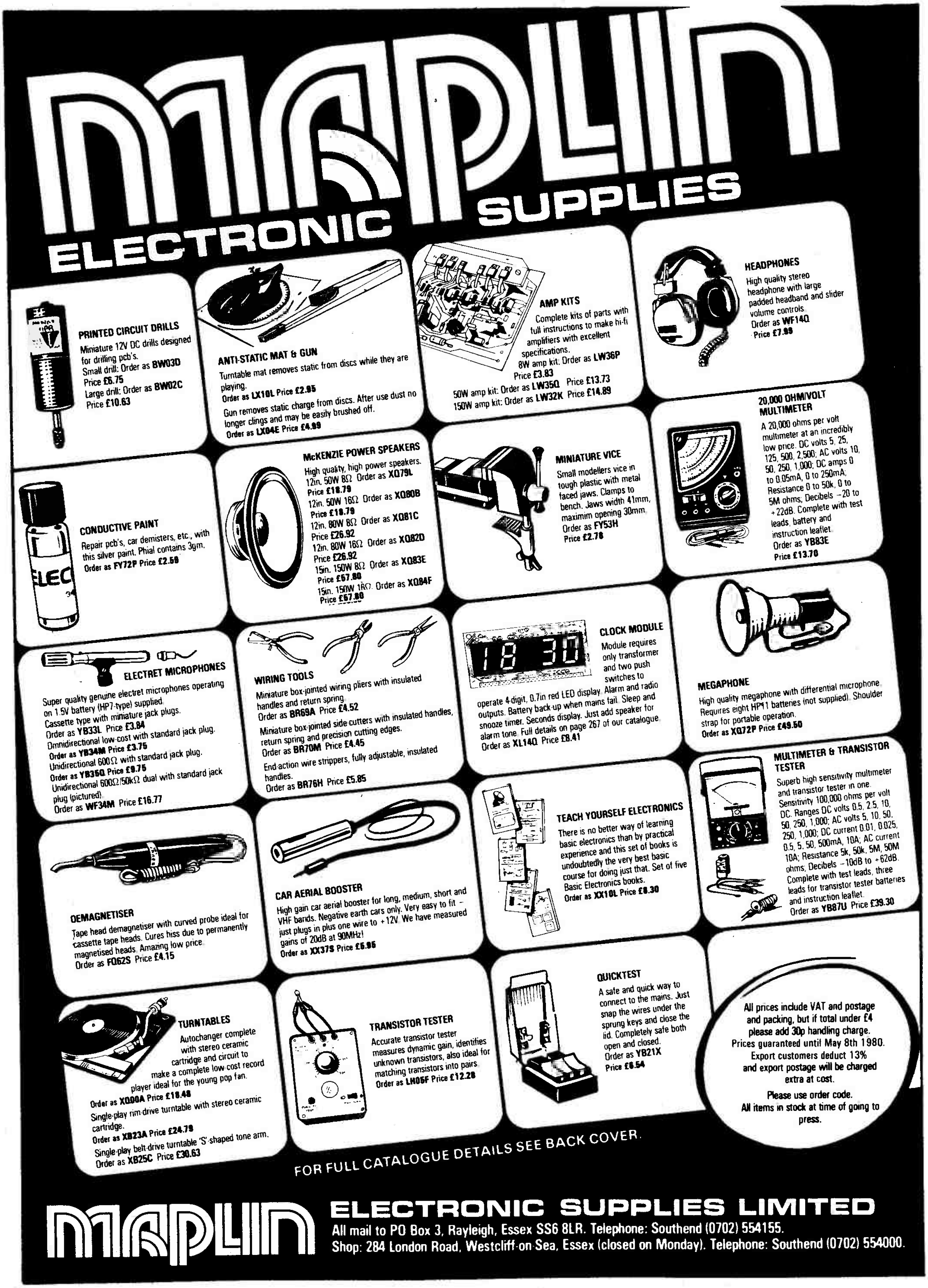
MIDGET WAFER SWITCHES
Single bank wafer type–suitable for switching at 250V ac 100mA or 150V dc non-reactive loads make-before-break contacts. These switches have a spindle 0 25 in dia. and 30 indexing.

Description	No.	Price	Description	No.	Price
1 pole 12 way	1965	£0·55	3 pole 4 way	1967	£0·55
2 pole 6 way	1966	£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

Terms cash with order. Cheques/Postal Orders made payable to Bi-Pak at above address.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Turntable mat removes static from discs while they are playing.
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Order as LX04E Price £4.99
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Complete kits of parts with full instructions to make hi-fi amplifiers with excellent specifications.
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High quality stereo headphone with large padded headband and slider volume controls.
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Price £7.99
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Repair pcb's, car demisters, etc., with this silver paint. Phial contains 3gm.
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High quality, high power speakers.
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12in. 80W 8Ω Order as XQ81C Price £26.92
12in. 80W 16Ω Order as XQ82D Price £26.92
15in. 150W 8Ω Order as XQ83E Price £67.80
15in. 150W 16Ω Order as XQ84F Price £67.80
MINIATURE VICE
Small modellers vice in tough plastic with metal faced jaws. Clamps to bench. Jaws width 41mm, maximim opening 30mm.
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20,000 OHM/VOLT MULTIMETER
A 20,000 ohms per volt multimeter at an incredibly low price. DC volts 5, 25, 125, 500, 2,500; AC volts 10, 50, 250, 1,000; DC amps 0 to 0.05mA, 0 to 250mA; Resistance 0 to 50k, 0 to 5M ohms; Decibels −20 to +22dB. Complete with test leads, battery and instruction leaflet.
Order as YB83E
Price £13.70
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Super quality genuine electret microphones operating on 1.5V battery (HP7-type) supplied.
Cassette type with miniature jack plugs.
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Omnidirectional low-cost with standard jack plug.
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Unidirectional 600Ω with standard jack plug.
Order as YB35Q Price £9.75
Unidirectional 600Ω/50kΩ dual with standard jack plug (pictured).
Order as WF34M Price £16.77
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Miniature box-jointed wiring pliers with insulated handles and return spring.
Order as BR69A Price £4.52
Miniature box-jointed side cutters with insulated handles, return spring and precision cutting edges.
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End-action wire strippers, fully adjustable, insulated handles.
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CLOCK MODULE
Module requires only transformer and two push switches to operate 4-digit, 0.7in red LED display. Alarm and radio outputs. Battery back-up when mains fail. Sleep and snooze timer. Seconds display. Just add speaker for alarm tone. Full details on page 267 of our catalogue.
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High quality megaphone with differential microphone. Requires eight HP11 batteries (not supplied). Shoulder strap for portable operation.
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Superb high sensitivity multimeter and transistor tester in one. Sensitivity 100,000 ohms per volt DC. Ranges DC volts 0.5, 2.5, 10, 50, 250, 1,000; AC volts 5, 10, 50, 250, 1,000; DC current 0.01, 0.025, 0.5, 5, 50, 500mA, 10A; AC current 10A; Resistance 5k, 50k, 5M, 50M ohms; Decibels −10dB to +62dB. Complete with test leads, three leads for transistor tester batteries and instruction leaflet.
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Tape head demagnetiser with curved probe ideal for cassette tape heads. Cures hiss due to permanently magnetised heads. Amazing low price.
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MAPLIN ELECTRONIC SUPPLIES LIMITED
All mail to PO Box 3, Rayleigh, Essex SS6 8LR. Telephone: Southend (0702) 554155.
Shop: 284 London Road, Westcliff-on-Sea, Essex (closed on Monday). Telephone: Southend (0702) 554000.

PE

VOLUME 16 No. 4 APRIL 1980

THE TROUBLE with looking at the future in electronics is that advances take place so quickly that by the time the prophesies are made the ideas are often already at prototype stage or even in production. Our video supplement takes a look at the present state of the art and also mentions some new techniques. These techniques will undoubtedly lead to a new range of smaller, cheaper domestic recorders though, at the present time, it is difficult to see how LVR will ever achieve the quality of reproduction now available from helical scan recorders. Perhaps by the time these words are published the new machines will be in production.

The video market has now taken off in this country and the indications are that sales will quickly grow over the next few years. What we don't yet know is the influence the videodisc will have.

MONEY

How about electronic money? We warn you that SGS ATES have already made the first steps in that direction with the introduction of an electronic credit card. Designed for an Italian telephone company—PO where are you?—the card is intended for use with pay phones but the implications are obvious.

In the future you may never need loose change, in fact we can forsee a time when the minting and printing of money will no longer be necessary. Instead of drawing out money from your bank you simply get a new card. You then use your card for purchases—possibly over the phone—or stick it in the till or ticket barrier on the bus, at the station, cinema, sports centre, etc.

Each time you use the card the relevant credits are used up. When all the credits are used the card reader withholds the goods or services. Where are the benefits? No money to be stolen or carted to the bank—no loose change to carry or acquire when necessary. For the vendor it also means payment in advance, reduced machine maintenance and no money left in machines to tempt thieves. It will be possible to develop tills to accept the cards, to put card readers in taxis, TV's, petrol pumps, amusements etc.

Once again this is a product that is now available; the type numbers are M274D1 for the d.i.l. ceramic evaluation package and XCARD for the card. The chip is essentially an EPROM of 17 × 8 bits with a claimed 100 year data retention.

Security is taken care of by writing in an 8 bit word during manufacture and then blowing an on-chip fuse. If any attempt is made to erase the card to regain its original credit value the security key is also erased rendering the card useless. A plastic tab, which has to be removed to use the card, prevents resale after initial use.

APRIL!

Although this is the April issue and certain devices described elsewhere in these pages are not all they seem at first glance, we assure you that the above information has nothing to do with the date and is based on an actual product.

What other advances are there? How about a hi-fi amp of excellent quality for about £70—see the *PE Congress;* an MPU kit for less than £30—read the EDUKIT review, or even a *2 Wire Train Controller*—we believe we are the first to publish a design for the hobbyist in the U.K.

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.

Back Numbers
Copies of most of our recent issues are available from: Post Sales Department (Practical Electronics), IPC Magazines Ltd., Lavington House, 25 Lavington Street, London SE1 0PF, at 75p each including Inland/Overseas p&p.

Binders
Binders for PE are available from the same address as back numbers at £4·10 each to UK or overseas addresses, including postage and packing, and VAT where appropriate. Orders should state the year and volume required.

Subscriptions
Copies of PE are available by post, inland or overseas, for £10·60 per 12 issues, from: Practical Electronics, Subscription Department, Oakfield House, Perrymount Road, Haywards Heath, West Sussex RH16 3DH. Cheques and postal orders should be made payable to IPC Magazines Limited.

Market Place

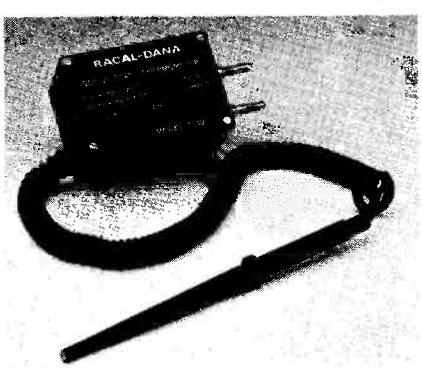
Items mentioned are usually available from electronic equipment and component retailers advertising in this magazine. However, where a full address is given, enquiries and orders should then be made direct to the firm concerned. All quoted prices are those at the time of going to press.

by David Shortland and Jasper Scott

TEMP PROBE

The new T–10 temperature probe from Racal-Dana Instruments has been designed to turn a digital multimeter into an accurate digital thermometer.

The unit uses a constant current bridge circuit with a solid state sensor to give an output of 1mV per degrees Centigrade. The basic accuracy of the T–10 is to within 2 degrees from 0°C to 100°C and to within 3°C from −50°C to 150°C.



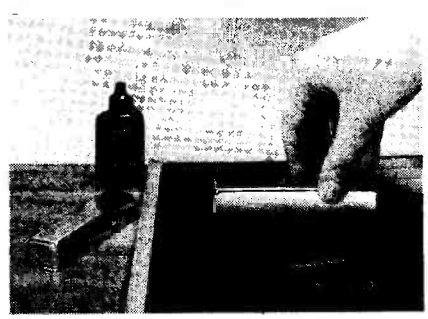
The sensor, which is housed in a high temperature plastic probe, is embedded into a low mass brass tip for improved response during measurement. The probe is attached to the main unit via a coiled lead and the compact, self-powered mains unit plugs directly into a multimeter.

The T–10 is priced at £79·00 excluding VAT and p&p.

For further information contact **Racal-Dana Instruments Ltd., Duke Street, Windsor, Berkshire SL4 1SB (07535 69811).**

RECORD VALET

The improved Record Valet from BIB is ideal for removing dust and static from gramophone records. The handle is a reservoir for anti-static liquid which is fed to a velvet cleaning pad. Adjacent to the pad is a brush which removes the dust from the record and deposits it on the cleaning pad.



The Valet which should ideally be used before each record is played, to ensure both the record and the stylus are protected is priced at £5·47 including VAT. A 15ml bottle of anti-static cleaning fluid is also included with each Valet.

BIB Hi-Fi Accessories Ltd., Kelsey House, Wood Lane End, Hemel Hempstead, Herts. HP2 4RQ.

HOME RADIO

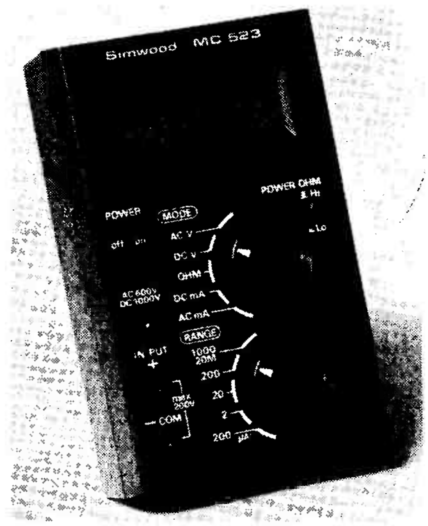
Home Radio have informed us that they have now moved to new premises at 269A Haydons Road, Wimbledon, London SW19 8TY.

The mail order address is still PO Box 92, 215 London Road, Mitcham, Surrey (01-543 5659).

DMM

The Simwood MC523 battery powered DMM provides a full range of measurement functions, and uses CMOS LSI circuitry for accuracy, long-term operational stability and low power consumption.

Five measurement functions are available with 30 current, voltage and resistance ranges. These consist of five a.c. and five d.c. voltage ranges from 200 mV to 600 V, with basic d.c. accuracies from 0·25 per cent; five a.c. and five d.c. current ranges from 200 µA to 1A,



with accuracies from 0·8 per cent; and ten resistance ranges from 200 ohms to 20 megohms, with accuracies of 0·25 per cent on all but the 20 megohm range. The ohms ranges offer high- and low-power measurement capabilities, for checking both circuit resistance and active components.

The liquid crystal display automatically indicates the measurement parameter—a.c. or d.c. volts; a.c. or d.c. current; ohms; kilohms or megohms—as well as polarity.

Other features of the MC523 which is priced at £75 include a high input resistance, autozero and auto-overange, and overload indication. Battery life of 200 hours is claimed under normal conditions of usage. The instrument measures 95 × 155 × 45mm and weighs 300g.

Simwood Limited, Garretts Hall, Shalford Green, Essex (0371 820006).

WORDPROCESSOR PACKAGE

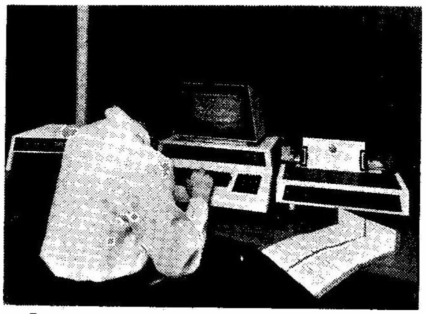
The latest WordPro II wordprocessor package from Commodore has been specifically designed for use with the 16K and 32K "big keyboard" versions of their PET Computer. WordPro II is unusual for as well as floppy disk-based software, the package also includes the necessary ROM hardware to accommodate the program functions.

The WordPro II package, which can be installed in the PET with a minimum of fuss, in conjunction with Commodore's 2040 dual drive floppy disk unit, gives the user a capability to process up to 303 pages of text.

Combine this with a printer and you have an extremely powerful computer-word processor system for under £2,600. For applications requiring a high quality print-out, the system configuration can include a daisy wheel printer instead of the matrix printer, but as such, will still cost less than £4,000.

In operation, WordPro II follows conventional wordprocessor practise. Firstly the text is entered into the PET, using the keyboard and the VDU displays a working text area of 24 lines. As the text is processed, it can be moved either up or down the screen thereby bringing fresh text onto the VDU. A "status line" at the top of the screen ensures that the operator is always fully aware of the cursor position as line editing is carried out.

Other text handling features include: an option to carry out right hand justification, variable left and right hand margins and a variable page length facility.



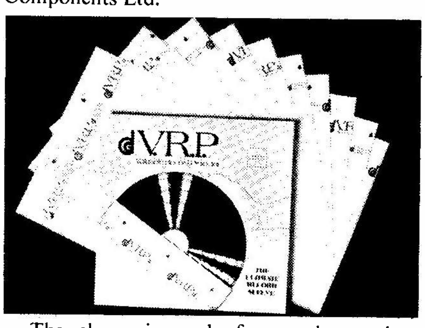
Once the text editing is complete, then it can be converted into hard copy via the printer, controlled by a formatting routine. It is therefore possible to produce both multiple copies of a fixed content letter from one command and multiple copies of a variable content letter from one command with insertions, such as name, address etc., taken from a secondary file.

The Commodore WordPro II Wordprocessor package which costs £75 comes complete with ROM, diskette, documentation and demonstration files in a stiff-backed multi-ring binder.

Commodore Business Machines, 360 Euston Road, London NW1 (01-388 5702).

ANTI-STATIC SLEEVE

A new protective record sleeve which is claimed to offer distinct advantages over ordinary sleeves is being introduced by Zerostat Components Ltd.



The sleeve is made from polypropylene which is extremely smooth for scratch free record removal and replacement. This stable material which is electrostatically compatible to the record vinyl greatly reduces the attraction of static charges.

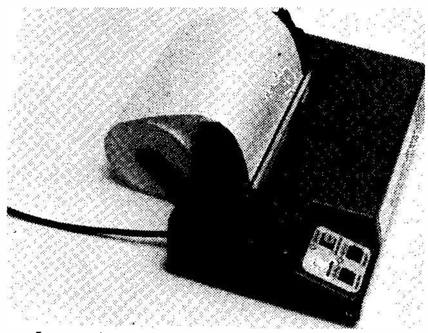
The Zerostat Discwasher 'VRP' is on sale through hi-fi retailers at approximately £1·95 for a pack of ten or may be ordered direct from **Zerostat Components Ltd., Edison Road, Industrial Estate, St. Ives, Huntingdon, Cambridgeshire PE17 4LF.**

NASCOM PRINTER

A compact, low price printer which accepts both punched and unpunched plain paper is available from Nascom Microcomputers Ltd.

Called the IMP, the printer is of the impact matrix type producing characters in a 7×7 dot matrix at a speed of 80 characters per second. It accepts either pinfeed paper under tractor feed, to a maximum width of 9½ in, or unpunched paper under pressure feed. The latter allows the use of A4, foolscap or quarto letterheads.

The IMP offers bidirectional printing and a 96 ASCII character set with the hash mark replaced with a £ sign. The ribbon used is a cartridge-loaded, endless loop type with a five-million character life.



Input data may be in either seven or eight bit formats with either one or two stop bits. Parity may be odd, even or ignored. Should a data transmission error be detected, an ASCII 7F character will be printed and the operator informed by indicator. "Linefeed" signals may be automatically generated when the printer is in use with computer systems providing only "carriage return" signals. In conjunction with Nascom monitors NAS-SYS 1 and NASBUG T4 this facility may be used to generate double spaced output.

Input is designed for RS232 levels and may be at any standard baud rate between 110 and 9600. A TTL output is available at 16 times the selected baud rate for operating an external 6402 type UART. A "busy" signal will be output when only 10 characters need to be input to fill the 945 character buffer. The signal will be maintained until more buffer space is available.

Priced at £325 plus VAT, the Nascom IMP is available from Nascom Microcomputers and selected Nascom distributors.

Nascom Microcomputers Ltd, 92 Broad Street, Chesham, Bucks. (02405 75155.)

VERO CATALOGUE

Designed to a new format, the latest 52 page hobbyist catalogue from Vero Electronics contains a wide selection of products that are particularly interesting to the home constructor.

Several new products are illustrated including Verobloc; a new prototyping method of building and testing circuits; a S100 bus system; a rack mountable development kit for evaluation or microprocessor-based systems to the S100 format and low profile d.i.p. sockets.

The catalogue is available for 40p from **Vero Electronics Limited, Industrial Estate, Chandlers Ford, Eastleigh, Hants. SO5 3ZR.**

CO-AX CONNECTORS

From Greenpar Engineering comes a new range of u.h.f. co-axial connectors designed specifically with the hobbyist in mind.

The range consists of three basic designs—free plug, panel socket and straight adaptor. Various versions of the plug are available to suit different types of co-axial cable. All connectors have nickel plated brass bodies and silver plated centre contacts. Phenolic insulators in the plugs and sockets ensure high temperature stability.

The connectors come in packs of ten, and are available direct from: **Greenpar Engineering Ltd., PO Box 15, Station Works, Harlow, Essex.**

KEYBOARD

A solid state ASCII keyboard measuring just 8·2mm thick has been introduced by Interface Components Ltd.

Known as the TASA Micro-Proximity Keyboard the touch-activated keyboard is claimed to be virtually indestructible.

The keyboard is a thin rectangular board with a totally flat surface. The micro-proximity touch sensors are protected by a shield of tough polycarbonate which can be kept clean by wiping with a damp sponge. Because it can be easily cleaned and disinfected, it is ideal for sterile environments. It also can be used in hostile environments where dust, temperature extremes, moisture, chemicals or radio frequency interference are a problem.

Measuring 158mm deep by 382mm wide by 18·2mm thick the keyboard has a full 128 position 8 bit ASCII output plus continuous strobe, parity select. Other features include:

Built-in electronic shift lock; two-key rollover to prevent accidental two-key operation (excluding "control" and "shift") electronic hysteresis for firm "feel"; signal activation time of 1 millisecond; Output via 12-way edge connector; CMOS compatible with pull-up resistor; parallel output: active pull-down, direct TTL compatible (one load) open collector type.

The TASA Keyboard costs £49·50 excluding VAT and is available from **Interface Components Ltd., Oakfield Corner, Sycamore Road, Amersham, Bucks. (02403 5076.)**

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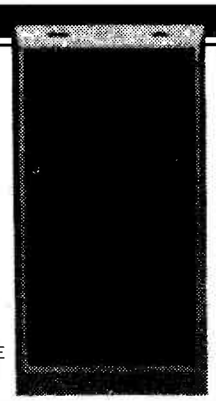
Handy multitester for home and work-shop. Easy-to-read two colour 5cm meter, pin jacks for all 8 ranges. Reads AC and DC volts: 0-15-150-1000 DC current; 0-150 mA. Resistance: 0-100,000 ohms. Accuracy: ± 3% full scale on DC ranges, ± 4% on AC ranges. Complete battery. **22-027.** REG. PRICE **£6.95**

6-DIGIT FREQUENCY COUNTER

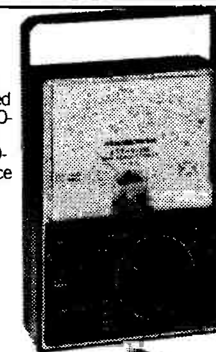
Counts frequencies from 100 Hz to over 45 MHz with 100 mS gate time. Accuracy is 3 ppm at 25°C or less then ± 30 Mkz on 10 MHz! Overload-protected 1-meg input. Sensitivity, 30 mV up to 30 MHz. Req. 9V battery. **22-351.** REG. PRICE **£79.95**



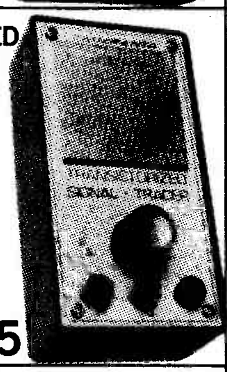
MULTITESTER

Dual FET imput for accuracy and minimum loading. 11.5cm mirrored scale. DC volts, 0-1-3-10-30-100-300-1000. DC current 0-100 a. 0-3-30-300 milliamp. Resistance 0-30-300-3k-30 IC-1 megaohm. 0-100-1k-10 IC-100K-3 megaohms. Req. 9V battery. **22-209.**

REG. PRICE **£29.95**



TRANSISTORIZED SIGNAL TRACER



Spot circuit troubles and check RF, IF and audio signals from aerial to speaker on all audio equipment. With 9V battery, instructions. **22-010.**

REG. PRICE **£9.95**

DIGITAL IC LOGIC PROBE

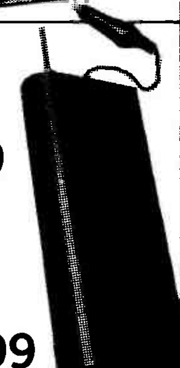
Unique circuitry makes it a combined level detector, pulse detector and pulse stretcher. Hi-LED indicates logic "1". Lo-LED is logic "0". Pulse LED displays pulse transitions to 300 nanoseconds, blinks at 3 Hz for high frequency signals (up to 1.5 MHz). Input impedence: 300K ohms. With 36" power cables. **22-300.**

REG. PRICE **£19.95**

SIGNAL INJECTOR

For RF, IF, AF circuits. Maximum accuracy. Easy pushbutton operation. Needs two "AA" batteries. **22-4033.**

REG. PRICE **£2.79**



AC/DC CIRCUIT TESTER

Accuracy in 1-300 volts ranges. Safe in live/dead circuits. Needs two "AA" batteries. **22-4034.**

REG. PRICE **£1.99**

REALISTIC DX 300

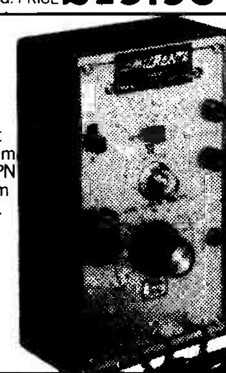
General coverage receiver. Quartz-synthesised tuning, digital frequency readout. 3-step RF Attenuator. 6-range preselector with LED indicators. SSb and CW demodulation. Speaker. Code oscillator. Batteries (not included) or 12V DC. **20-204.**

REG. PRICE **£229.95**

DYNAMIC TRANSISTOR CHECKER

Shows current gain and electrode open and short circuit. Tests low, medium or high power PNP or NPN types. Go/no-Go test from 5-50mA on power types. **22-024.**

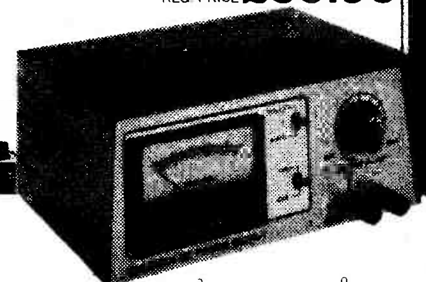
REG. PRICE **£9.95**



VARIABLE POWER SUPPLY

Power project boards. IC's, other low-voltage DC equipment. Load regulation: less than 450mV at 1 amp at 24V DC. Ripple: less then 25mV. Maximum output current: 1.25 amps. Switchable colour-coded meter reads 0-25V. DC and 0-1.25 amps. Three-way binding posts take wires, banana plugs or dual banana plugs with 0.75" centres. For 220/240V AC. **22-9123**

REG. PRICE **£35.95**



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VIDEOTONE

Videotone who have joined with us this month in our special speaker offer (see pages 68, 69) have decided to open a direct selling showroom in South London and cease selling through retail outlets. Videotone believe they are the first major hi-fi company to enter the direct selling market which has proved so successful for other consumer products.

The aggressive change in marketing policy which has resulted in price reductions of up to 50 per cent also allows speakers to be brought on a 21 day home trial basis; money back guarantee on all products; an extra 10 per cent discount on any own brands which are out of stock when an order is placed and also any hi-fi club who registers with Videotone will be given an extra 10 per cent discount.

Typical prices include Minimax II's at £44·00 including VAT and Coral MC81 moving coil cartridges at £48·87 including VAT.

A brochure and order form is available from **Videotone Ltd., 98 Crofton Park Road, London SE4 (01-690 8511).**

SECOND-HAND INSTRUMENTS

With rapid advances in electronic technology making the latest "state of the art" instrumentation almost obsolete within 24 months, it might be reasonable to assume that there was a booming market for the sale of unwanted and under-utilised equipment within the electronics industry.

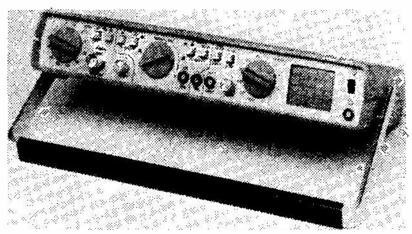
But this is not the case, according to second-hand instrument dealers Carston Electronics are a subsidiary of Livingston Hire. Carston's business is to buy unwanted instruments and equipment from various sectors of the electronics industry, restore and re-calibrate it to the manufacturer's original specification and then resell it. The result is that most of their equipment is between 1 to 8 years old in perfect working order, but only costs between 50–70 per cent of its original price.

Several educational establishments have already taken advantage of the Carston service and have purchased items such as signal generators, power supplies and pulse generators. The value of the service is that it is now possible to buy high performance/high quality instrumentation at economical prices.

Further details and catalogues are available from: **Carston Electronics Limited, Shirley House, 27 Camden Road, London NW1 9NR (01-267 3262).**

SCOPE FOR PORTABILITY

In addition to their range of handsome digital multimeters, Sinclair have now come up with a truly portable oscilloscope. While most standard oscilloscopes are supposed to be portable, Sinclair's SC110 will actually fit into the average briefcase or handbag, as it measures only 254 × 147 × 40mm and weighs a mere 1½ lbs. To compliment its portability, the SC110 has the added advantage of exceptionally low power consumption, enabling it to run for long periods on low cost disposable batteries. With a 10MHz bandwidth and 10mV sensitivity, Sinclair claim that its performance matches that of many standard bench models.



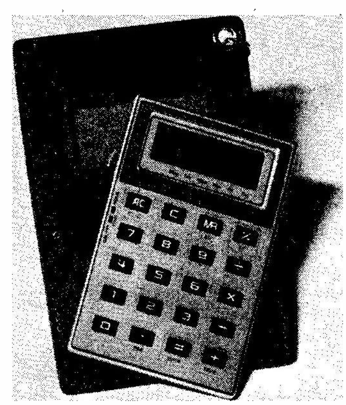
At £139, the SC110 must be well within reach of most serious hobbyists. Further information from: **Sinclair Electronics Ltd., London Road, St. Ives, Huntingdon, Cambs., PE17 4HJ.**

CALCULATOR NOTES

What's the square root of "Yes we have no bananas"? Beethovens Fifth? Not quite—in fact I can guarantee it's a tune that you've never heard before. With the Casio ML-81 your calculations will certainly take on a new dimension, for as well as having three ready-programmed pieces of music for the timer and two alarms, the calculator can be used to play melodies within an eleven note range. Unfortunately, the lack of semi-tones severely limits the variety of tunes available, though in other areas the ML-81 is more versatile. In addition to the calculator and clock functions, the ML-81 incorporates a stopwatch and a calendar programmed until the year 2099.

Two silver oxide batteries give approximately 14 months continuous operation and to save battery life the duration of a note is limited to between one and two minutes.

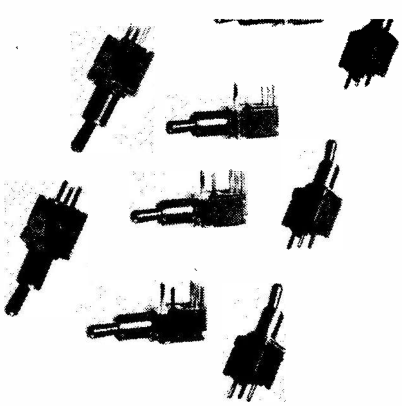
Also emanating from the Casio stable is their MQ-6 Micro Card Watch, which measures a mere 67mm × 43mm, and is only 5mm thick. Obviously intended as a modern equivalent to the pocket-watch, it comes complete with a leather pouch and chain. This model also incorporates calendar, stopwatch and basic calculator functions, though surprisingly, it lacks an alarm. The MQ-6 is priced at £19·95 (Tempus discount price) and for another £3 or so you can buy the ML-81, and have the pleasure of being woken every morning by 'Fruhlingslied'.



Both the ML-81 and the MQ-6 are available from **Tempus, (Dept. PE), Beaumont Centre, 164–167 East Road, Cambridge CB1 1DB.**

MINI MOUNTABLES, MEMORY MINDERS

A new range of p.c.b. mountable miniature switches has been launched by Hunter Electronic Components. Both single and double pole switches are available, and they are particularly suited to p.c.b. mounting as the terminals are spaced to fit into the standard 0·1 grid pattern. Contacts and terminals are gold plated, giving a contact resistance of less than 20 Mohm @ 100mV 1mA d.c. The price for a single pole double throw switch is about 50p.



Also available from Hunter is a new low-voltage, 5-volts, MOS Memory Protector series. These TransZorb transient voltage suppressors, designated the GMP-5 Series, have a maximum surge rating of 215 amps for 50 microseconds and 70 amps for 1 millisecond. They feature a very low 6·9 volt maximum clamping level at 10 amps for an impulse waveform of 10 × 1000 microseconds. The series is characterized by its extremely fast response time (theoretically 1 × 10–12 seconds), and low series resistance (RON).

They are effective in providing protection for VMOS, HMOS, NMOS, and CMOS circuits from pulses generated by electromechanical switching, electromagnetic coupling, capacitive or inductive load switching, voltage reversals, and electrostatic discharge (ESD). TransZorbs effectively shunt unwanted transients while maintaining the circuit voltage level for continuous system operation.

For further information, contact: **Hunter Electronic Components Ltd., 55 High Street, Burnham, Bucks. Telephone (06286) 65421.**

EDUKIT Reviewed

MIKE ABBOTT

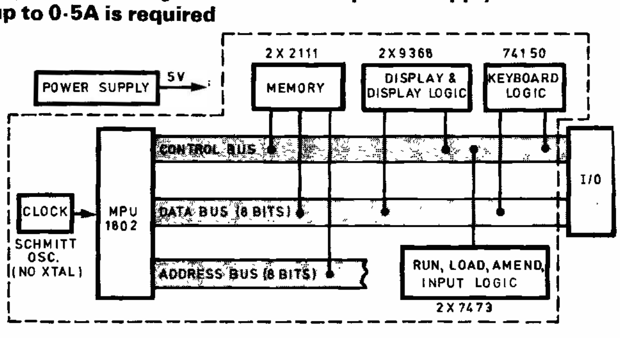
AT £30 the Edukit is a genuine "throw away" training tool, although the "waste bin" will *really* be the spares box, or dedication to some micro based project. At any rate no fortune is lost should you fail to get on with the *microprocessor,* and you are not plagued with the usual pre-purchase questions such as upwards expandability. The idea was conceived, and the machine designed by Dr. A. A. Berk. There is no keyboard monitor, cassette interface or I/O port, and two seven segment displays indicate memory contents only—you have to know the address you should be at! Yet it is precisely because of these points that the Edukit is excellently tailored to its vocation.

THE HARDWARE

The glass fibre p.c.b. is double sided; not plated-through, and measures 130 × 210mm. There are no edge connector fingers, and only one i.c. socket is supplied, which is for the RCA COSMAC 1802 µP. This is a good choice of m.p.u., for it incorporates 40 × 16-bit registers, 32 of which are general purpose. With this much memory *on the house* and capable of simultaneous hi/lo order byte storage at any one address, the 1802 is eminently suitable for that intelligent burglar alarm, or musical doorbell project. Just the kind of thing, in fact, you might wish to do with your Edukit when you have "graduated".

A Memory Protect toggle switch is edge mounted on the p.c.b. with a tinned copper wire loop strapped over it to give stability. Two l.e.d.s indicate the processor's mode of operation, and a third l.e.d. can be linked to indicate the status of the m.p.u.'s Q flag. See Fig. 1 for the block diagram.

Fig. 1. Block diagram. An external power supply of 5 or 6V at up to 0·5A is required



KEYPAD

There are twenty keys, sixteen of which are hexadecimal (0–9, A–F), and four control keys which are used in conjunction with the two mode status l.e.d.s. These control keys are: "L" for load, "R" for run, "Am" for amend, and "In" for increment.

In order to minimise expense, the Edukit uses the cheapest of keypad switches; a very firm push being necessary with some keys. This was rather a nuisance in the case of the *In* key because it is the number of pushes by which you determine the memory location you are looking at.

However, these switches can be "popped" apart, cleaned, and reassembled if necessary. To be fair, our keypad underwent an excessive amount of "fiddling", which resulted in the switches being less reliable than evidenced by their past record. In addition, a switch debounce modification is now being incorporated in all machines being sold.

Legends for the keys are cut into strips from a printed card, and spot glued across each row of switches. See photographs.

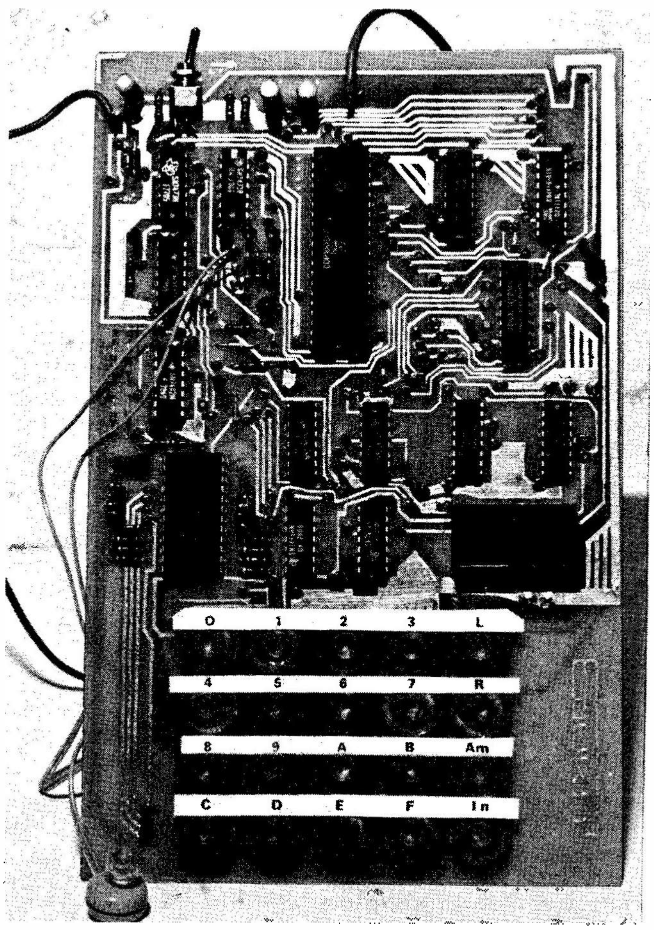
OPERATION

Entering a program is simply a matter of turning off the Memory Protect switch, entering each op-code (or data) via the keyboard, and then pressing *In* to move on to the next location. Before entering or running a program it is necessary to reset the program pointer to the first memory location (00) again by means of the *R* key. Under memory protect, the *In* key can be used to inspect memory contents without altering it in any way. The contents of any individual memory location can be altered using the *Am* key. Using Edukit is simple. Because you find yourself eyeball to eyeball with the microprocessor itself, without a monitor throwing up a smoke screen, you soon learn, that cleared of these clouds of firmware "the chip" is essentially a simple programmable i.c.

A link connects the third l.e.d. to the Q flag, but if this link is replaced by an earphone or small speaker, sound effects can be produced quite easily, whilst still allowing the l.e.d. to work.

THE MANUAL

With a teaching aid such as this, the manual is all important, and it is always difficult for the knowledgeable author to predict what will confound the beginner, particularly in a jargonistic discipline. However, in the Edukit Manual every attempt has been made to accompany all references with an explanation.



The constructional notes in Chapter One overlook nothing. Even the l.e.d.s are described as "red translucent objects". Chapter Two swoops in on the various numbering systems; binary, hexadecimal and decimal etc., and Chapter Three starts you off with a simple program, showing how you can see and hear the machine operate.

To help in understanding how the machine functions, so called "Dry Run" tables describe the step by step operation. One group of instructions missed out, is the Long Branch instruction which involves high address locations. This omission is deliberate because only the low order address byte is used by Edukit on account of its limited memory (two 2111s plus the 1802 registers). The whole package is only meant to be an introduction and plenty of supplementary reading material is recommended.

Chapter Five moves on to matters of a hardware and control nature, describing a "switches and l.e.d.s" experimentation circuit. Some example applications include a temperature gauge and a security system; which is good because dedicated applications such as these seem to be comparatively neglected on the amateur micro scene.

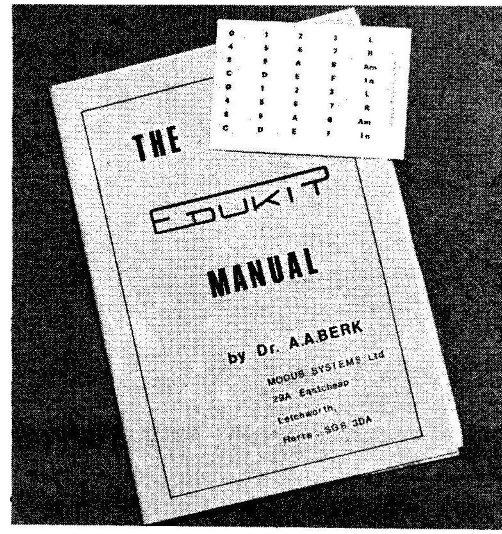
The appendices include a short teach-in on soldering, and the COSMAC op-code table.

CONCLUSION

The two winning features of the Edukit must be: (a) its simplicity without pretence to being the first building block of an enormous system, and (b) its remarkable price tag, which means you can risk being wrong.

Some expansion/add-on plans are in the pipeline which will allow the Edukit to be put to good use in its retirement. The exact nature of the expansion plans were not crystallised at the time of writing, but it was expected that a small RAM or ROM memory board would be available which would plug into the 1802's socket, re-housing the 1802 on itself.

An Edukit Users' Club is also anticipated, so anyone who would like to participate in, or belong to it, should contact Modus Systems.



Edukit Manual, and keypad legend card. Although there is no I/O chip as such, the manual explains fully how to interface to the outside world. The 1802's four External Flag lines can be used to scan the status of up to 16 sensor switches, or simply accept BCD data. The method of transferring bytes to and from external devices using direct bus access is also covered. To clarify the capability of the machine, and to set the heading straight, it was really Mike Abbott who reviewed the Edukit, although in a few generations time . . . who knows?

Some prices are: Basic Edukit £29·95 plus VAT and 80 pence for post and packing. The 1802 manual can be purchased for £3·99 plus 50 pence p&p, and a set of sockets for the remaining i.c.s at £2·60 plus VAT. Edukit is available from **Modus Systems Ltd., 29a Eastcheap, Letchworth, Herts. SG6 3DA.** There will be a special Edukit offer in PE next month for those that can wait!

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Semiconductor UPDATE...

FEATURING ZMOS F.E.T. AG 1000 IU 101

R.W. Coles

ZMOS F.E.T. (X520, X530)

All the rage in U.K. discos later this year will be the new range of ZMOS f.e.t.s from the Welsh firm of Llyis Electronics. At last the unflagging research efforts of this energetic young company have come to fruition, and there will be no stopping them now. Working with only limited capital and outdated equipment, the back-room boys at Llyis have taken on the might of giants like Texas Instruments and Motorola, beating them at their own game with radical and innovative technology of the very highest standard. Llyis make their own silicon because they have found imported material to contain too many impurities, and with the confidence encouraged by a bulging order book, they have now found it possible to take up their option on a section of Prestatyn beach, thus ensuring a ready supply of raw material for years to come.

The new ZMOS power transistor family is typical of Llyis products. Designed primarily for high current, high power applications in disco power amplifiers, the new ZMOS family manages to combine the best of bipolar, MOSFET and valve technology in one easy to use "HEX-NUT" package. The ZMOS X520 for example, is very sensitive to static charges and requires a high current drive source, and yet it has the highest "on" resistance in the industry and runs from a 200V h.t. supply. All the ZMOS range feature industry-standard 6·3V a.c. heaters and unique "disco safety" circuits which render the amplifier harmless during transient musical passages which might otherwise lead to auditory damage. The 4kW per channel (typical, using 4 × X520S) or 8kW per channel (typical using 4 × X530S) is higher than anything unleashed in discos before, and has forced Llyis to develop companion loudspeakers with leather cones. Every device carries a government health warning, but under extreme conditions the "disco safety" circuit will cause the output devices to self-destruct before the 160db pain threshold is exceeded.

The novel ZMOS "HEX-NUT" package features ports for standard microbore central heating pipes, and for evaluation purposes a domestic radiator and central heating pump system topped up with ice water before a session will be about ready to brew coffee two mind blowing hours later. For serious applications a thirty gallon header tank will be needed, and a full quadrophonic system can provide central heating for an average street if used for just four hours per day.

Nice one boyos!

MINI-DIP GRAVITY CIRCUIT (AG 1000)

In these days of energy crisis and threats to our oil supplies, it is refreshing to find that the energy problem is not being ignored by the semiconductor manufacturers. The German firm of TRASKERT Gmbh has been experimenting with new forms of energy conversion using gallium arsenide photon emitters for several years now, and if the data sheets and samples we have just received are anything to go by, they are on the edge of a breakthrough in this fascinating area. Their AG 1000 anti-gravity circuit is integrated on to a small semiconductor chip, and yet when coupled to a low cost gravity anomalizer it can generate the power of 10^9 space shuttle engines. Details of the chips operation are still secret at this stage, but we wired ours up on a small piece of Veroboard using the application notes in the data sheet and tried it out. Despite the "birds-nest" layout, we achieved warp factor 8 on our first run, but re-entry was a problem and the legs of our bench were badly charred. Hobbyists are cautioned not to run the chip above 2 volts unless proper ablative heat shields are worn. (Note: Wicket keeper's pads are *not* sufficient.)

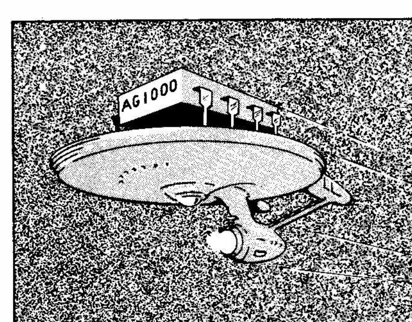
On our second try we fitted the circuit board in place of the engine in an old Ford Popular and wore skin diving air tanks. Since their AG 1000 takes only 2 ma at 9 volts we were able to do an orbit of Jupiter on a single PP3 battery before returning via the sling-shot effect. A fully charged car battery should get you to *Alpha Centauri* and back if you take enough sandwiches.

The AG 1000 is packaged in an 8 pin mini-dip, but at warp factor 1 this actually turns into a flatpack, so make sure your soldering is up to standard. The device is currently priced at 18p in hundreds, but this is certain to fall as demand increases.

ROBOT MICRO (IU 101)

At last the millions invested by the British taxpayer in Inmos seems to be paying off. The first circuit to be unveiled by Doctor A. N. Droid at a recent press conference is a new microprocessor designed for applications in robotics. The design of this chip was carried out entirely in the U.K. although pilot production will initially take place in the U.S.A. until the Inmos manufacturing facility over here is fully operational. The new device, coded IU 101, is unlike other microprocessors in that it can be programmed in a "learn" mode. Pins on the 64 pin package are allocated for serial audio inputs and outputs, and two 8 bit DMA channels are available for the connection of a pair of colour TV cameras. Motor outputs are driven by means of a multiplexed control bus which can handle up to 256 separate muscle servos. Internally the IU 101 CPU has a 64 bit wide pipe-lined architecture with no less than 18 subsidiary 8 bit processors for I/O handling and memory management. On-chip firmware in ROM provides a high level English language interpreter (French available late 1980) and various utility routines to handle basic motor functions and sensor interpretation. A fast NMOS cache memory (64K × 64 bit words) and a 20 Megaword long term backing store using bubble memory technology are also included on the chip. Although the chip is large by today's standards Dr. Droid stated that yields were high, and earlier testing problems were now being overcome. One of the most exciting innovations on the chip were the 2 nanosecond A to D converters which had been fabricated using Schottky technology, said Dr. Droid.

Applications for the IU 101 are expected to include basic household robots and the manufacture of Fiat cars. All the pilot production is being used in-house at Inmos at the moment, ostensibly for brain transplants. Dr. Droid stated that a politician version (with limited memory and stripped down CPU) would be available in early 1981.



Warp testing the AG 1000

CHIP CHECKER

L.V. COOPER

THIS device differs from most i.c. testers in as much that the logic states of all the i.c. pins can be seen at a glance. Not only are the high and low states displayed, but this checker differentiates between high, low, inadmissible, and open circuit states.

Although the tester does not check *all* the different aspects of a logic i.c. it does allow go/no-go devices to be identified quickly and can, with practice, go a long way to identifying an unknown i.c.

The circuit design allows the use of cheap calculator type multiplexed displays.

OPERATION

The operation of the device is basically simple and consists of a set of three comparators which are very rapidly switched around the pins of the i.c. under test, whilst at the same time enabling the appropriate display digit.

CD4016 quad analogue switches i.c.'s 1 to 4 are employed to switch the comparators onto each pin.

The switching sequence is controlled by a four to sixteen line decoder (IC5) which operates the switch controls and also enables the digit drivers (IC's 7, 8 &9).

The decoder is fed by a binary counter IC6 which is in turn clocked by a 500Hz oscillator made up from two of the gates in IC12.

Interdigit blanking is necessary and is achieved by feeding clock pulses from the oscillator, after inversion by TR2, to the blanking input of the binary to seven segment decoder IC13. This ensures that all displays are off during the first half of the clock pulse.

COMPARATORS

IC10 (LM324) is a quad op-amp and three of the four amplifiers in the package are used as comparators to detect the logic state of the pin being sampled.

Logic "1" is detected by IC10c, the output of which goes high if a voltage greater than +2·4 volts is present at its input.

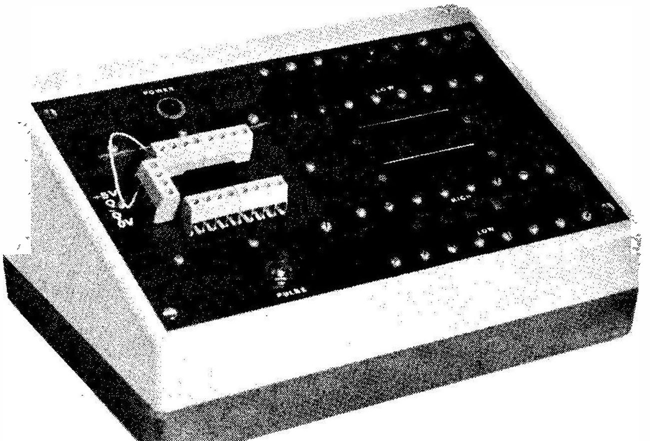
Logic "0" The outputs of all three comparators are arranged to be low when a voltage between 0 and +0·4 volts is present on the inputs.

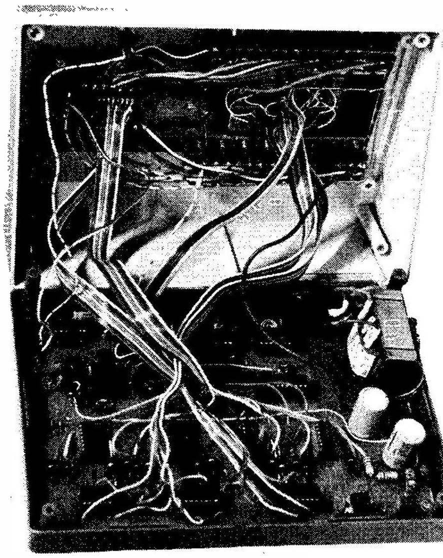
Inadmissable levels (+0·4 volts to +2·4 volts) are detected by IC10a. The output is high when a voltage greater than +0·4 volts is present on its input.

Open circuit Any pin that is open circuit either by design or a fault condition is detected by IC10b.

A negative voltage is fed onto each test pin by means of 1MΩ resistors 1-16, and clamped by germanium diodes D1-16 to approximately −0·2 volts. When an i.c. is plugged into the test socket this small negative voltage, when connected to a live pin, will be clamped to zero or overridden by the positive voltage present on that pin, provided of course that the supply is connected to the i.c. under test by means of the terminals provided.

IC10b detects the presence or absence of this negative voltage, and if present its output goes high, the output from the gating circuitry presents a binary code greater than nine to the decoder IC13 and it automatically blanks the display. Any other condition causes IC10b to produce a low output, leaving the display format to be decided by the other two comparators.





COMPONENTS . . .

Resistors

R1-R16, R32	1M $\frac{1}{8}$W (17 off)
R17-R19, R21, R22, R33	100k $\frac{1}{8}$W (6 off)
R20, R23, R34, R54	10k $\frac{1}{8}$W (4 off)
R56, R24	22k $\frac{1}{8}$W (2 off)
R57	6M8 $\frac{1}{8}$W (1 off)
R25-R31	150 $\frac{1}{8}$W (7 off)
R51, R52, R55	1k $\frac{1}{4}$W (3 off)
R35-R50	2k7 $\frac{1}{4}$W (16 off)
R53	330 $\frac{1}{4}$W (1 off)

Potentiometers

VR1, VR2, VR3	47k min. preset
VR4	100k min. preset

Capacitors

C1	10n Disc Cer.
C2	1µ Tant.
C3, C9	470µ elect. 15VDC (2 off)
C4, C5, C7, C10	100n 30V Disc Cer. (4 off)
C6, C8, C11	100µ 16V Tant (3 off)
C12	22µ 16V elect. (1 off)

Transistors

TR1, TR2	BC107 (or similar) (2 off)

Diodes

D1-D16, D29	OA90/91 (gen. purp. germanium) (17 off)
D17-D23	IN914 (or similar) (7 off)
D24-D25	IN4001 (or similar) (2 off)
D26-D27	6·8V Zener 400mW (2 off)
D28	0·2 in. l.e.d. (green) & holder

Integrated Circuits

IC1-IC4	4016 or 4066 (4 off)
IC5	4514
IC6	4516
IC7-IC9	75492 (3 off)
IC10	LM324
IC11, IC12	4011 (2 off)
IC13	4511
IC14	74121 optional
IC15	7805

Switches

S1-S16 3-way centre-off slide switch (16 off) (Progressive Radio)
S17 Single or double pole 250V ac 1A toggle (1 off)
S18 Push-to-make switch (optional)

Miscellaneous

14-pin d.i.l. i.c. sockets (11 off)
16-pin d.i.l. i.c. sockets (3 off)
24-pin d.i.l. i.c. sockets (1 off)
T1. mains transformer 6·3V 1A
Displays. Bowmar 8 or 9 digit, or NSA 1298 (2 off) (Henrys Radio) These are common cathode
1½ Metres 8-way ribbon cable
Printed circuit board
2-core ,mains cable
Vero case 2523E
Terminal blocks Electrovalue type 7204 4-way (5 off)

DISPLAY FORMAT

The outputs from the comparators are gated by IC's 11 and 12, TR1 and D21, D22 and D23, to produce the following display characters:—

Logic "1"—displays "1"
Logic "0"—displays "0"
Inadmissable—displays "8" flashing at 2Hz.
Open circuit—displays *blank*

The fourth op-amp in the LM324 package is used as an astable oscillator running at 2Hz. By feeding this into the gating arrangements it causes the "8" to flash at 2Hz.

PULSE GENERATOR

A 74121 monostable (IC14) is provided on board to provide a clock pulse for checking counters. The Q and $\overline{Q}$ outputs are brought out to a terminal block near the test socket. The monostable is triggered by means of a push button switch, S18 mounted on the front panel. This part of the circuit may be omitted if not required.

POWER SUPPLY

The power supply consists of a 6·3 volt mains transformer feeding two rectifiers D24 and D25 which together with the reservior capacitors C7 and C9 provide positive and negative rails of approximately 9 volts each. A split supply is provided from the op-amp package of ±6·8V, Zener stabilised by D26 and D27.

The output voltage of the op-amps is 1·5 volts less than the supply at maximum and a further 0·6 volts is dropped by the isolation diodes, D17, 18, 19, 22 and 23, which are in series with the op-amp outputs. The total voltage loss is therefore approximately 2 volts. In order to ensure that the 5 volt logic circuitry interprets a high output from the op-amps as logic "1" the supply rail for the amplifier package needs to be 2 volts above the 5 volt supply, hence the 6·8 volts.

The 5 volt logic supply and the supply for the i.c. under test is provided by a 7805 i.c. regulator from the raw 9 volt supply, IC15.

The use of a 7805 in this situation provides a double benefit because apart from providing good regulation, should one inadvertantly switch a test pin down to chassis whilst it is connected as a supply pin, the 7805 shuts down and restores power when the short is removed, suffering no ill effects and with no damage to the offending switch.

A power indicator l.e.d. is fitted (D28), mainly to help avoid an i.c. being inserted with power on, which could result in damage to the i.c. The indicator also reduces the risk of leaving the tester switched on when not in use, which could all too easily happen if all switches were set to the centre position and the test socket unoccupied, leaving a totally blank display.

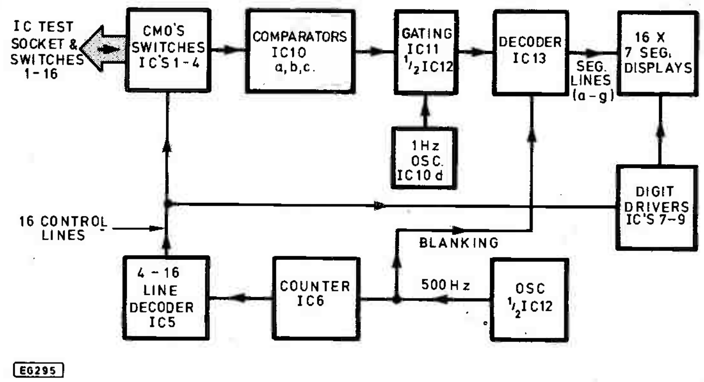


Fig. 1. Block diagram of Chip Checker

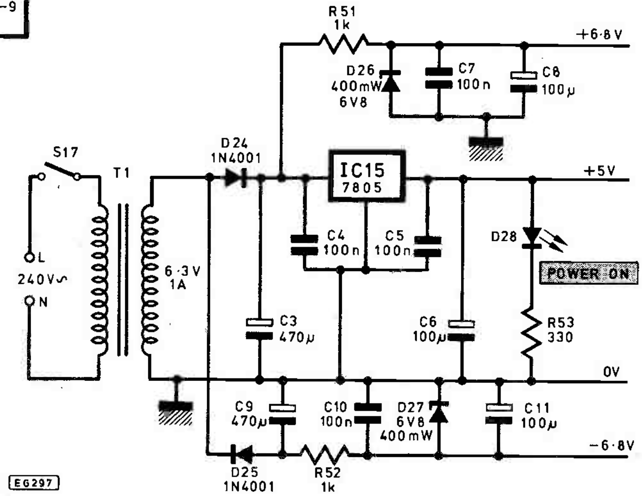


Fig. 2. Power supply

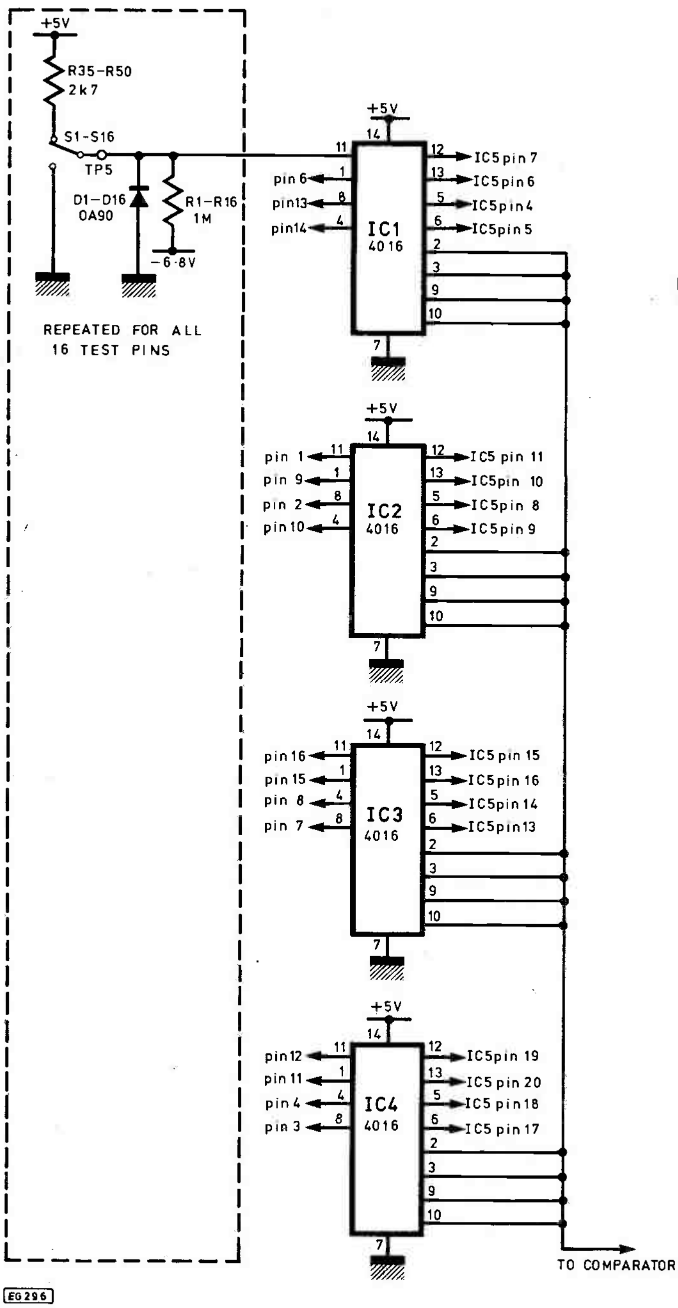


Fig. 3. CMOS switching stage

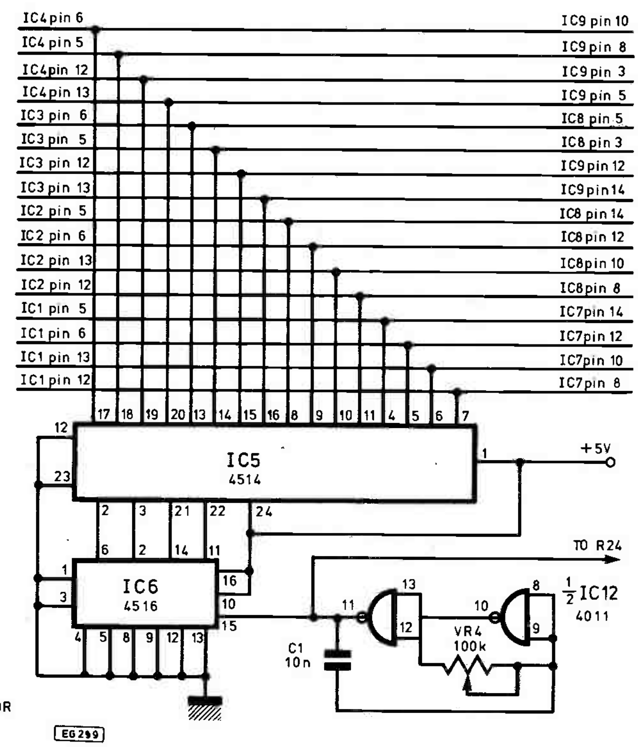
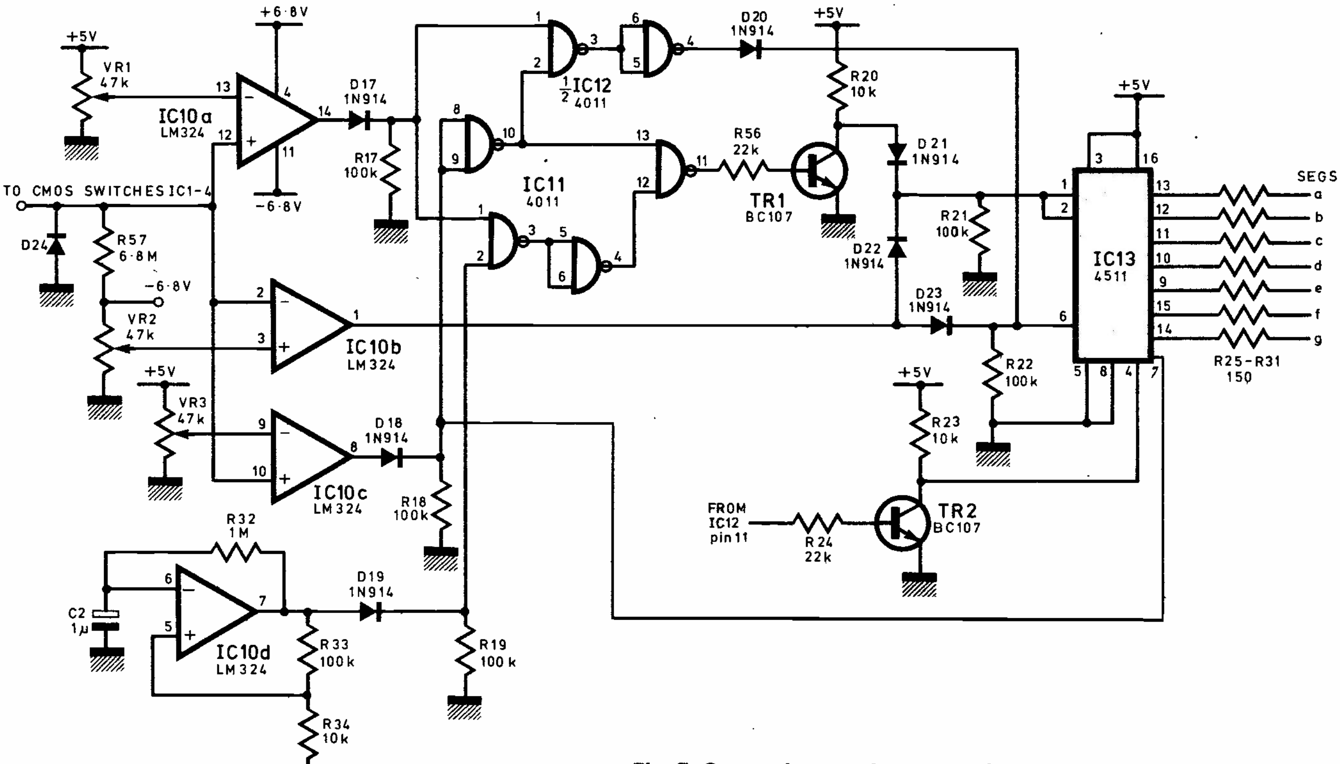
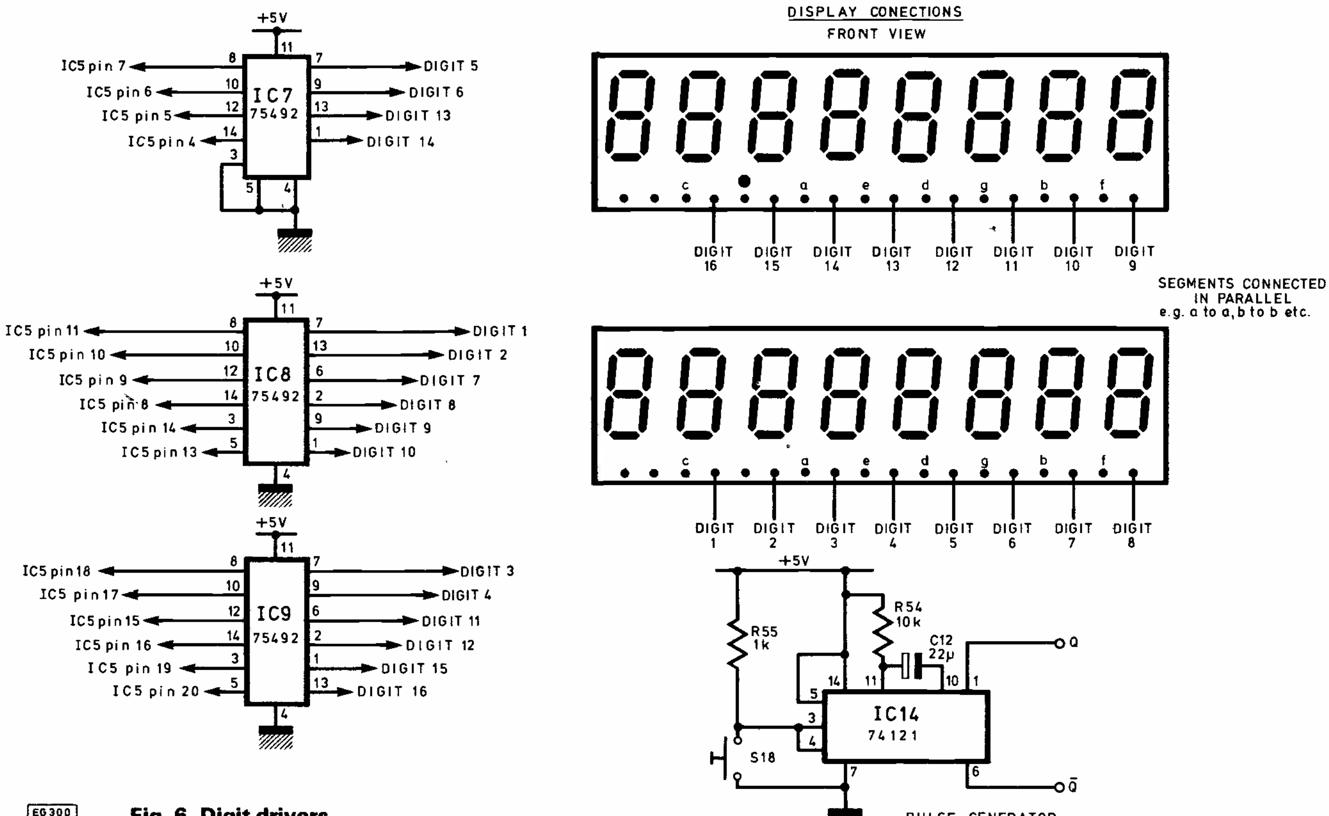


Fig. 4. Clock, and switch sequence control



EG298

Fig. 5. Comparitors and segment decoding



EG300

Fig. 6. Digit drivers

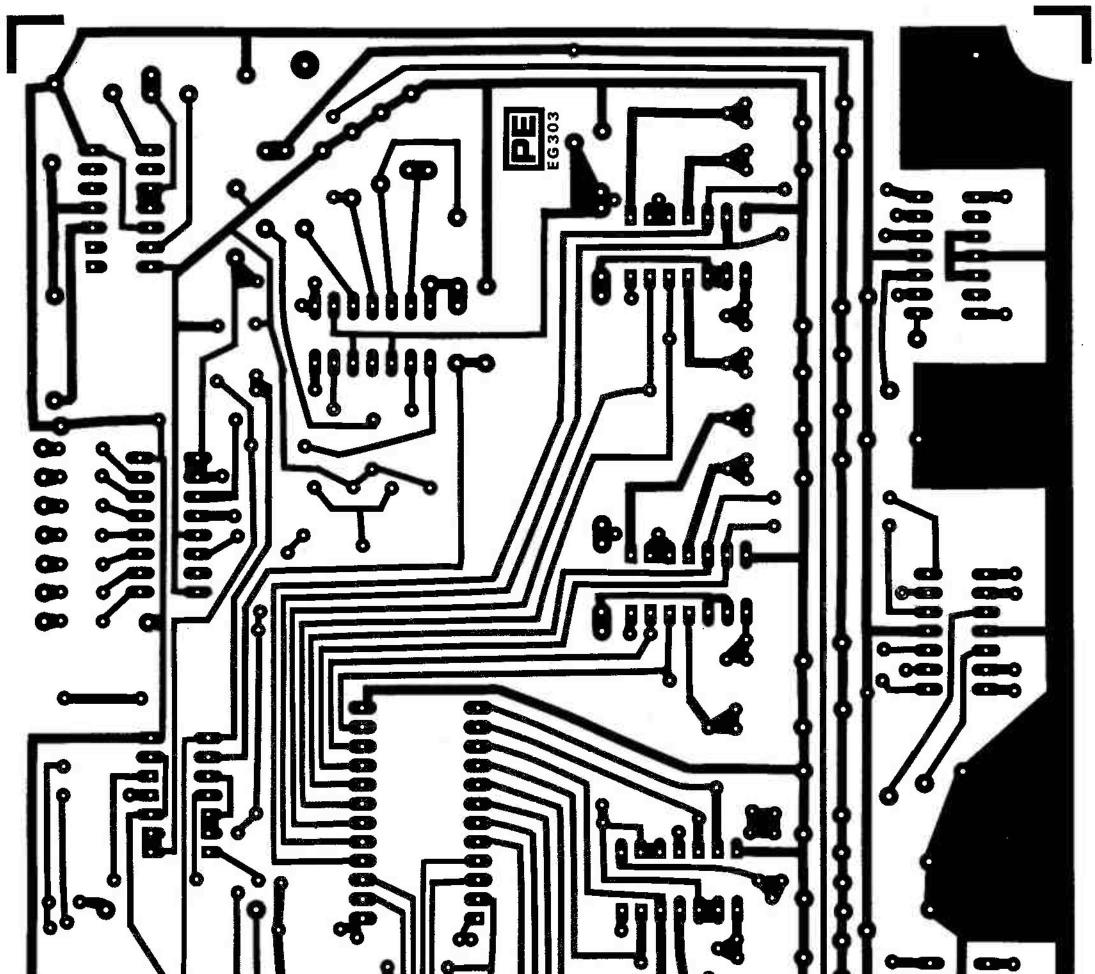


Fig. 7. Printed circuit layout (actual size)

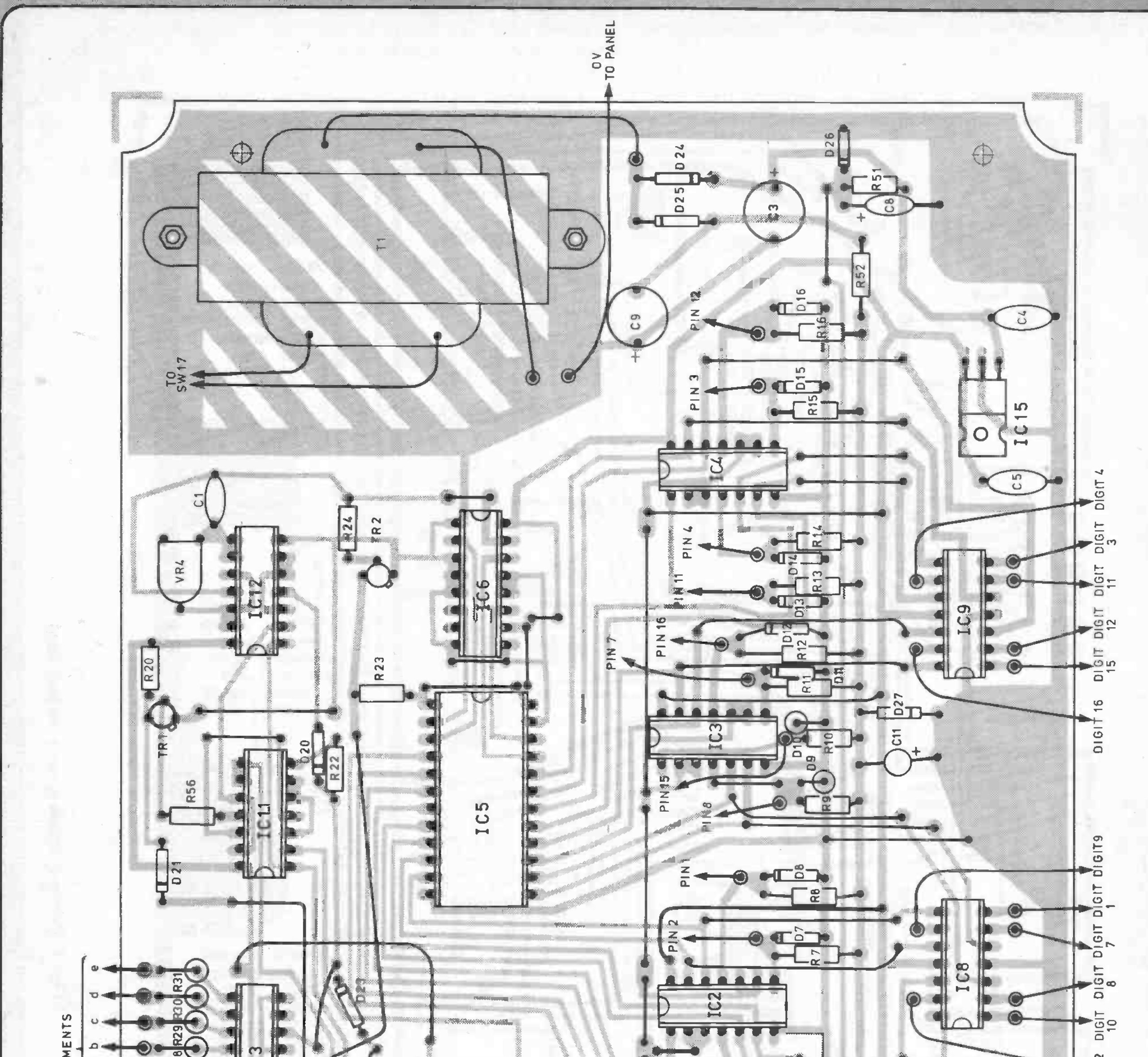


Fig. 8. Component layout

The +5 volts rail and the ground rail are brought out to terminals on the front panel to power the i.c. under test, and for external use if required.

The +5 volts is connected to the i.c. under test by means of a wire link connected to the +5V terminal and the appropriate supply pin on the test socket. The ground connection is made by switching the appropriate switch low.

TEST SOCKET

The test socket, apart from being wired to screw terminals, is also wired to a set of sixteen switches, S1-16, which allow any one pin to be set high, low or floating. In high position +5 volt is applied to the pins by 2k7 pull up resistors (R35-50), which allow open collector devices to be tested, and prevent smoke being produced by the device under test if two inputs are short circuit.

CONSTRUCTION

The layout is in no way critical and should present no problems to anyone wishing to use a different form of construction.

If the printed circuit layout is used it may help to fit all the jumper wires first, using sleeving if required. This avoids missing and jumpers due to the position being obscured by other components.

Before fitting any i.c.s, check that the negative voltage on the cathodes of the clamp diodes D1-16 and D24 is −0·2 volts or less. Any voltage greater than −0·2 volts will cause the 4016 i.c.s to fail. The various supply rails should also be checked at this point.

When fitting the i.c.s, make sure the power is off, and check orientation very carefully.

Ribbon cable is strongly recommended for connections between the front panel and the main board; it makes for a much easier time during assembly and fault finding if necessary.

SETTING UP

(1) Set all front panel switches to the centre position.
(2) Set all four presets to mid position. Displays should now be active.
(3) Adjust VR2 until displays are just off.
(4) Switch off and connect a 1K or 5K potentiometer across the +5 volt supply with the wiper to any test pin terminal. Connect a meter between wiper and zero volts. Switch on.
(5) Adjust the pot. for a reading of +2·4 volts on the meter and adjust VR3 until display just reads "1".
(6) Reset the pot. for a reading of +0·4 volts on the meter and adjust VR1 until display just reads "0".
(7) Rotate the pot. from one end to the other and check that the display reads "0" at one end, "flashing 8" around the centre and "1" at the other end. If this does not happen you have a fault.
(8) Disconnect pot. and meter and set all front panel switches to the low position one at a time, and check that the digit applicable to that switch reads "0".
(9) With all switches set low adjust VR4 for minimum flicker on the displays.
(10) Set all front panel switches high and check the appropriate display reads "1".
Returning all switches to centre should leave display totally blank.

USING THE CHIP CHECKER

When a TTL or DTL i.c. is plugged in and the power supply connected, if all switches are placed in the floating position, the open circuit pins if there are any, will be blank. The output pins will display one or zero and of course so will the supply pins. The input pins will normally adopt an inadmissible level of approximately +1·4 volts. The input pins will be obvious due to the flashing 8 displays. The switches may be used to program the inputs whilst the outputs can be observed on the displays and correct or faulty operation ascertained.

Counters may be clocked using the push button and monostable arrangement and the outputs all monitored at once.

If an *unknown* i.c. is plugged in, the power supply pins may sometimes be found by leaving all switches in the floating position and applying +5V only to each pin in turn and noting the number of ones present on the display. The supply pins produce the largest number of ones, thus the two pins that produce the same number as well as the larger number, may normally be assumed to be the supply pins. The polarity can then be determined with an ohmmeter.

If the supplies are then connected, the inputs will be visible by the presence of the inadmissible logic levels. The inputs can now be systematically programmed high or low, the outputs monitored and a truth table made up.

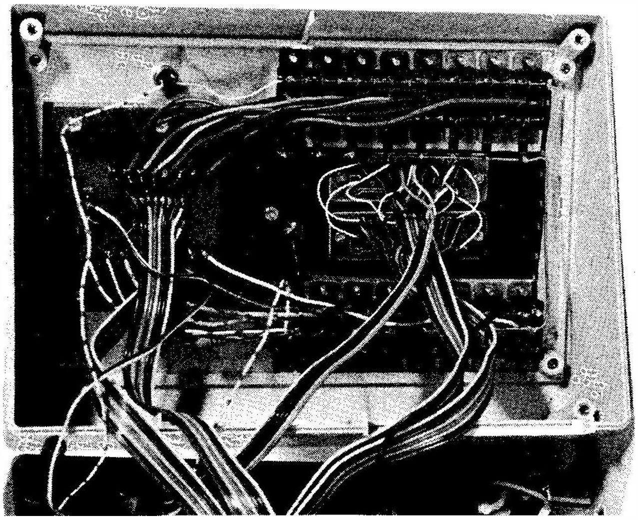
The ability of Chip Checker to detect an open circuit pin is useful when testing tri-state devices, a disabled tri-state output should behave as an open circuit and produce a blank display digit.

It should be noted that input pins can interact with one another if left floating and so all pins that need to be high should be switched high and not left floating. A short circuit between two inputs or adjacent pins will be obvious, when one is taken low by a switch the other will indicate low also even though it is switched high.

Chip Checker was primarily designed to test TTL i.c.s. EG 74L, 74S, 74LS, and of course standard 74 series. It will however handle DTL and CMOS i.c.s although the input pins of CMOS will produce blank displays due to the very high input impedance of these devices, and of course the logic levels are incorrect for CMOS. DTL i.c.s behave similar to 74 series.

Since the tester was first built it has been used for checking untested "fall out" devices and the monitor ROM's of an MK14, also buffers and gates from home computer systems after those inevitable accidents that occur during system expansion and modification.

The device has proved both reliable, and with a little practice, easy to use. ★



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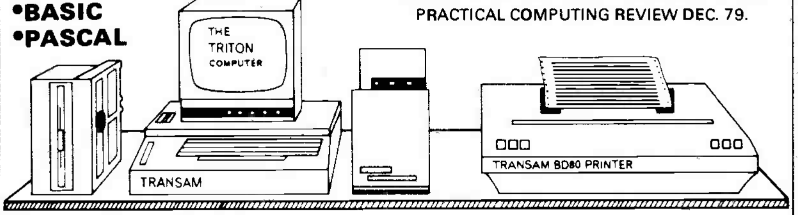

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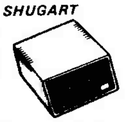

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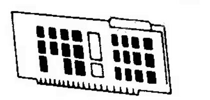

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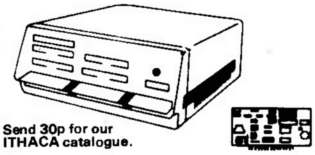

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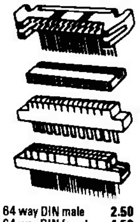

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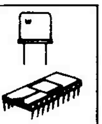

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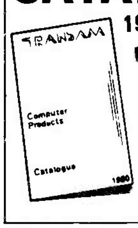

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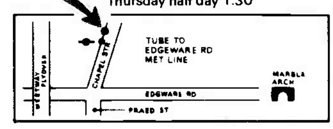

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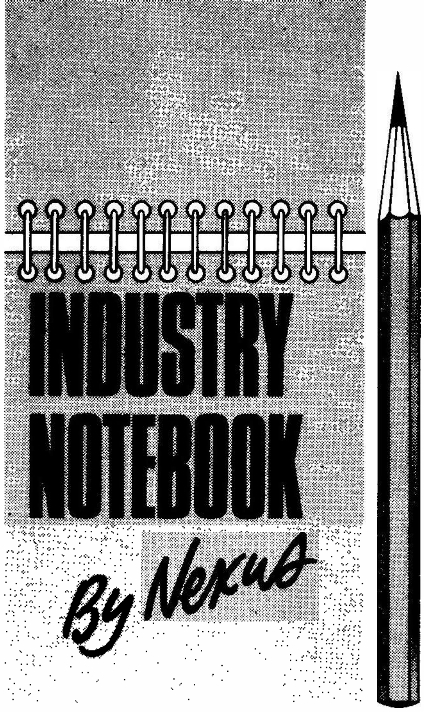


'Finniston'

The Committee of Inquiry into the Engineering Profession started its work under the chairmanship of Sir Montague Finniston, F.R.S., in July 1977. Its 65,000 word Report, 'Engineering Our Future', was published in January this year by Sir Keith Joseph, Secretary of State for Industry, and the next step, a White Paper, is expected by about Easter. This, in turn, will be debated publicly over a further period of months.

'Finniston', as the Report will doubtless be called, is of immediate value only in calling the attention of the general public to the importance of engineering. Professional engineers, their learned societies and institutions, and their employers already know this.

All the old topics of the past 20 years are served up once again, spiced with some new catch-phrases such as 'the engineering dimension' and 'awareness brokers'. It was clearly difficult to find anything really new to say about the lowly status of engineers in society, salary levels, education, trade union and employer attitudes, codes of practice, registration of engineers, encouraging lady entrants to the profession and 'regeneration of UK manufacturing competitiveness through market-oriented engineering excellence in British products.'

The main interest of 'Finniston' is not in the diagnosis but in the cure which, in the view of the Committee, is the establishment of more bureacracy and spending more taxpayer's money, some £60 million, with a new Engineering Authority costing about £10 million a year to run. The Authority will promote and strengthen the influence of engineering within the British economy, working in co-operation with the National Economic Development Council and acting as the qualification and registration body for all engineers.

Registration, except for consultant engineers, will be voluntary. Except that if you want a job with the Government or in the public sector of industry or in any company which supplies them, registration will be virtually mandatory because these organisations are to set the lead by recruiting only registered engineers. If found unfit to practice you will be struck off the register.

A new three-tier structure to take care of status is proposed. The elite would become Registered Engineering Diplomates, the great bulk of present degree engineers will become Registered Engineers and the army of technician grades Associate Engineers. Paid study leave should be a statutory right and, as at present, there will be 'ladders and bridges' for engineers to move upwards.

Effect

What effect 'Finniston' will have on civil, mechanical, aeronautical, mining or chemical engineers, or for naval architects and other categories of engineers I am not qualified to judge. But so far as electronic engineers are concerned it is difficult to imagine that it will make the slightest difference.

In fact the broad proposals already exist. Engineers are already registered and existing institutions should only need strengthening, not dismantling. On the question of status, the present title of Chartered Engineer surely sounds more professional than the proposed Registered Engineer. This however is a small point but nothing is achieved by tinkering around with job titles and setting up new committees even though dignified by the title of Authority. In the end it is only job satisfaction and salary which have real influence in attracting people to any occupation, in determining performance and even status in society. Electronic engineers are generally enthusiasts who can't imagine doing anything else. In this they are fortunate as, indeed, in working in an expanding industry with consequent high morale.

It is all a question of attitudes of people towards work and achievement, and Sir Monty Finniston has admitted that he does not expect attitudes to change in less than a generation. My own belief is that the new drive towards a universal core curriculum in schools with compulsory mathematics, English and far greater emphasis on science subjects will do far more to encourage young people into engineering and in raising the status of engineers than any number of talking shops spending weary months compiling reports, however learned they may be.

Rewards

In the light of 'Finniston' a quick check of current job offers showed a remarkable spread of financial reward in electronics. Starting salary for a lecturer can still be as low as £3,480 and a degree standard information officer preparing abstracts starts at £3,700. In the mid-range a development engineer can command £5,335, a test engineer £6,830, a MPU applications engineer £7,000 plus car. At the higher level a group leader on instrumentation, £12,000.

Overseas posts are looking less attractive than they once were for salary, but £8,630 tax free in Brunei looks reasonable. In West Germany £8,000–10,000 is offered for tidying up the grammar in English literature on data sheets and technical manuals for an instrument company, suggesting that the UK is not the best place to work in Europe if salary is the prime consideration.

The beauty of employment in electronics is the enormous spread of job interests. You can practice in almost any field. If you have a secondary interest in aircraft, you can get into avionics; if you are keen on human welfare, take up medical electronics; or if keen on chemistry, get into analytical instruments. The variety is almost unlimited, and with the present demand for electronic skills at all grades, nobody need stay in a job with an uncongenial environment.

Decca

As forecast last month in this column, Racal has now emerged into the open with a bid for Decca. I have frequently billed Racal as 'unstoppable' and this seems to be the case through good times and bad. Racal-Tacticom has landed a turnkey project worth £40 million for an undisclosed overseas customer. The contract, spread over three years, includes equipment and systems from all the Racal radio companies in the UK. Another order, worth £4 million, came from the British Ministry of Defence. This is for automatic antenna tuning units for Clansman military radios. The ATUs were designed as a private venture, illustrating Racal's consistent get-up-and-go philosophy.

Inmos

The 'British Disease' was once again exemplified by screams of protest on the proposed siting of the first Inmos manufacturing plant at Bristol, near the company's technology centre. The screams are entirely political from the development areas of the country which all see the siting of the four plants in other than strictly business terms. Inmos has a difficult enough task to succeed without being instructed to site plants in what the management views as unsuitable or otherwise inconvenient locations. One sympathises with those depressed regions which are naturally disappointed, but trying to block the building of the first factory is no solution if the national need for a large micro-circuit facility is really necessary.

Meanwhile the new GEC-Fairchild plant at Neston, Cheshire, is on schedule with the exterior completed and inside work proceeding at a fast pace. It is difficult not to draw comparisons and conclude that private enterprise gets better and quicker results than enterprises in the public sector.

FREQUENCY METER

PRESCALER

Michael Tooley B.A. **David Whitfield** B.A. M.Sc.

CONSTRUCTORS who have built the Digital Frequency Meter featured in last month's issue may find the maximum operating frequency of the basic counter rather limited for many applications. The performance of the portable DFM may, however, be extended well up into the v.h.f. region by the addition of the self-contained prescaler described here.

The prescaler is a small self-contained unit which may be used with almost any digital frequency counter. It provides a fixed frequency division of ÷100 for signals in the range from 1 MHz to typically over 200 MHz, with corresponding outputs in the range 10 kHz to 2 MHz. The unit may be built for a total outlay of under £10, and the simple alignment procedure requires only a d.c. voltmeter.

CIRCUIT DESCRIPTION

The circuit for the prescaler is shown in Fig. 1. It essentially consists of two distinct sections: the input r.f. preamplifier, and the ÷100 frequency divider. The amplifier is used to provide a useful gain (>10 dB) over the operating range, thus extending the low frequency sine-wave performance down to 1 MHz (the prescaler i.c. requires a minimum signal slew rate of 50 V/μs for reliable operation).

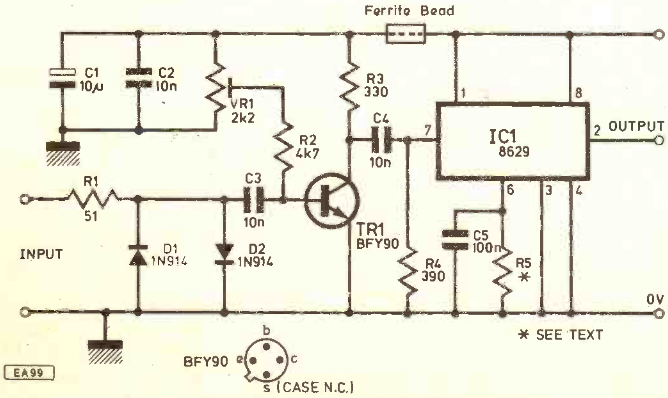


Fig. 1. Circuit diagram of the Prescaler

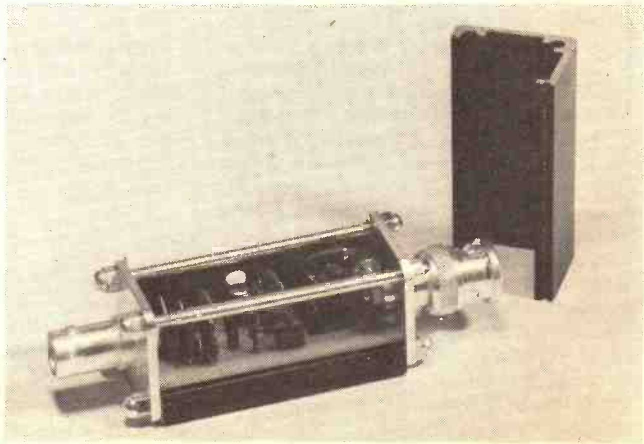
The maximum operating frequency is limited by the prescaler i.c.; the input stage still provides around 6 dB gain at 500 MHz.

The input r.f. pre-amplifier makes use of the high cut-off frequency ($f_T \simeq 2$ GHz) and high gain characteristics of the BFY90 to provide a gain of more than 10dB over the operating range. The transistor, TR1, operates in common emitter mode with the base bias adjusted by VR1. A relatively low value of collector load is used to ensure a reasonably flat gain/frequency characteristic.

The 8629 used in the second stage is a fixed ratio ECL ÷100 counter with a minimum guaranteed toggle frequency of 150 MHz (typically to over 200 MHz). The device is used here in single-ended mode and is capacitively coupled to the preceding stage. The output from the divider stages is converted to TTL signal levels.

CONSTRUCTION

It is important that all components used in the circuit are suitable for the frequencies involved. Leads should be kept short to minimise stray inductance, and signal connections



should be made by means of screened cables. Printed circuit construction is recommended and a suitable track design is shown in Fig. 2. The corresponding component layout is shown in Fig. 3. An ideal encapsulation for the p.c.b. is an in-line module case. These modules feature male and female connectors at opposite ends of the fully screened circuit enclosure, allowing direct connection to the normal counter input socket without the need for an additional co-ax cable. The signal cable may then be connected to the female socket on the front of the module. A small connector (e.g.

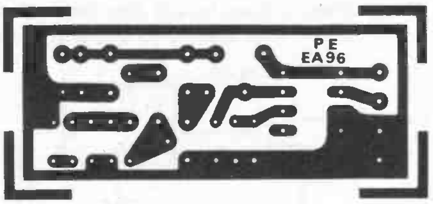


Fig. 2. P.c.b. design

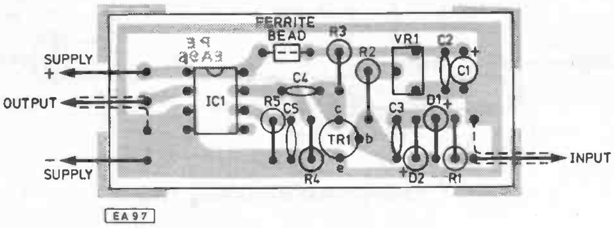


Fig. 3. Component layout

3·5 mm jack socket) should also be provided to supply power to the module; the prescaler requires approximately 6V d.c. at approximately 50mA. The supply should not be allowed to exceed 7·5V, and it should be noted that performance is seriously degraded below approximately 5·2V. A suitable power supply is a pack of four HP7-type dry cells.

COMPONENTS . . .

Resistors

R1	51
R2	4k7
R3	330
R4	390
R5	See text

All resistors ¼W 5% carbon

Potentiometers

VR1	2k2 sub. min vertical preset

Capacitors

C1	10µ tant.
C2, C3, C4	10n ceramic (3 off)
C5	100n ceramic

Semiconductors

TR1	BFY 90
D1, D2	1N914 (2 off)
IC1	8629

Miscellaneous

Ferrite anti-parasitic bead
p.c.b.
In line circuit module (RS 456-201)

Constructor's Note

Components and p.c.b. are available from **Howard Associates, 59 Oatlands Avenue, Weybridge, Surrey KT1 9SU, s.a.e. for details.**

Alignment of the prescaler is simply a matter of setting the d.c. potential at the collector of TR1 to half of the supply voltage by varying the setting of VR1. The value of R5 is a compromise between open-circuit stability and overall circuit sensitivity. Under no-signal conditions the prescaler i.c. will tend to oscillate (at typically 160 MHz). This may or may not be desirable, depending on the application. To avoid this oscillation, which does not otherwise affect the circuit, a resistor may be connected between pin 6 of IC1 and ground. This will cause some loss of sensitivity. Typically a value of 2k2 will prevent oscillation, though larger values (up to 10 k)

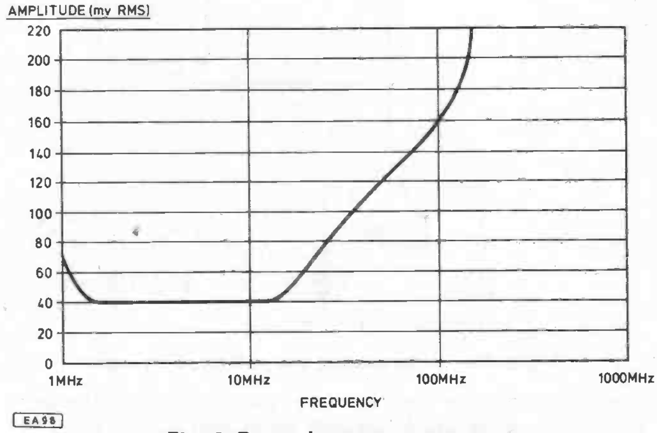


Fig. 4. Prescaler response curve

may be required. Thus, R5 is an optional component. The response of the prescaler circuit to sine-wave signals is shown in Fig. 4; the value of R5 was 2k2.

ADDITIONAL FACILITIES

A number of modifications can be carried out to the DFM which extend the basic facilities provided to the user. Unlike the v.h.f. prescaler, these enhancements require slight modifications to the wiring layout of the basic instrument. For this reason it is suggested that these additions are made after the basic circuit has been built and tested.

VARIABLE SAMPLING INTERVAL

The basic counter features a fixed interval between samples for each range. The sampling interval may be increased by wiring additional resistance, conveniently in the form of a potentiometer, in series with the existing R6. Thus, doubling the value of series resistance (i.e. R6 + potentiometer) will increase the sampling interval by approximately 50 per cent. A potentiometer of 100k or 220k will provide a useful range of control. Fig. 5 shows the modified circuit details. In

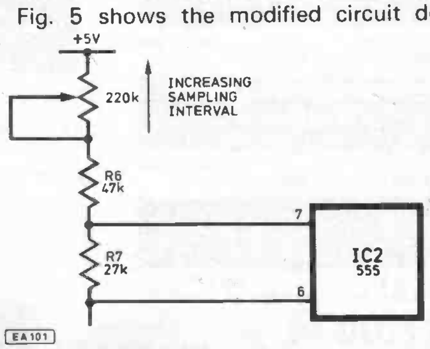


Fig. 5. Modified sampling circuit

practical terms it is only necessary to open circuit R6 and connect one end of the potentiometer to the free end. The other end of the pot is then connected to +5 V at any convenient point.

STORED DISPLAY

In many situations a signal is only available for measurement for a limited period of time. It is then often desirable to save the measured value for later use (e.g. measure the frequency of an oscillator one day and compare it against the value on the next day). This facility is easily provided by inhibiting the action of the re-sampling logic in the control logic section. The simplest way to disable the re-sampling logic is to open circuit the timing capacitor (C4/C5). The arrangement is shown in Fig. 6. The switch shown may be

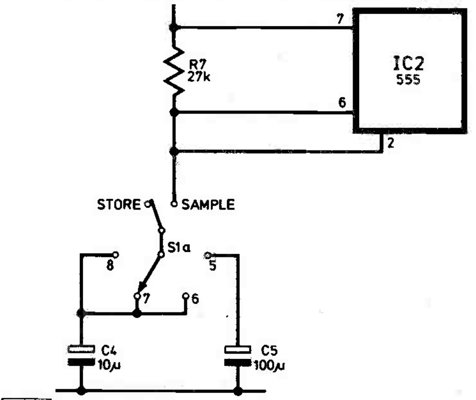


Fig. 6. Circuit to disable the re-sampling logic

combined with the potentiometer used in the variable sampling interval control to provide an overall display sampling control.

MEASUREMENT OF WAVEFORM PERIOD

The signal gating circuitry can be modified to measure waveform period rather than frequency by interchanging the Clock and Signal connections (see DFM Fig. 4). This will then provide a readout of the waveform period with a resolution equal to the periodic time of the selected clock, e.g. using a 1 kHz clock (periodic time = 1 ms) will provide a readout in milli-seconds (ignoring the decimal point). The resolution corresponding to each of the four ranges on the basic counter is shown in the table below:

Range 1 reads in units of seconds
Range 2 reads in units of 100's of ms
Range 3 reads in units of 10's of ms
Range 4 reads in units of ms

In all cases the decimal point should be ignored.

The circuit details for the changeover switching are shown in Fig.7. The printed circuit board has been designed with two wire links (LNK1 and LNK2) to allow this modification

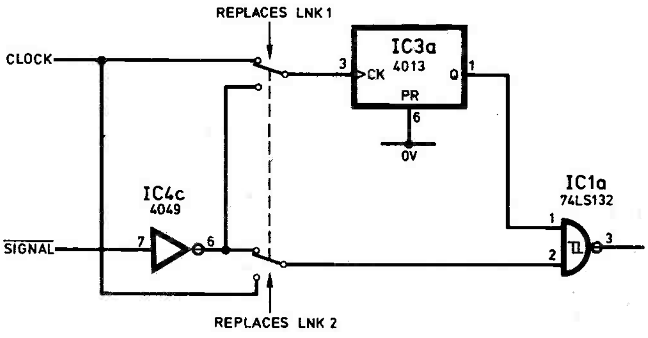


Fig. 7. Changeover switching details

to be implemented with the minimum of disruption to the existing wiring. All that is required is a two-pole changeover toggle switch, though greater elaboration may be employed with S1 being replaced with a multi-wafer type switch and additional l.e.d.s used to indicate the display units. ★

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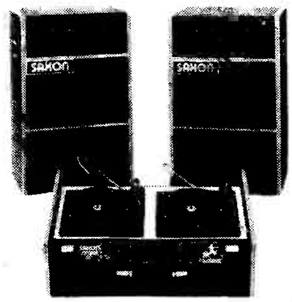

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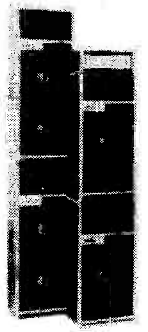

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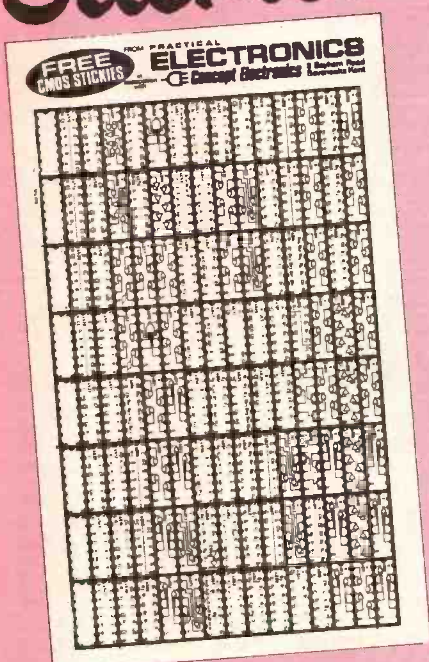

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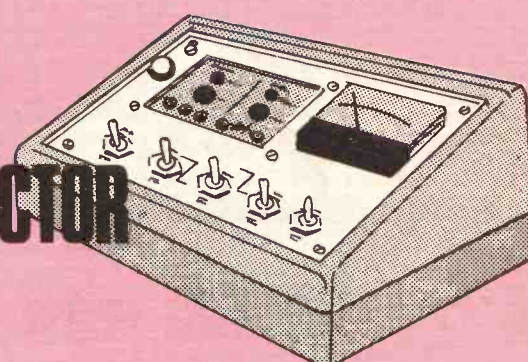

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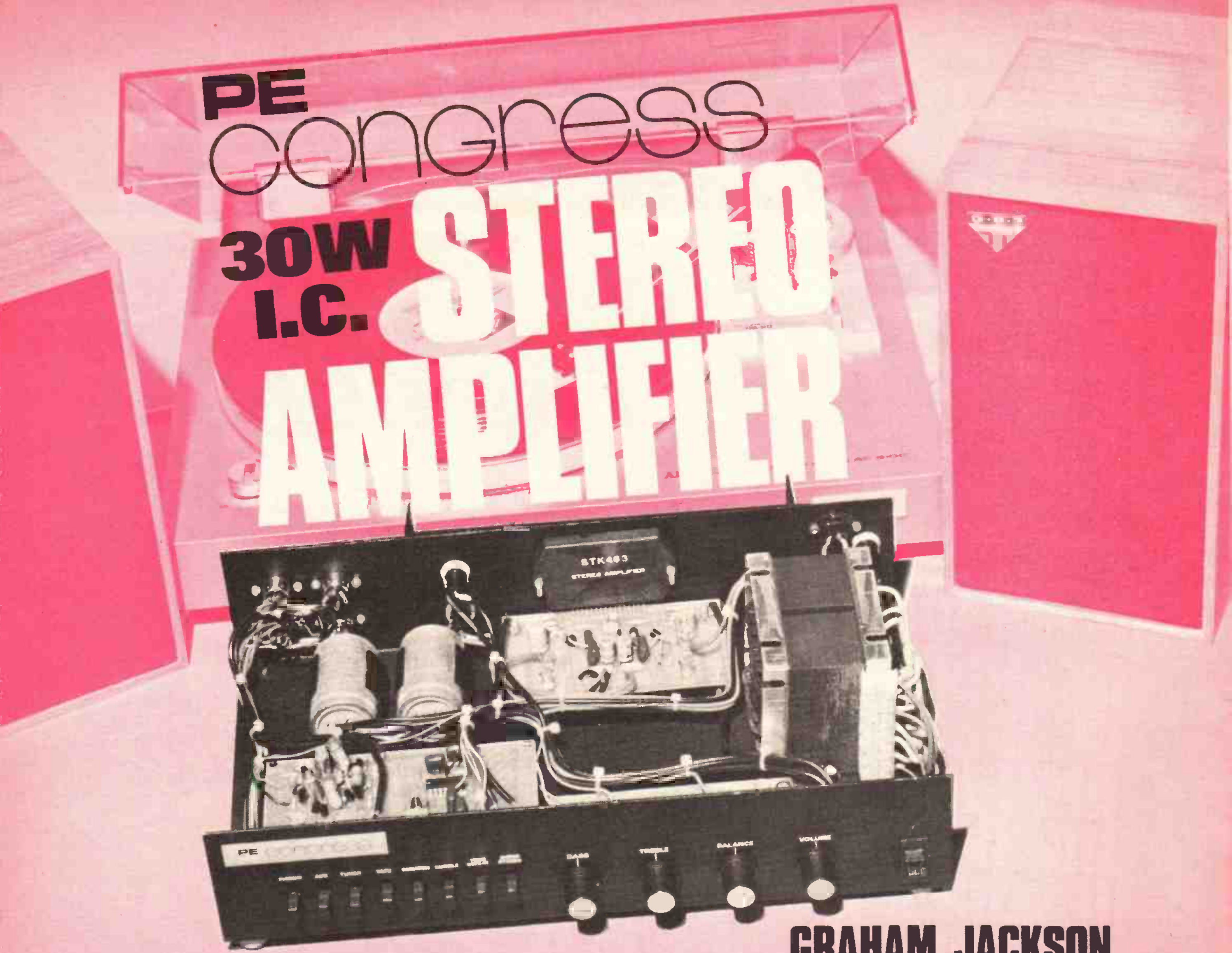


GRAHAM JACKSON

ON DECIDING to design a budget amplifier certain considerations immediately spring to mind. What is meant by "budget", apart from inexpensive for example. It seems that a budget amplifier suffers by virtue of its necessarily basic circuitry. Filters, are often not included, the phono stage is based around an integrated circuit, or a simple two transistor stage, which is either noisy or has poor overload or distortion characteristics, and the main amplifier is generally of modest standard with an output power in the range of 10-15 watts, both channels driven.

Over the months leading to the design featured here, many circuits were tried, and the result is a coming together of the various circuits that gave the best results, hence the name "Congress". It is felt that although the price puts it in the budget range, the performance that can be expected puts it on par with amplifiers costing a good deal more. The decisions behind each design stage are therefore detailed in the following article.

BLOCK DIAGRAM

Looking at the block diagram of Fig. 6, it can be seen that a separate phono input stage is provided. This is so that there is no switching in the input and equalisation paths which would be necessary if this stage was made to amplify all of the inputs. This goes to the select switches where auxiliary and tuner inputs are provided. Any input not used is switched to ground to help prevent unwanted breakthrough.

A tape monitor function is also provided. The selected input then goes to a buffer amplifier, with a gain of two, which can also be switched as a scratch filter. A rumble filter is incorporated in the disc input stage where it may be independently selected. The tone control section providing bass cut and lift and treble cut and lift, can be switched out of circuit if not required by the tone defeat function. This has the advantage that any noise generated by this stage is removed, and that both channels are then known to have a "flat" response. The main amplifier follows the volume and balance controls and the stereo-mono switch. The tape input has its own buffer amplifier so allowing monitoring via the tape decks own internal amplifier whilst recording the input signal.

SPECIFICATION...

We have noticed that in some published amplifier projects parts of the specification have been omitted and in some cases quoted figures are not theoretically obtainable. In order to obtain a totally unbiased specification for the PE Congress, which could be compared with reviews in the hi-fi press, we asked Gordon J. King to carry out a full laboratory test on the amplifier. Mr. King has written many books on hi-fi and is employed by a number of hi-fi publications as an equipment reviewer, his book Audio Equipment Tests will aid readers requiring more information on the data.

The following figures, notes and diagrams are the results of Gordon King's tests on the final amplifier design which will be described in this short series of articles. The data is published in full without any alteration. **We believe this is a unique step in the presentation of an amplifier design and one which will allow readers to feel confident in the specification given.**

Editors Note The 2dB rise in the R1AA equalisation curve (Fig. 5) at approximately 40Hz has been corrected and the scratch filter response is now 12dB per octave. The photographs are of the prototype which was modified before these tests were carried out.

O/p to clipping continuous sinewave	20Hz	1kHz	20kHz
per ch. both driven 8 ohms:	30W (14·8dB)	32·4W (15·1dB)	32W (15dB)
ditto 4 ohms:	33W (12·2dB)	37·2W (12·7dB)	37W (12·7dB)
per ch. one driven 8 ohms:	38·3W (15·8dB)	40·5W (16dB)	38·3W (15·8dB)
ditto 4 ohms:	45·5W (13·6dB)	49W (13·9dB)	49W (14·1dB)
O/p 16kHz per ch. one driven 5 ohms:	45W (14·5dB)		
ditto Z_L:	— (15dB)		
Z_L/5 ohms headroom:	+0·5dB		
O/p 1kHz 1HF bursts per ch. both driven			
8 ohms:	42·3W (16·3dB)		
4 ohms:	50W (14dB)		
Burst/steady state headroom			
8 ohms:	+1·2dB		
4 ohms:	+1·3dB		
Recovery from 10dB symmetrical 1HF burst overload:	virtually instantaneous		
Distortion factor 500mV i/p	8 ohms	4 ohms	
auxiliary both ch. driven			
20Hz* 10dB/0dB o/p:	0·083%/0·086%	0·1%/0·1%	
1kHz 10dB/0dB o/p:	0·024%/0·024%	0·046%/0·044%	
20kHz 10dB/0dB o/p	0·04%/0·041%	0·09%/0·068%	
Distortion factor and residual 500mV i/p auxiliary both ch. driven 16kHz			
5 ohms:	0·044% (Fig. 1) at −10dB o/p		
Z_L:	0·048% (Fig. 2) at −10dB o/p		
Intermodulation distortion 19kHz + 20kHz 10dB o/p per ch.	0·03% 1kHz product		
both driven	0·063% 1kHz product (Fig. 3)		
8 ohms:			
4 ohms:	Fig. 4		
Squarewave 16kHz Z_L 0dB o/p:	3·2μs		
Rise time 0dB o/p 4 ohms:	≈5·5Hz–109kHz (−3dB points)		
Freq. response auxiliary i/p 0dB o/p 4 ohms:	>5 (ref. 14·8dB 1kHz o/p 8 ohms)		
Slew factor ref. 13dB o/p 4 ohms:	66		
Damping factor 8 ohms 40Hz and 0dB o/p:			
Input sensitivity 1kHz, 0dB 4 ohms**	22mV		
high level i/ps:	0·4mV		
PU:	44mV		
Tape			
PU overload threshold			
20Hz:	15·5mV		
1kHz:	185mV		
20kHz:	1,800mV		

SPECIFICATION...

Signal/noise ratios ref. 0dB 4 ohms o/p***	
high level i/ps ref. 500mV:	85·7dB (86dB tone defeat on)
PU ref. 5mV i/p:	74dB (74·6dB tone defeat on)
Stereo separation 0dB 4 ohms o/p****	
auxiliary 1kHz/10kHz:	72dB/49dB ref. 500mV i/p
tuner ditto:	72dB/49dB ref. 500mV i/p
tape ditto:	51dB/36dB ref. 500mV i/p
PU ditto:	70dB ref. 5mV i/p/48dB ref. 50mV i/p
Crosstalk 1kHz from 500mV i/p tuner 0dB 4 ohms o/p	
to auxiliary:	84dB (noise floor of test) i/p open
to tape:	84dB (noise floor of test) i/p open
to PU:	77dB i/p open
Residual hum and noise 4 ohms o/p	
DIN audio band:	0·66mV
weighted:	0·115mV
Offset d.c. at o/p across 4 ohms	
left ch.:	6·6mV
right ch.:	0·5mV
Deviation from RIAA PU i/p:	Fig. 5 upper curve
Tone control responses relative to "flat" and defeat:	Fig. 5 middle curves
Low and high filter responses:	Fig. 5 upper left/middle right
Tape recording o/p:	120mV for 100mV i/p at aux.

* Includes mains ripple
** Measured in tone defeat mode
*** Signal/noise ratios and noise measured with CCIR/ARM weighting
**** Non-speaking channel input shorted for these measurements

Notes: Tests made after amplifier was conditioned for one hour at one-third rated output. The dB outputs refer to 2·828V across the stated load (n.b.: 2·828V into 8 ohms equals 1W). Z_L refers to a reactive load simulating a difficult loudspeaker of 5 ohms modulus and 60 degrees phase angle at approximately 16kHz.

Laboratory facilities by Gordon J. King (Enterprises) Limited, Brixham, Devon.

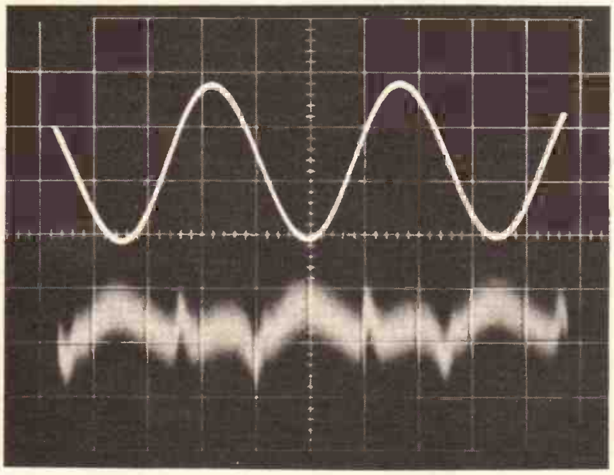


Fig. 1. Distortion factor residual at 16kHz −10dB output across 5 ohms resistive, corresponding to 0·044 per cent. Input auxiliary

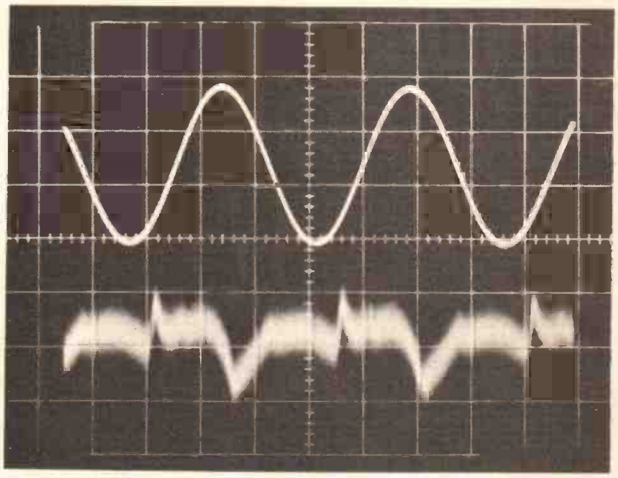
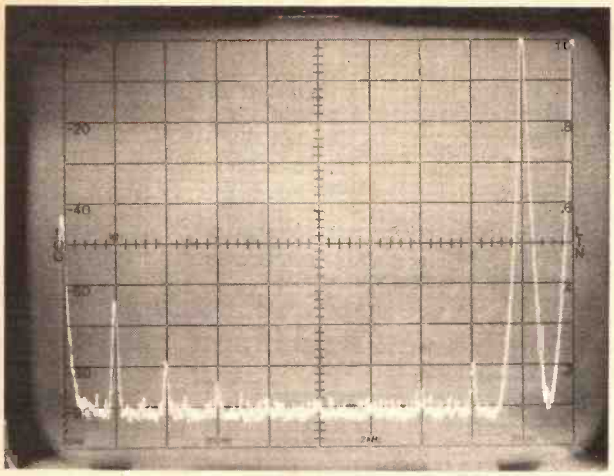


Fig. 2. Distortion factor residual at 16kHz −10dB output across Z_L (see notes at bottom of the lab chart for definition), corresponding to 0·048 per cent. Input auxiliary



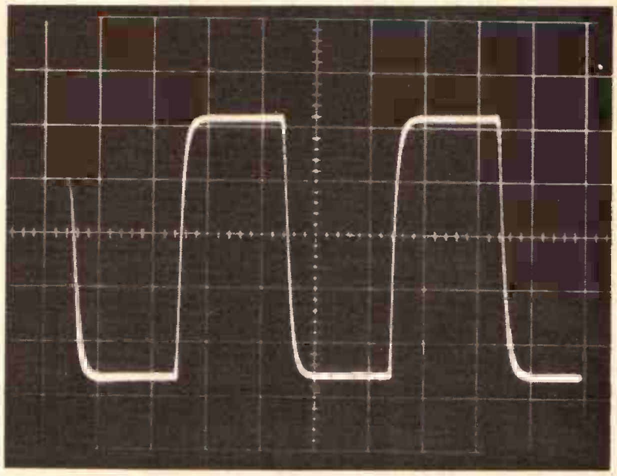


Fig. 3. Two-tone 19+20kHz equal amplitude intermodulation distortion with the 1kHz product as the parameter, corresponding to 0·063 per cent at 10dB output across 4 ohms resistive. Input auxiliary

Fig. 4. Squarewave at 16kHz across Z_L at 0dB output, input auxiliary

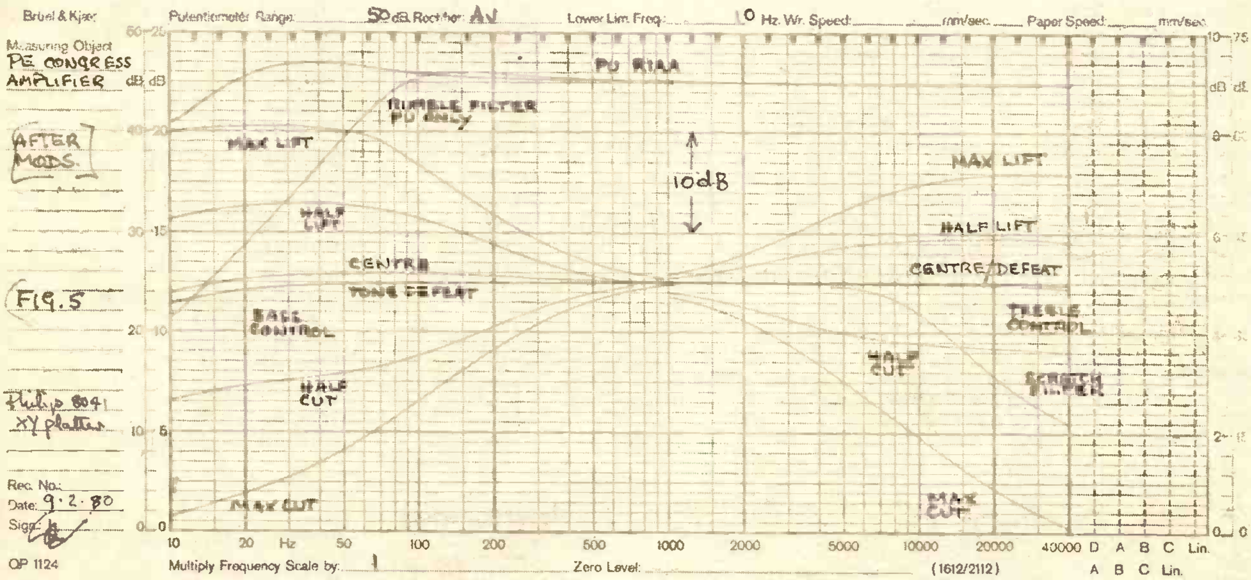


Fig. 5. Pen-chart graph of 50dB range (1dB per minor vertical division) and 10Hz–40kHz sweep showing deviation from RIAA at pickup upper, tone control responses relative to "flat" and defeat middle, and low (rumble) and high (scratch) filter responses. Input auxiliary

COMPONENTS . . .

Resistors

R1 —101	10k	R35—135	120
R2 —102	47k	R36—136	120
R3 —103	47k	R37—137	10k
R4 —104	220	R38—138	15k
R5 —105	10k	R39—139	33k
R6 —106	10k	R40—140	10k
R7 —107	180k	R41—141	3k3
R8 —108	82k	R42—142	180k
R9 —109	56	R43—143	47k
R10—110	56	R44	10k
R11—111	1k	R45—145	10k
R12—112	10k	R46—146	47k
R13—113	10k	R47—147	120
R14—114	100k	R48—148	120
R15—115	100k	R49—149	1k
R16	470	R50—150	33k
R17—117	100k	R51—151	330
R18—118	27k	R52—152	0Ω33 2W5 w.w.
R19—119	27k	R53—153	33k
R20	10k	R54—154	100
R21—121	180k	R55	10k
R22—122	10k	R56—156	4Ω7 1W
R23—123	10k	R57	10
R24—124	120	R58	10
R25—125	120	R59	33
R26—126	180k	R60	120
R27	10k	R61	10k
R28	470	R62	10k
R29—129	10k	R63	120
R30—130	100k	R64	33
R31	10k	R65 100	1W w.w.
R32	10k	R66—166	10k
R33—133	100k	R67—167	1k
R34—134	180k	R68—168	10k

$\frac{1}{3}$W carbon film unless stated

Capacitors

C1 —101	5p6 polystyrene
C2 —102	22µ elect 25V
C3 —103	22n
C4 —104	1n5
C5 —105	8n2
C6 —106	47µ elect 16V
C7	10µ elect 35V
C8 —108	1µ elect 35V
C9	10µ elect 35V
C10—110	1n
C11—111	470p polystyrene
C12—112	10µ elect 35V
C13	10µ elect 35V
C14	10µ elect 35V
C15	10µ elect 35V
C16—116	1µ elect 35V
C17	10µ elect 35V
C18—118	10µ elect 35V
C19—119	47n
C20—120	680p polystyrene
C21	10µ elect 35V
C22—122	10µ elect 35V
C23—123	390p ceramic
C24—124	100µ elect 16V
C25—125	100n
C26	10µ elect 35V
C27	10µ elect 35V
C28	10µ elect 35V
C29	4,700µ elect 40V
C30	4,700µ elect 40V
C31	4,700µ elect 40V
C32	4,700µ elect 40V
C33	10µ elect 35V
C34	10µ elect 35V
C35	10µ elect 35V
C36	10µ elect 35V
C37	470µ elect 50V
C38	470µ elect 50V
C39—139	22p polystyrene

Mylar unless otherwise stated

Semiconductors

TR1 —101	BC184C
TR2 —102	BC184C
TR3 —103	BC212C
TR4 —104	2N5400
TR5 —105	2N5550
TR6 —106	BC182B
TR7 —107	2N5400
TR8 —108	2N5550
TR9 —109	BC182B
TR10—110	2N5400
TR11—111	2N5550
TR12—112	BC184C
TR13—113	BC184C
TR14—114	2N5400
TR15—115	2N5400
TR16—116	2N5550
TR17—117	2N5550
TR18	BD535
TR19	BD536
TR20	BC212B
TR21	BC182B
TR22—122	BC182B
IC1	STK463 (Sanyo stereo power amplifier i.c.)
D1—D13	1N4148 (13 off)
D14—D17	1N5402 (4 off)
D18, 19	BZY88 C30V
D20—D23	1N4148 (4 off)
D24—D27	WO2 1A bridge rectifier

Potentiometers

VR1—101	100k dual ganged lin.
VR2—102	100k dual ganged lin.
VR3—103	10k dual ganged lin.
VR4—104	22k dual ganged log.

Miscellaneous

SK1 to 4, SK101 to 104 phono sockets (4 pairs)
SK5—105 panel mounted 4mm banana sockets (4 off)
S1 to S8, S101 to S108 preassembled switch bank with buttons
S9 single pole mains switch with built in neon
T1 125VA mains transformer 28-0-28V plus 35-0-35V (off load voltages)
FS1 500mA antisurge fuse and panel mounting holder
FS2, FS3—102, 103 3A quick blow fuses and p.c. mounting holders (4 off)
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All components, including p.c.b.s are available from **Wicca Electronics Systems Ltd., Orchard Works, Church Lane, Wallington, Surrey.**

Components for second channel shown with designations plus 100.

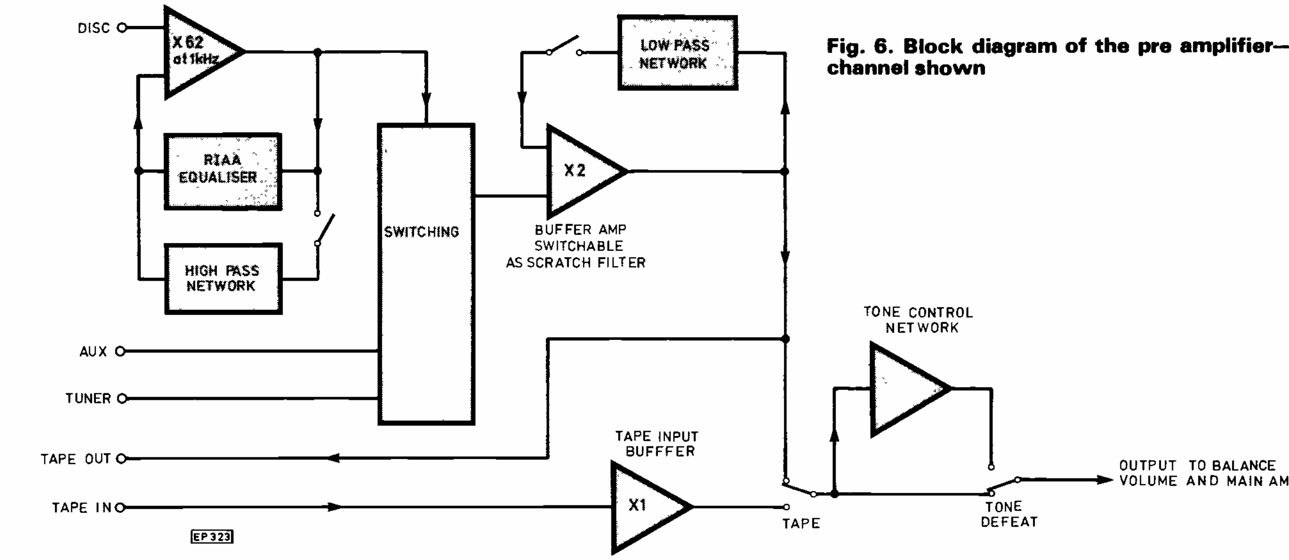


Fig. 6. Block diagram of the pre amplifier—one channel shown

PHONO INPUT STAGE

It was decided to use the operational amplifier configuration so that the entire amplifier runs on the split rail principle giving very good supply ripple rejection at the speaker and saving the expense of a regulated supply for the main amp. Various i.c.s were tried at the input stage but all were found to be far too noisy. It is surprising how much detail in the sound from disc can be masked by noise, and it is important to get the noise generated by the input stage down to as low a value as economically possible.

A discrete version of the op. amp has therefore been adopted. Referring to Fig. 7 which shows a simplified circuit of the one employed, TR1 and TR2 form the differential input. These two transistors (BC184Cs in the amplifier) have been designed to run on collector currents of 40μA which is about optimum for noise generation in these devices. Transistors TR3 and TR4 form a high gain stage so as not to load TR1's collector too severely. The collector load for these transistors is a constant current source set at about 10mA. A network giving equalisation for RIAA with an accuracy of ±1dB is then returned to the base of TR2.

The tone control circuitry is the standard Baxandell type and is built round two discrete differential amplifiers of the same type as the disc input stage. The amplifier has been designed so that this stage can be switched out if not required.

MAIN AMPLIFIER

The main amplifier posed a problem. It was decided that 35 watts one channel driven or 30 watts per channel both driven into 8 ohms was a minimum requirement with 40 watts being ideal to allow the handling of transients. Low distortion coupled with good bandwidth was also required and preferably the elimination of the normal a.c. load line protection which can cause problems when driving inductive or capacitive loads such as speakers with their associated crossover networks. Various circuits were tried with price in mind, but the output transistors either did not have suitable characteristics or were too expensive to keep the amplifier to a sensible overall price.

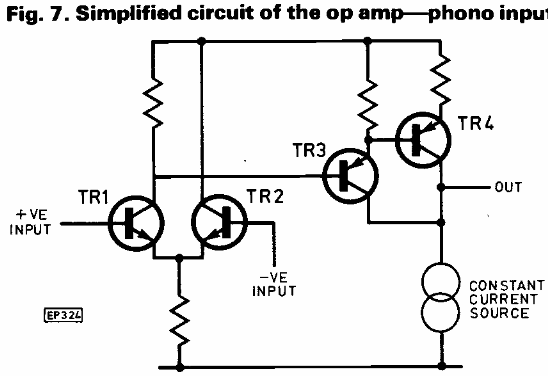
Attention was drawn to the new Sanyo device type STK463 which is a dual output stage. This fulfilled all of the requirements except that crossover distortion was apparent when tested. However, it was noticed that this distortion was symmetrical showing that the output stage was well designed. Also it was noticed that clipping at 20kHz into 8Ω gave some tendency to instability and was not symmetrical. On close inspection of the recommended circuit it was noted that a bootstrap load was externally provided for the class A drive stage, formed from two resistors and a capacitor.

From the value of the resistors the nominal current had been set at 5mA. As an experiment this was replaced by a 5mA constant current source with impressive results. The crossover distortion was reduced to a very low level, even at 20kHz, and the clipping became stable and symmetrical showing good recovery time. Having obtained these results this module has been adopted without reservation for its excellent performance.

In this design power outputs of 30 watts r.m.s. sine wave were given per channel, both channels driven or 38 watts r.m.s. sine into one channel (8 ohms). The module has been designed to fuse under short circuit conditions as it can withstand 2 seconds into a short circuit, long enough for a fuse to blow. This has the advantage cited previously of eliminating a.c. load line protection, but it is of course essential that fuses are replaced with the correct types. A complete circuit diagram will be shown next month.

It is interesting that this amplifier was used to replace one costing several hundred pounds, driving Yamaha NS1000 monitor loudspeakers and employing a Shure MkIV magnetic cartridge on a Thorens deck for the disc input, and that the opinion of people hearing the comparison, albeit not under controlled conditions, was that they could not tell the difference!

Fig. 7. Simplified circuit of the op amp—phono input stage



We would like to thank Quality Hi Fi, North Road, Poole, for supplying the AKAI deck shown in the front cover and heading photographs

NEXT MONTH: circuit and construction

SPECIAL SUPPLEMENT

VIDEO FOR EVERYONE!

G.K. GARDNER

ONE OF the major problems encountered with video recording techniques is that the developments have been extremely rapid, with the result that there is a profusion of conflicting information made available to the general public.

This article is intended to clarify the situation a little. One word of warning . . . Although video techniques have reached an important point in their development, it goes without saying that new ideas and developments are just around the corner.

That is not to say—don't go out and buy—the existing systems will be with us for many years. However, it must be recognised that progress in the advancement of the technology in electronics is so rapid that new ideas are inevitable. During the next decade video equipment of all kinds is all set to undergo an unprecedented boom, the like of which has never been seen before. It is an established fact that domestic video recording techniques are still very much in their infancy. Despite this fact it is conservatively estimated that about 100,000 VCRs were sold during last year, and sales for this year are predicted to be some 50 per cent higher.

APPLICATIONS

The basic application of the VCR is its ability to record TV programmes off air, and replay them through a conventional domestic TV receiver at the owner's leisure. The current technology enables the user to record a programme either when it is being viewed, or record an alternative channel at the same time. Additionally, with the aid of a preset timer, it is possible to record programmes without the presence of the viewer, so that they can be watched at a convenient time. This concept of "time shift" is an important feature of modern domestic video.

The addition of a suitable TV camera (either black and white or colour) offers the facility for the viewer to make his own programme. At present the cost of a colour camera is disproportionately high, and this is probably the limiting factor in growth of this market.

The comparatively recent availability of portable systems (Portapack) running of rechargeable batteries means that it is now feasible to record "live events" such as the school sports, football matches, or even the local airshow. The advantages of this system over conventional cine is that the pictures and sound are instantly replayable through the domestic TV. The major drawback is the comparatively bulky nature of the camera and recorder compared to cine equipment, but is is only a matter of time before this problem is rectified.

HISTORY

In order to understand the development of domestic video techniques, it is necessary to take a brief look at developments in this field since 1948.

In the early days, it was demonstrated that the magnetic tape medium was capable of recording and playing back video information, albeit of a quality below broadcast standards. Between 1958 and 1968, many companies developed video recording systems, which because of their lower complexity and smaller size became acceptable to both industry and education alike. The major breakthrough in recording techniques was that of the open reel helical scan system, and as a direct result of this system it was possible to further simplify and drastically reduce the price to an acceptable level.

One of the most significant advances made was the development by the BBC of an experimental recorder in 1952. This system was called VERA, but not surprisingly disappeared soon after its debut on "Panorama" in 1958. Toshiba in 1953 lay claim to the development of the helical scan system now common to all domestic recorders. This system was at that time not without problems, which were caused by inferior tape quality and frictional drag of the rotating head drum. In 1956 Ampex in the U.S.A. developed the Quadruplex system, and such was the enthusiasm shown for this in the U.S.A., some 80 units were sold within months of its debut. Consequently the VR-1000 as this was called, became the recognised broadcast standard in the U.S.A.

In 1961 Sony took the wraps off a completely transistorised recorder designated the SR-201. Unlike the VR-1000, it used the helical scan principle of Toshiba. 1962 heralded the arrival of the Telecan system from the Nottingham Valve Co. Unlike its competitors it used ¼ inch tape and a fixed head system. The fact that this recorder sold for £61 (the VR-1000 by comparison was $50,000) may have something to do with the technical difficulties which killed off this machine by 1964. Not a serious competitor!

Philips then introduced the EL 3400 which broke the £1,000 price tag barrier. By achieving this low price new markets were opened up, mainly in the industrial sector. It is interesting to note that at this time Ampex were close to introducing a fixed head recorder (VR 303) but withdrew this in favour of a helical scanner (HVR) selling at only £450.

This American breakthrough was short lived, however, when Sony introduced a helical scanning recorder selling for only £200 (TVC 2000). Sony did not stop there, they also produced the world's first domestic VTR (a four head version of the CV 2000). Their rival Akai introduced the VX 1100, but this machine was never sold, and a helical scanning model was offered in its place.

In 1967 Sony offered the DVK 2400 portable recorder, which sold for a mere £700, and weighed in at a modest 9lb. By comparison, a year later Ampex offered a portable recorder based on Quadruplex, which sold for £23,000 and weighed 50lb. Hardly a domestic machine.

Sony produced a ¾ inch cassette format which was aimed predominantly at the domestic market in 1969. This system was called Umatic, and was to become so successful it was adopted as the world standard for industrial and educational use. Its relatively high price limited its domestic acceptance though. Philips introduced the 1500 series cassette based VCRs in 1972, and to all intents and purposes the 1500 was the first true domestic recorder.

The main reasons for this so called "domesticity" were the fact that it contained its own UHF tuner, timer, and modulator meaning it could be easily used with a domestic TV. The inclusion of a timer/time switch gave birth to the concept of "time shift recording". Unfortunately the ruggedness and reliability aspects of this recorder were to lose it the battle with the Umatic system for worldwide acceptance as a non-domestic recorder but despite this Philips claim to have sold over 200,000 of these machines.

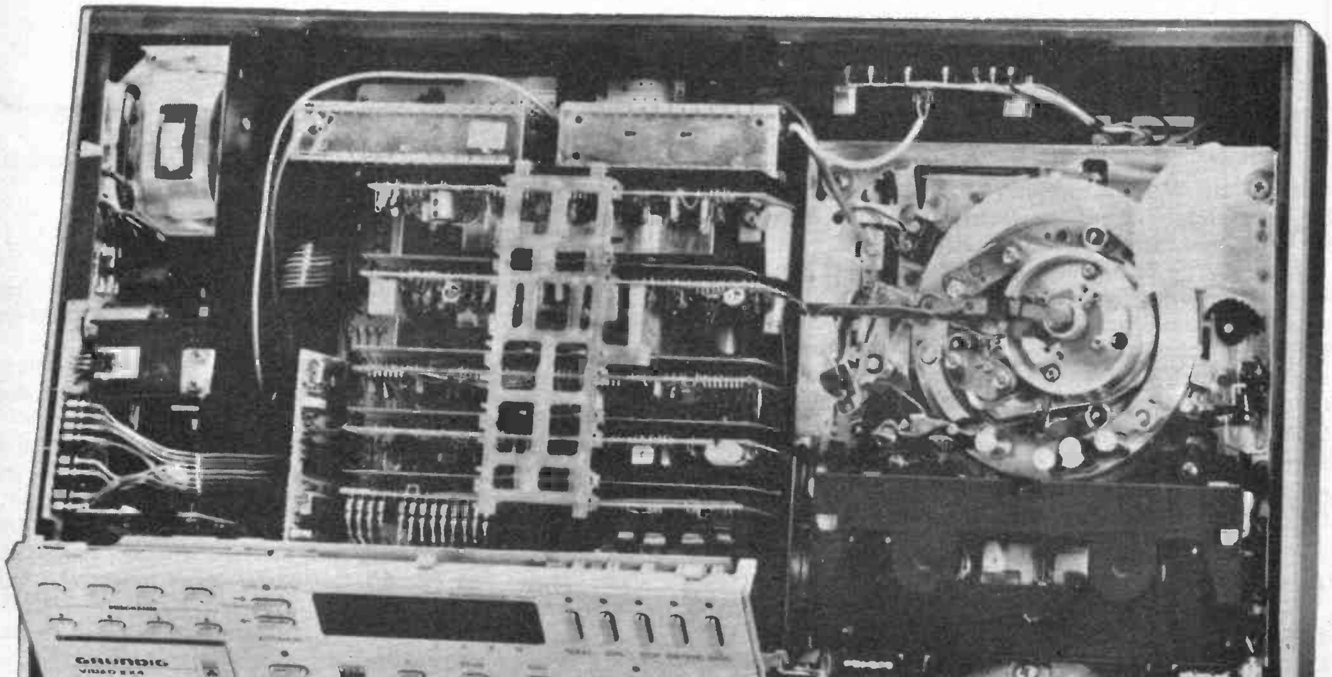
Meanwhile in Japan, Sony had introduced the Betamax I system, and one year later in 1976 JVC introduced their own VHS system. With the threat of competition from these systems in Europe, Philips hurridly launched the 1700 series, The first machines arrived in the U.K. in the autumn of 1977. Philips designated this system VCR-LP and offered the user a two hours recording time. The following year, both Betamax and VHS systems were introduced by Sony and JVC respectively in Europe. Grundig followed with the Super Video Recorder (SVR) which is a variant of VCR-LP. The ensuing battle has resulted in the fact that VHS has captured a large share of the market with VCR-LP running second, with Betamax a surprising third. SVR has found relatively little support so far.

It will be interesting to observe the effect on the market of the Philips Video 2000 system, which is potentially capable of regaining the lead for Philips. However, it may well be that the battle is already lost to VHS, and that 2000 series will become the white elephants of the 80s. Time alone will tell.

DOMESTIC CASSETTE RECORDER

The essential feature of all domestic machines is the helical scan system, which together with the use of ½ inch wide tape

Internal view of the new Grundig 2X4 (Video 2000 system)



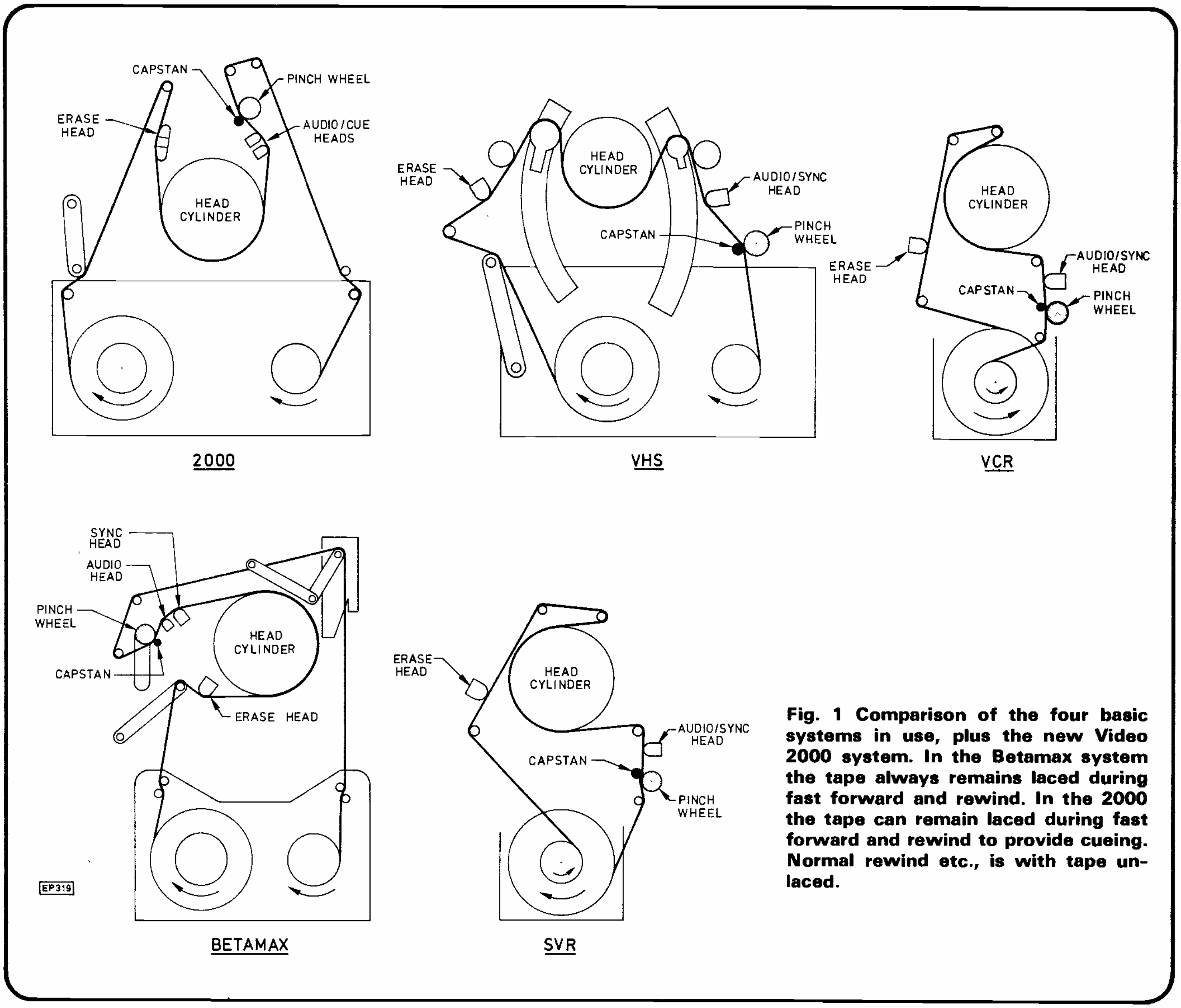


Fig. 1 Comparison of the four basic systems in use, plus the new Video 2000 system. In the Betamax system the tape always remains laced during fast forward and rewind. In the 2000 the tape can remain laced during fast forward and rewind to provide cueing. Normal rewind etc., is with tape unlaced.

allows the high packing density necessary for the storing of video signals. With the exception of SVR, VCR and VCR-LP, the tape is stored in a cassette (rather like an enlarged version of the well-known Philips audio cassette), see Fig. 1.

Ironically, the Philips VCR uses a stacked spool arrangement which is mechanically inferior to both the VHS and Betamax cassettes. Philips reluctant admission of this is clearly evident in that the tape format adopted for the new 2000 series is very similar to the VHS, but is unfortunately incompatible. One of the major advantages of using a cassette based system for domestic applications is that mechanical handling of the tape is greatly simplified, as the tedious (and delicate) process of threading the tape around the drum without damaging the heads is eliminated.

SYSTEMS AVAILABLE

Apart from the new Video 2000, there are four basic systems currently in use for domestic machines. The Philips 1500 VCR format is effectively obsolete, mainly because of its limited playing time. However, there are still a large number of these machines in every day use, and some specialist companies are offering to update these to VCR-LP.

For the sake of simplicity, and so that the reader can quickly compare the systems, Table 1 shows technical details and differences between them.

WHY VHS?

There are several reasons why the VHS format has a high popularity, particularly in Europe. Some of these reasons are listed below:

1) Cheaper tape feed costs (typically £3·50/hr.).

2) Aesthetic appearance of hardware (it has a professional appearance).

3) VHS is supported by far more brand names than its rivals, which gives the customer more confidence in this system (see Table 2).

4) Fast winding is achieved with the tape retracted into the cassette, rather than with the tape wrapped around the drum. This has the real advantage of minimising head wear.

5) Video input and output facilities mean easy interface with a Video camera, and enables two machines to be connected together, so that dubbing of recordings from one machine to the other can be achieved with optimum quality.

The picture quality is related to the writing speed, which by

TABLE 1. TAPE FORMATS

Format	Video Writing Speed (M/sec)	Linear Tape Speed (cm/sec)	Drum Rotational Speed (r.p.m.)	Drum Diameter (mm)	Maximum Recording Time (min)	Lace Up Time (secs)
VHS slant azithmuth 2 head helical scan	4·83	2·34	1500	105	180	3
Betamax slant azithmuth 2 head helical scan	6·60	1·873	1500	62·5	195	3 (laced up in FF and REW modes)
SVR slant azithmuth 2 head helical scan	8·21	3·95	1500	105	240	
VCR slant azithmuth 2 head helical scan	8·10	14·29	1500	105	60 nominal 75	3 thread 3 lockup
VCR-LP slant azithmuth 2 head helical scan	8·10	6.56	1500	105	120 nominal 150 (1702—180)	3 thread 3 lockup
Video 2000 slant azithmuth 2 head helical scan	5·08	2·44	1500	65	240 + 240 (reversible cassette)	5·5

reference to Table 1 would appear to indicate that SVR and VCR-LP in theory at least are capable of slightly better quality than the others. In actual practice, provided a well adjusted TV receiver is used, then it is hard to distinguish between the different systems. It goes without saying that the picture quality of all the machines can be improved if a small (12 inch to 18 inch) screen TV is used, rather than the more usual domestic giant. The differences in the systems are most probably more markedly shown with projection TV systems.

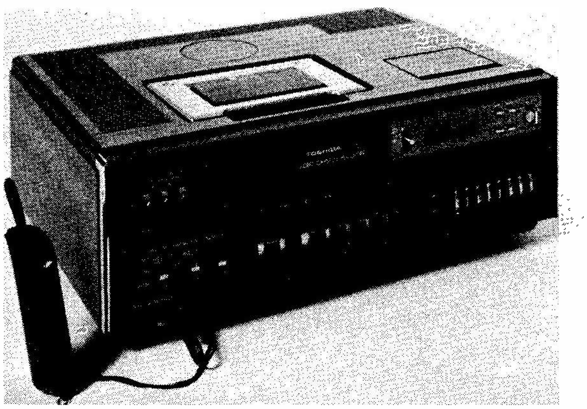
Table 2 shows the principle features, and highlights the differences between the different VCRs currently available on the UK market. No doubt the list will grow. Most extensive details can be found in the various manufacturers' handbooks, and the inclusion of this data in this table has been deliberately omitted for the sake of clarity.

PORTABLE RECORDERS

With the introduction of the video cassette for domestic VCRs it was only a matter of time before this system was adapted for use in a totally portable system. Existing semi-professional and professional portable systems employ the Umatic format, which for reasons already stated, exclude its acceptance in the domestic market on the ground. It came as no surprise when JVC introduced the 4100 portable colour video system in June/July 1979.

This system incorporates the GC4100 twin tube camera, HR4100 VHS recorder, TU41 tuner/timer, and AAP41 power

The Toshiba Betamax recorder model V-5470B with freeze frame, frame advance and double speed facilities, plus visual cue and review in fast wind modes



Matsushita's prototype solid state colour camera built around a 210,000 element chip. Claimed to virtually eliminate blooming the camera gives resolution of 280 (hor) by 480 lines and will operate at 500 lux. Mass production techniques are now being investigated for this small, lightweight camera

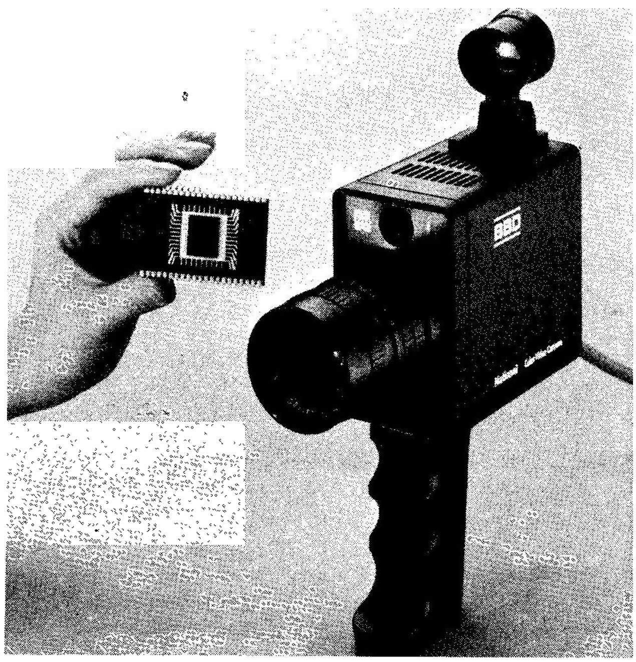


TABLE 2. DOMESTIC VIDEO RECORDERS

Make/Model	Format	Timer	Resolution	Audio Dub	Input/ Output	Special Features	Other Remarks
JVC HR330EK Ferguson 3292 Akai Vs 9300 Mitsubishi HS 200 B Baird 8900 Nordmende	VHS	24hrs on only. Timer 1 sec	240 lines S/N 40dB max	Yes	RF: coax Video: uhf	Electronics — Mitsubishi	
JVC HR 3330 Ferguson 3VOO Akai VS 9500	VHS	8 day	250 lines S/N 40dB	Yes	as above	Search button	
JVC 3660EK	VHS	8 day on/off	as above	Yes	as above		Remote control, including variable speed playback. RF output test signal
Hitachi VT 3000	VHS	3 day on only	Probably similar to HR330EK	Yes	as above		
National Panasonic NV8600B NV8610B	VHS	24 hrs. on/off 7 days on/off	240 lines about 42db s/n	Yes	as above	RF test signal, moisture sensor	NV 8610 has still frame, single frame advance
Sony SL8000	Betamax	3 days on only	270 lines S/N 42db	No	RF in/out standard coax	Still frame	Max. recording time 195 mins.
Toshiba V-5250	Betamax	3 days on only	270 lines S/N 42db	No		Remote pause	
V-5470B	Betamax	7 days allows 3 separate recordings	240 lines S/N 42db			Still frame, single frame advance, double speed, visual cue	
Sanyo VTC 9300	Betamax	3 days on only	270 lines S/N 42db	No	Video BNC		Timer 0-62 min. every day at same time
Grundig SVR 4004	SVR	on/off 10 days ahead	240 lines min. (300)	No	RF only Standard coax	Still frame transport logic. Remote control and self seek timer	max. recording time 240 mins.
Grundig SVR 4004 AV	SVR	as above	as above	Yes	RF and Video	as above	
Grundig 2X4	2000	10 days 4 separate recordings	approx 3MHz	Yes during recording	AV (DIN)	Full function remote control	Reversible tape 2X4 hrs can remain laced on ff/rew for cueing
ITT	SVR						as for SVR 4004
Philips	VCR						Max. recording time 60 mins. (90m)
Philips 1700	VCR-LP	3 days on/off	3·5 MHz max s/n 40 db	No	RF only standard coax		Max. recording time 150 mins.
Philips 1702	VCR-LP	10 days on/off	as above	no	as above	3 hrs. tape duration. 4 digit tape counter	Max. recording time 180 mins.
Philips 2020	2000	Micropro-cessor controlled, allows 5 separate recordings up to 16 days forward	S/N 50db	Yes, with add on unit	RF and Video in add-on unit	Infra red hand held remote control. 26 input channels. 4 digit LED tape counter	Max. recording time 2 × 4 hrs., on reversible cassette

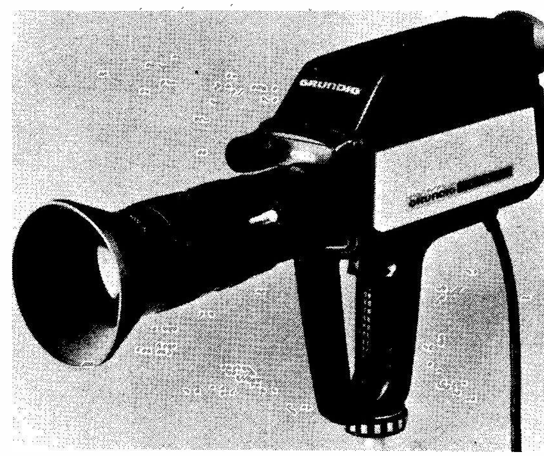
supply. For simple portable recording all that is required is the camera and recorder. To convert the recorder to a machine having off air recording facilities, including pre-set recording, the other units are required.

One of the major problems with any portable piece of equipment is making the system small and light enough. The GC4100 camera weighs 3·7kg, and the recorder a mere 9·3kg, including rechargeable battery pack. Not too bad when you think about it.

One additional problem encountered with this type of equipment is its ability to operate in a variety of positions without malfunctioning. JVC have overcome these problems in the 4100 using a quartz locked capstan servo, and a quick response head drum servo to maintain the stability of the mechanics at all times. Ruggedness is an essential quality for portable machines.

There are now several other VHS portables on the market, the majority of which show similarity to the 4100. Table 3 shows current models available in the U.K.

Panasonic WV 3300E camera in action. This model has an electronic viewfinder and is priced at £839·50



The Grundig FAC 1800 single tube colour camera incorporates on electronic viewfinder

PORTABLE VIDEO CAMERAS

There are a number of colour video cameras, suitable for use with both portable and mains operated domestic VCR's. Where it is intended to use the camera with a portable recorder, then it is important to have the facility of having an electronic viewfinder, thus enabling the operator to actually see what is being recorded.

Another important aspect is the facility that a zoom lens can offer. Ideally a zoom lens with a 6:1 zoom ratio and having a wide angle (12·5mm) is a must for creative work. It is also useful to have a macrofocussing facility, so that close up work can be accomplished. Ideally the provision for connecting a remote microphone enables a high signal to noise ratio for the sound to be maintained.

TABLE 3. PORTABLE VIDEO TAPE RECORDERS (COLOUR)

Make/Model No.	Tape System	Tape Speed (cm/sec)	Writing Speed (M/sec)	Power	Resolution	Recording Time	Weight (Kg)
JVC CR440E	Umatic	9·53	8·54	13·5W	140 lines	20 min.	11·2
Hitachi SV340	Umatic						
Sony V03800P	Umatic				240 lines		14·0
RCA HR1020	$\frac{3}{4}$ inch type A	not known		12V at 14W	not known	over 2 hrs.	12·2
JVC HR4100 Ferguson 3V01 Akai VT530	VHS	2·339	4·83	12V at 10W	240 lines at 40dB S/N	60 min. record. 180 min. playback	9·3
National Panasonic NV8400	VHS	as above		12V, 3AH	not known, but similar to above	as above	8·9
Grundig VCR601 Philips LDL1100	VCR	14·29	8·10	12V	3MHz, 42dB S/N	60 min.	10·0
Sony SL3000	Betamax		as for standard Betamax system			not known	not known

TABLE 4. COLOUR VIDEO CAMERAS (DOMESTIC & SEMI-PROFESSIONAL)

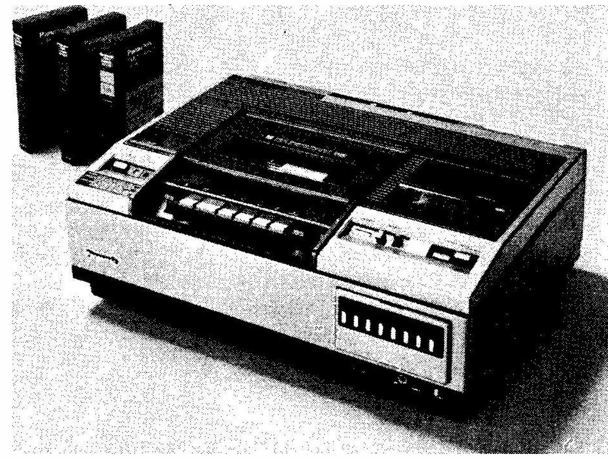
Make/Model No.	Vidicon	Resolution	Lens	Power	Sensitivity	Weight (Kg)	Remarks
JVC G71-P	single 25mm	230 lines (hor) 300 lines (vert)	6 × Zoom (17–102mm)	12V, 12W	down to 100 lux	3·6	Macro lens facility
JVC G31-P	as above	as above	25mm f1·8	as above	as above	2·7	Optical viewer
JVC GC3300 JVC GC4100	2 × 17mm vidicon	400 lines S/N 45dB	12·5–75 mm f1·8	12V, 13W	down to 250 lux down to 100 lux	3·4 3·7	 used in HR4100
JVC G X33U JVC G X66U	not known		3 × Zoom 6 × Zoom	not known		1·5 1·5	
Hitachi-Denshi GP-7 GP-5	single 25mm vidicon	250 lines (hor) 40 dB S/N	details not known	12V 11W	100 lux at f2	2·2	
Hitachi Denshi FP 3030H	single 25mm vidicon	270 lines (hor) S/N 43dB		12V 12W		3·0	
FP 3060H	single 25mm saticon	270 lines (hor) S/N 46dB		12V 15W			
FP 1020	three × 17mm saticons	500 lines S/N 46dB		12V 22W		7·0	
Ikegami HL 77	three × 17mm PbO	500 lines (hor) S/N 48dB				7·4	
CTC 2400	three × 17mm saticon, newvicon, PbO, chalnicon, vidicon	550 lines (hor) S/N 46dB					
National Panasonic WV 3300E WV 3310E	25mm cosvicon		17–102mm 25mm f1·8		down to 100 lux	2·5 1·7	
Sony DXC–1610P	single 25mm MF trinicon				optimum 1000 lux min 200 lux (f/2·1)	6·6	
Grundig FAC 1800	single 25mm	250 lines (hor)	6 × Zoom 17-102mm	220–240V a.c.	100 lux at f/2	2·5	

Table 4 lists a number of domestic and semi-professional colour video cameras that are available. Of particular interest is the Hitach-Denshi GP5, which unlike the JVC GC4100 contains only one vidicon tube. The use of this single tri-electrode tube enables a high quality, small and low cost camera to be made available to the public.

It is claimed that this single vidicon is capable of producing pictures which are just as good as those produced by two and three tube cameras. One important point about the tube used in this model is that it is capable of functioning at very low light levels. The manufacturers also claim that this camera is capable of operating correctly between temperatures of −10 degrees C and +40 degrees C.

The camera is extremely easy to use. The built-in automatic sensitivity control (ASC) circuits means that the camera at all times operates under optimum conditions. The only controls that require adjustment are the "Colour Temperature" and "Brightness". Because of the very low power consumption, the camera can operate off batteries for a maximum of one hour. Alternatively it can be operated from the mains using a suitable adaptor. The optional electronic viewfinder can easily be attached to the camera. Apart from the desirability of having this facility, it is also possible to observe the recording already made using this device. Further details of this camera are included in Table 4.

Sanyo VTC 9300 Betamax machine



Panasonic NV-8610 with freeze frame facility

Mitsubishi VHS recorder

FUTURE DEVELOPMENTS

The Philips 2000 video system has already been mentioned in this report, but with its introduction, a new generation of microprocessor controlled recorders must be just around the corner. If past events are anything to go by, it is almost a forgone conclusion that the Japanese rivals of Philips have their extensive research and development facilities working flat out to produce yet another type of machine. One can only hazard a guess and suppose that as the current generation of machines has almost certainly reached the technological limit, then the next will have to utilise digital rather than analogue recording techniques.

As far as camera improvements are concerned, we can look toward the introduction of solid state technology in place of the conventional vidicon. Although, like digital recording techniques, the introduction of CCD's in cameras could almost be prohibitive from a cost point of view, mass production will ultimately result in systems that will be physically smaller, more reliable, and cost less.

One development that certainly lends itself to miniaturisation is a system of recording originally developed by BASF for domestic machines called LVR (linear video recording). This has recently been used by Blaupunkt to produce a new miniature machine called Mini-Maz 1. This uses a tiny tape transport mechanism which is capable of being held in one hand. The distinct possibility of incorporating such a device *inside* a video camera would mean a camera system comparable in size to a standard Super 8 Cine camera. The sheer ease, convenience and low cost of such a system suggest a very interesting future for the Mini Maz, assuming this reaches large scale production.

Toshiba have also developed an LVR system, first shown in prototype form at the Chicago Consumer Electronics Show last June. Toshiba plan to launch their system in September, it will have a two hour recording capability and employ an endless loop cassette. The "target price" will be £250 and a three to four hour cassette is also being developed.

DISC

So far this article has concentrated solely on the recording and playback of video information, and no article that was seeking to state the future of video would be complete without at least a mention of the Videodisc. Although a playback only type system, it is bound to make a profound impact when it arrives. Introduction of at least one or possibly as many as three systems are due to be launched in the UK in June or July of this year. The main advantage of VLP (as Philips call it) is that it will be possible to offer full length feature films at a fraction of their cassette cost. A further advantage is that high quality slow motion and still facility is offered by this system.

One thing is certain about the future — whatever format wins the battle, and whatever disc system is accepted, the growth of this sector of the electronic market will be such that it is confidently predicted that there will be over one million VCRs in British homes in four years time. ★

The new front loading Grundig 2X4, Video 2000 recorder

Metac ELECTRONICS & TIME CENTRES

QUARTZ LCD 11 Function Slim Chronograph

12:30 pm 45 — Hours mins secs
8 14 TH — Month date day
0:00 00 — Min secs 1/10 1/100

6 digit, 11 functions, Hours, mins., secs., day, date, day of week, 1/100th, 1/10th, secs., 10X secs., mins. Split and lap modes. Back-light, auto calendar. Only 8mm thick. Stainless steel bracelet and back. Adjustable bracelet.

Price only **£9.95**

Also available: SOLAR CHRONOGRAPH M9 Price £11.95

SAME DAY DESPATCH.
M3 Price includes POST & PACKING

QUARTZ LCD ALARM with Snooze Alarm

12:30 pm 45 — Hours mins secs
8 14 TH — Month date day
7:30 A — Alarm

6 functions plus Alarm. Conference signal, 5 minute snooze alarm, Conference signal sounds 4 secs. before main alarm to give advance warning and an option to cancel. Snooze sounds 5 mins. after main alarm and is always preceeded by the conference signal.

Price only **£9.95**

SAME DAY DESPATCH.
M4 Price includes POST & PACKING

QUARTZ LCD ALARM CHRONOGRAPH with 12/24 display

12:30 pm 45 — Hours mins secs
8 14 TH — Month date day
0:00 0 — Min sec 1/10th
7:30 A — Alarm

Hours, mins, secs, day of week. Month, date, day of week, alarm, hour, mins., a.m./p.m. 24 or 12 hour display mode. Alarm test. Chronograph, lap time, stop watch 1/10 secs.

Price only **£13.95**

Also available: SOLAR ALARM CHRONO M7 Price £17.95

M16 Price includes POST & PACKING

QUARTZ LCD Ladies Day Watch

Hours, mins., secs., day, date, back light, auto calendar.

12:30 — Hours mins
8 14 — Month date
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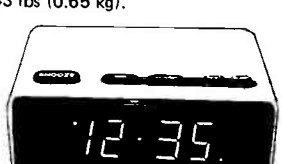

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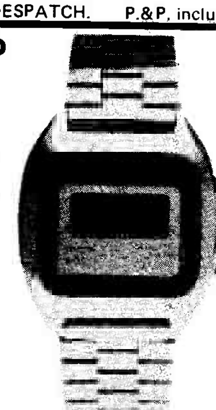

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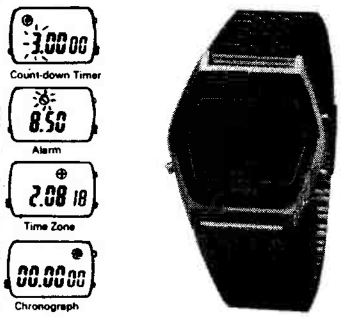

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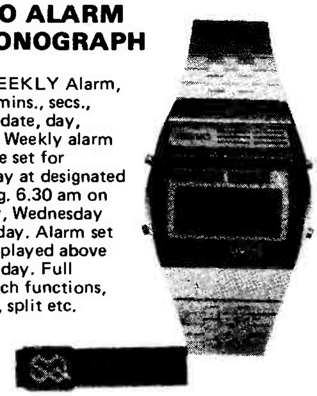

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Power Supplies for M.P.Us

Alan Clements B.Sc. Ph.D. **Part 1**

AN article devoted to power supplies for microprocessors may, at first sight, appear odd. After all, a power supply is often dismissed as nothing more than a black box with its input terminals connected to the public 240V, 50Hz, electricity supply. However, this black box has the physical characteristics of volume, mass, power dissipation, regulation, reliability, and cost. In this article a brief description of the operation and characteristics of power supplies is given. The aim is to make the designer of a microprocessor system aware of the power supply, and in particular of the penalties which must be paid if it is inadequate.

All microprocessors require a source of current at a constant voltage to provide them with the power without which they cannot function. The vast majority of microprocessors, their MOS peripherals and bipolar support chips have a single 5 volt supply. Some devices, notably EPROMs and dynamic RAMs, require additional sources of current at 12V, −12V or −5V. Fortunately, the trend is to design new i.c.s needing only a single 5V supply.

It is often thought that the provision of a power supply for a microprocessor system is a trivial matter. This is not so. In the last few years the power consumed by active devices has fallen dramatically, from the watts dissipated by valves, to the milliwatts dissipated by discrete transistors, and now to the microwatts dissipated by active devices on silicon chips. However, as the power consumed per active devices has fallen, the total number of active devices per system has risen from tens to millions. Today, sophisticated multiple microprocessor systems can be found with power supply busses carrying 120 amps.

The primary function of a power supply is the production of an adequate current at a constant voltage. A secondary function of a power supply is the protection of the circuit being supplied with power from mains borne transients, or from the failure of some part of the power supply itself. The total power required by a microprocessor system is often largely dependent on the size of the memory used in the system. A small system with only 1024 bytes of RAM has a power consumption mainly determined by the microprocessor and its associated control circuitry. A large system with 64K bytes of static RAM tends to have a power consumption which is almost entirely dominated by the RAM. The actual power consumed by the memory of a microprocessor system is very much a function of the particular RAM chips which make up the memory.

In general, the power consumption per bit falls as the number of bits per chip increases. The power consumption of memory chips is also a function of the access time of the chip, the faster the chip the greater the power consumption (and the price). The relationship between power, access time and size of four memory components is given below, although it should be remembered that advances in technology are constantly improving these parameters.

Memory Components	Access Time	Total Power Ave/Max	Ave Power/1K bits
TMS44–45 (4096 bits)	450nS	275/495nW	69mW
TMS15–15 (4096 bits)	150nS	440/649mW	110mW
2102 AL–2 (1024 bits)	450nS	174/275mW	174mW
2102 AL–4 (1024 bits)	250nS	225/325mW	225mW

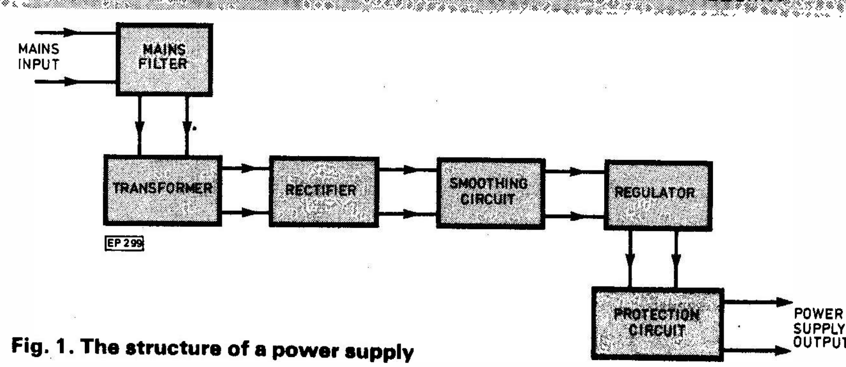


Fig. 1. The structure of a power supply

TYPICAL CIRCUIT

A power supply consisting of several circuits connected together in tandem, is illustrated in Fig. 1. The mains filter is used to keep mains borne high frequency noise and transients out of the system. The transformer performs two functions: it converts the 250V mains into a much lower voltage with very little loss of energy, and it provides a means of physically isolating the system from the mains. The rectifier and smoothing capacitor transform the alternating current from the transformer into a direct current at an approximately constant voltage. The regulator converts the approximately constant voltage into the precisely constant voltage required by the microprocessor system. The protection circuit plays a passive role, and isolates the microprocessor system in the event of a dangerous rise in the output voltage from the regulator. The protection circuit is often included in the regulator.

OPERATION

The operation of a power supply is now described and criteria for the selection of the components which make up the power supply are given.

TRANSFORMER, RECTIFIER AND SMOOTHING CIRCUIT

Three arrangements of transformer and rectifier are commonly used to provide a basic unsmoothed d.c. power supply. These are the half wave rectifier circuit, the full wave rectifier circuit with a centre-tapped transformer, and the full wave rectifier circuit with a bridge rectifier. The circuit diagrams of these three arrangements are given in Fig. 2 together with graphs of their respective outputs as functions of time. In practise the half wave rectifier circuit is almost never used (at least in microprocessor applications) because the rectifier conducts for only half a cycle, a very inefficient arrangement.

Furthermore, the half wave rectifier circuit puts a very heavy demand on the smoothing circuit, which must provide an output current to the load during the half cycle when the rectifier is not conducting.

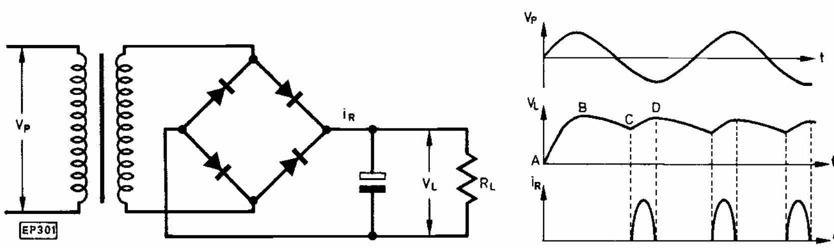


Fig. 3. The effect of a smoothing capacitor

The two full wave rectifier arrangements of Fig. 2 make use of both half cycles of the mains input so that the output of the rectifier consists of a series of pulses at a repetition rate twice that of the mains frequency.

Both the centre-tapped transformer circuit and bridge rectifier circuit are widely used in power supplies. An additional advantage of these circuits over the half wave rectifier circuit is that no net d.c. component of the output current flows through the transformer, magnetising the core and increasing the power loss. The bridge rectifier configuration is most widely used for two reasons:

1. Transformers are costly components and the bridge rectifier requires only one winding with two terminals which is cheaper to manufacture.
2. The bridge circuit requires a transformer with a lower volt-ampere rating than the corresponding centre-tapped transformer circuit, and therefore makes more efficient use of the transformer.

The chief disadvantage of the bridge rectifier configuration is the need for four rectifiers. It is not only the additional cost of a bridge rectifier that causes problems, but the power dissipated by it. Unlike hi-fi amplifiers or radio transmitters, with power supplies in the region of 60V in the former case and possibly 1000V in the latter case, a microprocessor system has a power supply of 5V. Clearly, if the voltage drop across a rectifier is approximately 1V, the power dissipated by the bridge rectifier is an appreciable fraction of the power consumed by the microprocessor system.

The pulses of current at the output of a full wave rectifier circuit must be smoothed or averaged to produce an approximately constant voltage. The process of smoothing may be thought of as that of integration or lowpass filtering.

SIMPLEST FILTER

A wide variety of smoothing or filtering circuits exist, but the simplest, and most common circuit uses a capacitor connected across the output of the rectifier circuit. Fig. 3 illustrates the effect of a smoothing capacitor (sometimes called a reservoir capacitor), and gives a graph of the voltage across the capacitor as a function of time.

Assuming that the power is first applied at a zero-crossing, the smoothing capacitor charges up during the first half cycle. After the peak of the cycle, point B, the voltage across the capacitor is greater than that across the transformer secondary, resulting in the rectifier becoming reverse biased and therefore non-conducting. Between points B and C the capacitor discharges exponentially into the load. At point C the transformer secondary voltage, which is now rising in the next half cycle, reaches the falling voltage across the capacitor, and the rectifier once more becomes forward biased. Current now flows through the rectifier to charge the capacitor to the next peak at D, and the process repeats itself every half cycle.

CHOOSING THE CAPACITOR

In Fig. 3 it can be seen that the rectifiers conduct for only a part of each half cycle, and that the rectifier current consists of a series of pulses. The amplitude of these pulses plays an important role in the selection of the rectifier and smoothing capacitor. Clearly, the effect of increasing the value of the smoothing capacitor is to reduce the ripple voltage superimposed on the average d.c. output of the power supply—a good thing. However, as the capacitance increases the period of conduction of the rectifiers is reduced resulting in an increase in the amplitude of the current pulses through the rectifiers—a bad thing. The amplitude of these pulses must not exceed the maximum surge rating of the rectifiers. To avoid excessive rectifier currents it is usual to limit the amount of smoothing to a peak to peak ripple voltage of 10 to 30 per cent of the mean voltage across the capacitor.

The simplest way of obtaining a value

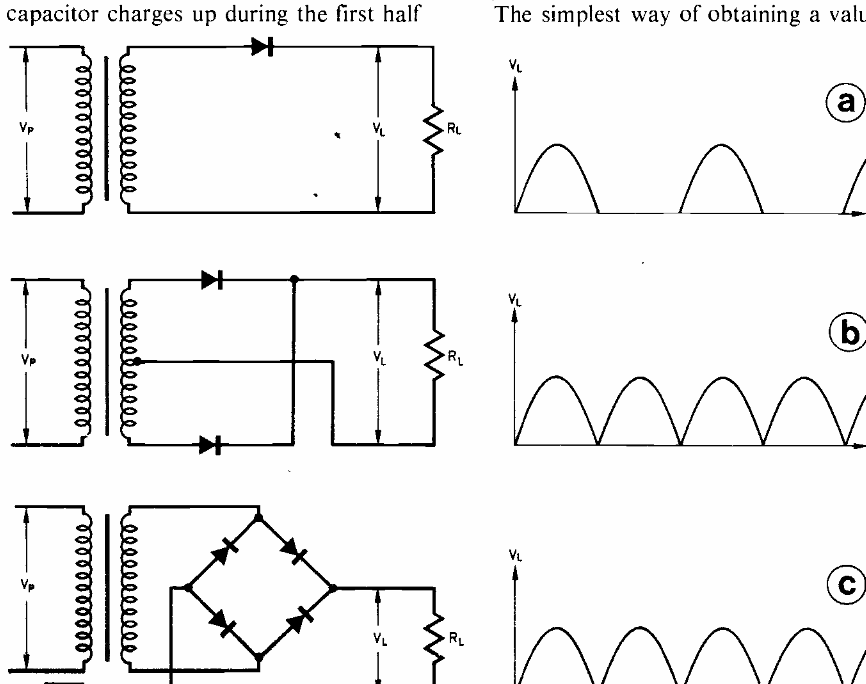


Fig. 2. Three rectifier circuits and their outputs

for the smoothing capacitor is to apply the formula Q = CV to Fig. 4, a linearised version of Fig. 3.

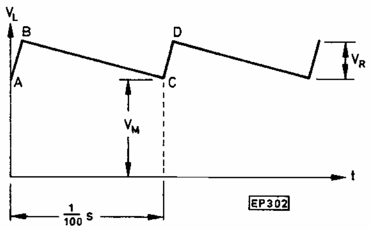


Fig. 4. A linearised representation of the voltage V_L across the load of a bridge rectifier circuit with a smoothing capacitor

$$Q = CV$$

so that $$i = C\frac{dv}{dt}$$

or $$C = i/\frac{dv}{dt}$$

The value of $\frac{dv}{dt}$ is given by the slope of BC in Fig. 4. For example, for a 50Hz power supply with a peak to peak ripple (V_R) of 5V and a mean output ($V_M + \frac{V_R}{2}$)of 20, the slope of BC is 5 volts in one hundredth of a second. If the mean load current is 5 amps, then C is given by

$$C = i/\frac{dv}{dt} = 5\frac{1}{1/100} = \frac{5}{500}$$

$$= \frac{1}{100}F = 10{,}000\mu F$$

One of the most popular procedures for the design of a power supply with a reservoir capacitor connected directly to the output of the rectifier (i.e. capacitor-input filter), is based on the use of tables or graphs. Of particular interest is the relationship between the peak alternating voltage at the output of the transformer secondary and the output voltage across the smoothing capacitor, as a function of ωCR_L. Fig. 5 shows such a set of curves for a full wave rectifier circuit, from which it can be seen that the output voltage is not greatly increased when ωCR_L is greater than about 10. Other graphs presented by Schade include the relationship between the peak rectifier current and the value of the smoothing capacitor. For a full wave rectifier circuit with ωCR_L = 10, the peak rectifier current is approximately seven times the average rectifier current.

SELECTING THE TRANSFORMER

In many manufacturers' catalogues four parameters are used to characterise transformers: the primary r.m.s. voltage, the secondary r.m.s. voltage, the volt-ampere (VA) rating, and the regulation. The maximum voltage across the smoothing capacitor under no load conditions is given by:

$$V_C = V_S \times 1{\cdot}41$$

where V_S is the r.m.s. secondary voltage of the transformer. From Fig. 5 it can be seen that this value of V_C can, in practise, be approached only when ωCR_L is greater than 100 and the effective series resistance is less than $\frac{1}{2}$ per cent of the load resistance.

The largest mean direct current which can be drawn by the load in a bridge rectifier current is given by:

$$I_L = I_{a.c.} \times 0{\cdot}62$$

$$= \frac{VA}{V_S} \times 0{\cdot}62$$

where VA is the volt-ampere rating of the secondary.

SELECTING THE RECTIFIER

The most popular form of rectifier is the relatively inexpensive silicon junction diode. Bridge rectifiers, containing four silicon diodes mounted in epoxy plastic, can readily be obtained and are widely found in full wave rectifier circuits. Rectifiers are usually characterised by four parameters: the peak inverse voltage, the average forward current, the maximum forward current, and the voltage drop across the rectifier when it is conducting.

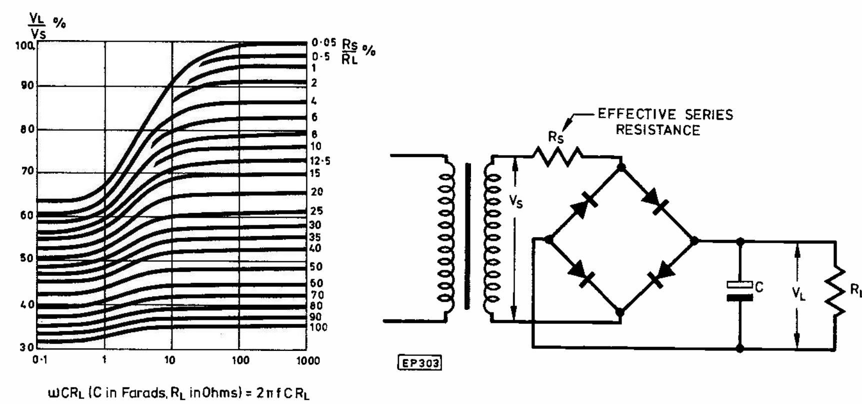


Fig. 5. The relationship between V_P and V_L in a bridge rectifier circuit with a capacitor-input filter

The maximum peak inverse voltage of a rectifier is the largest voltage that can safely be applied across the rectifier when it is reverse biased. In a half wave rectifier circuit the maximum voltage across the rectifier occurs at the peak of the half cycle when it is non-conducting. The total voltage across the rectifier is the transformer secondary voltage plus the voltage across the capacitor, i.e. $2 \times V_C = 2 \times 1{\cdot}41 \times V_S$, or nearly three times the r.m.s. rating of the transformer secondary. In a bridge rectifier circuit two diodes are connected in series so it might be thought that the p.i.v. rating of each diode need be only half that of the equivalent half wave rectifier circuit, i.e. $1{\cdot}41 \times V_S$. Unfortunately, when the diodes are reverse biased, their series resistance is indeterminate and there is no guarantee that the voltage will be distributed equally across the diodes. Hence both diodes in series in a bridge rectifier should have p.i.v.'s three times the value of V_S, or p.i.v.'s $1\frac{1}{2}$ times V_S only if voltage equalising resistors are connected in parallel with them.

The maximum current which flows through the rectifiers is governed by the value of the smoothing capacitor. In a bridge rectifier circuit the maximum rectifier current is approximately seven times the average forward current at ωCR_L = 10, and twenty times the average forward current at

$$\omega CR_L = 100 \ (\frac{R_S}{R_L} = 0{\cdot}02\%).$$

When a rectifier is forward biased there is a voltage drop between its anode and cathode, consisting of the voltage drop across the rectifying junction plus a voltage drop due to the ohmic resistance of the rectifier. A typical voltage drop across a bridge rectifier, at 10A, is 1·88V. The forward voltage drop across silicon diodes is of little importance in high voltage power supplies, but in low voltage power supplies, producing the high currents required by large memories, the forward voltage drop is an appreciable fraction of the voltage across the smoothing capacitor. Conventional silicon junction diodes lower the rectification efficiency of the circuit and waste a large amount of power. Possible alternatives to silicon junction diodes are Schottky diodes with their lower forward voltage drop, or synchronous rectifiers using transistors which have a collector-emitter saturation voltage of approximately 0·3V.

SELECTING THE CAPACITOR

The choice of an electrolytic capacitor in a filter circuit is determined by three parameters: the capacitance, the maximum applied voltage, and the maximum ripple current. The capacitance may be calculated as described earlier in this article, and the voltage rating of the capacitor must be greater than the peak secondary voltage plus an amount large enough to allow for increases in the primary voltage due to line overloads. Capacitors also have a maximum surge voltage rating which is the maximum instantaneous voltage which may be applied across the capacitor. Unfortunately the surge voltage of an electrolytic capacitor is often not appreciably greater than the maximum working voltage.

The ripple rating of the smoothing capacitor is very important, but is sometimes neglected by inexperienced designers. As we have seen, the voltage across the smoothing capacitor is composed of a constant voltage plus a ripple component. The ripple voltage causes a current, the ripple current, to flow through the capacitor. If we assume that the ripple voltage is approximately sinusoidal, the ripple current is given by:

$$I_{ripple} = \frac{V_r}{2\sqrt{2}} \times \frac{1}{X_C} = \frac{V_r\, 2\pi f C}{2\sqrt{2}}$$
$$= 222 V_r . C$$

In the above example, $V_r = 5$ and $C = 0{\cdot}01F$, so that $I_{ripple} = 11{\cdot}1A$. Failure to choose a capacitor with an adequate ripple current rating leads to high internal temperatures and a reduced capacitor life. Note that the maximum ripple current rating of a capacitor is temperature dependent.

THE REGULATOR

The smoothed voltage across the reservoir capacitor is far from the constant voltage required by most digital integrated circuits, i.e. 5V ±5%. In order to create a true constant voltage source an electronic regulator must be used. Electronic regulators can have very complex circuits, and several books have been written on the subject of their design. Fortunately, the designer of a small to medium size microprocessor system has been freed of the relatively complex task of designing his own regulator by the availability of monolithic regulators. Monolithic regulators are high performance integrated circuits which provide a constant voltage output from an unregulated input. Their advantage is twofold: they are very cheap; and they are easy to use, having only three terminals. Table 1 gives the parameters of four monolithic regulators, each of which has a 5V output, and Fig. 6 shows how a regulator is used. Note that most monolithic regulators have internal protection circuitry which saves the regulator from the effects of short circuiting their output. Some regulators (e.g. 78HO5) also include protection against thermal overload—the device is shut down when the junction temperature rises above a predetermined limit.

Monolithic regulators suffer from two

TABLE 1: CHARACTERISTICS OF FIVE MONOLITHIC REGULATORS

Characteristic	7805	L005	LM309K	LM323K	78H05K
Output current	1A	600mA	1·2A	3A	5A
Input voltage range	7-25V	7·5-20V	7-35V	7·5-20V	8-25V
Load regulation	0·2%	0·3%	1%	0·3%	10mV
Ripple rejection	70dB	62dB	70dB	58dB	60dB
Output resistance	30mΩ	15mΩ	50mΩ	—	2mΩ
Line regulation	0·2%	0·1%	0·1%	0·1%	10mV
Output noise voltage	0·04mV	0·07mV	0·04mV	0·04mV	0404mV
Short Circuit current	750mA	190mA	—	—	7A
Case	Plastic	T03	T03	T03	T03

important disadvantages. They are sometimes prone to instability and may oscillate in the megahertz region, superimposing a high frequency waveform with an amplitude of several volts on the 5V output. Such oscillations are normally prevented by connecting two capacitors between the regulator input and ground, and between the regulator output and ground, as shown in Fig. 6. These capacitors should be located as close as possible to the pins of the regulator. It may seem strange that a 0·22µF capacitor is used to bypass a smoothing capacitor of 10,000µF, but the reactance of an electrolytic capacitor rises rapidly above 10kHz. The effect of this is to prevent the capacitor from bypassing high frequency noise.

A second limitation of the monolithic regulator is its inability to pass really large currents (above 10 amps). This forces the designer to seek one of two alternatives, to design a regulator circuit with discrete high power transistors, or to distribute the unregulated power supply to each module in the microprocessor system and use on-board regulators to provide a local stabilised 5V supply. It is difficult to choose between these alternatives because both have their advantages and disadvantages. The SS50 bus and the S100 bus both have a power supply rail carrying an unstabilised (approximately 8V) power supply plus on-board regulation on all memory, CPU, and peripheral cards.

The principal advantages of a multi-regulator power supply are:

1. Simple, inexpensive, one-amp regulators may be used instead of a complex and, possibly expensive, high current regulator.
2. A very low impedance power supply bus need not be used to distribute the stabilised power between individual cards—this can greatly simplify the design of the system and save money.
3. The regulators provide additional isolation between the various modules.
4. The failure of a single monolithic regulator will not damage more than one module.

The principal disadvantages of a multi-regulator power supply are:

1. The power dissipation of the regulators is put on the modules where it is least wanted. On some large memory boards using the older 1K chips, up to four one-amp regulators are required considerably increasing the waste heat generated by the board. When a single regulator is employed it is normally located in an enclosure, away from the more delicate modules.
2. Although the use of several regulators reduces the total damage done if a regulator fails—the chance of a failure is increased because there are more regulators to fail.
3. Regulators with their associated bypass capacitors and heat sinks take up valuable space on the cards where they are located. Furthermore, they often limit the minimum spacing between adjacent cards.

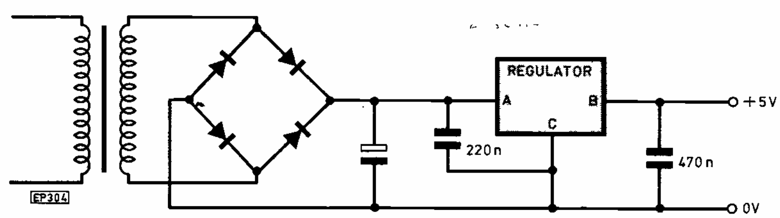


Fig. 6. A stabilised power supply using a monolithic voltage regulator

POWER SUPPLY PROTECTION

An ideal power supply and the a.c. mains to which it is connected should have the following characteristics:

1. The mains supply is a perfectly sinusoidal voltage of constant amplitude and frequency.
2. The mains has always been connected to the power supply, and always will be connected to it. That is, the

power is never turned on or off, thus avoiding switching transients.
3. The components which make up the power supply are perfect: they never age (i.e. change their properties) or fail.

Unfortunately the above situation does not exist. Because the mains supply has a non-zero impedance (typically 0·4 + 0·25j ohms at 50Hz), the waveform at the power supply transformer primary contains components due to the effects of other loads connected to the mains. Common sources of mains-borne interference are:

1. Switched inductive loads—motors, solenoids, relays etc.
2. Lightning strikes to, or near, the power distribution networks.
3. Alternating-current switching circuits—e.g. SCR phase control circuits.
4. Energising or de-energising transformer primaries.

It is not uncommon for transients of the order of 1000V to be superimposed on the mains supply, although most transients have an amplitude of less than 200V and a duration of tens of microseconds. Transients usually have the form of an exponentially damped sine wave with a very rapid rise time. Why are the designers of power supplies so concerned about transients? A transient can, occasionally, have enough energy to destroy components inside the power supply or within the microprocessor system itself. More commonly, a transient may be large enough to affect a logic level on the system bus, causing a logical one to be interpreted as a logical zero by some device (or vice versa). This can cause a program to crash—especially if an address is corrupted and a random jump executed.

TECHNIQUES USED

A common technique of removing some of the effects of mains borne interference involves the insertion of filter networks between the mains and the power supply. A typical commercially available filter has an attenuation of 35dB between 150kHz and 30MHz, and its circuit diagram is given in Fig. 7

Another type of transient suppressor is the zinc oxide voltage dependent resistor (VDR) which has a highly non-linear voltage-current characteristic. The V/I curve of a typical zinc oxide VDR is given in Fig. 8. A power supply is protected from mains borne transients by connecting the VDR across the mains terminals at the input to the power supply. When a transient appears across it, its resistance falls, causing a current to flow through. In this way a large fraction of the energy of the transient is dissipated within the body. A ten fold increase in the current through it corresponds to an approximately 8% increase in the voltage across it.

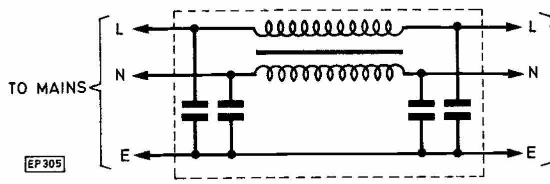


Fig. 7. The circuit diagram of a mains filter

LOAD PROTECTION

In addition to protecting the power supply from mains borne transients it is usual to provide protection against excessive load current and load voltages. To protect the power supply from excessive load currents, a current sensor must detect an overload condition and then take action to stop any further increase in output current. This is done in one of two ways, by holding the output current constant, or by fold-back current limiting, which reduces the current to a very low value until the cause of the overload is removed. As many microprocessor systems use monolithic regulators, the power supply designer must choose the regulator with the type of current limiting best suited to his application.

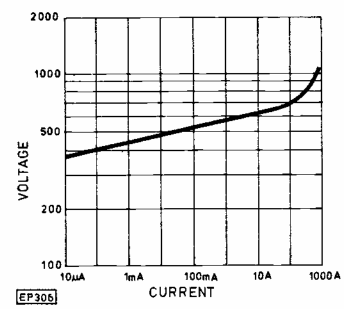


Fig. 8. Typical V/I characteristics of a zinc oxide VDR for use with a mains supply

It is advisable to add over-voltage protection to the output of a power supply. A widely used method of over voltage protection is the crowbar circuit. The crowbar circuit is so named because of its 'brute force and ignorance' technique of putting an almost dead-short across the power supply terminals in the event of an overload. The effect of the short circuit switches off the drive to the regulator either by means of a resetable electronic switch or by a simple fuse.

The circuit diagram of a crowbar circuit is given in Fig. 9. The silicon controlled rectifier (SCR) placed across the output terminals of the power supply, is normally in the non-conducting state. When a positive going pulse appears at its gate the SCR conducts and remains conducting until it is reset by turning off the power supply. The gate voltage required to turn on the SCR is provided by sampling the power supply output with a zener diode which is non-conducting until the reverse bias voltage across its anode-cathode terminals reaches its zener point. The crowbar circuit does not always give complete protection of the circuit because the SCR takes about a microsecond to turn on, and there is a further delay of several microseconds in the zener diode trigger circuit. During this delay it is still possible for a large over-voltage transient to cause some damage to MOS and TTL devices.

TRANZORBS

The zinc oxide voltage dependent resistor is usually used to suppress high voltage transients at the mains input. General Semiconductor Industries produce a device called the Tranzorb, which is able to suppress transients on low voltage lines. A tranzorb is a silicon *pn* avalanche device designed to suppress transients above a predetermined level, at which the *pn* junction breaks down (reversibly) and conducts—in other words a tranzorb is a special type of Zener diode. Tranzorbs have relatively low breakdown voltages and are designed to protect the outputs of power supplies, or even the MOS and bipolar TTL circuits themselves. Normally they are simply connected across the output of a power supply.

Next Month: A power supply for a small microprocessor system is described with design calculations.

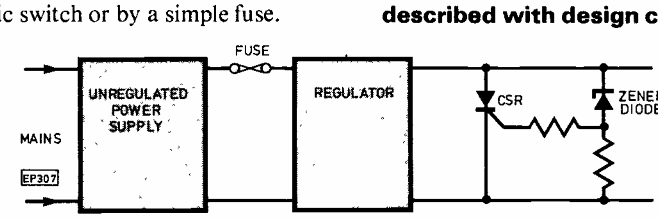


Fig. 9. A simple crowbar overvoltage protection circuit

CMOS

		4020	100p	4060	120p
		4022	100p	4066	50p
		4023	20p	4068	20p
		4024	50p	4069	20p
4001	20p	4025	20p	4070	20p
4002	20p	4027	45p	4071	20p
4007	20p	4028	85p	4072	20p
4009	40p	4029	85p	4081	20p
4011	20p	4040	110p	4093	50p
4012	20p	4041	85p	4510	80p
4013	35p	4042	80p	4511	90p
4015	80p	4043	95p	4518	80p
4016	30p	4046	110p	4520	80p
4017	65p	4049	45p	4527	90p
4018	90p	4050	45p	4528	90p

LINEAR

THIS IS ONLY A SELECTION!

		LM308	60p	NE531	98p
		LM324	45p	NE555	23p
		LM339	45p	NE556	60p
		LM348	90p	NE567	100p
		LM377	170p	RC4136	100p
709	35p	LM378	230p	SN76477	230p
741	16p	LM380	75p	TBA800	70p
747	45p	LM381	150p	TBA810S	100p
748	30p	LM382	120p	TBA1022	620p
7106	850p	LM3900	50p	TL081	45p
CA3046	55p	LM1458	35p	TL084	125p
CA3080	70p	LM3909	65p	ZN414	80p
LF356	80p	LM3911	100p	ZN425E	390p
LM301AN	26p	MM57160	590p	ZN1034E	200p

MICRO

CPU'S		MEMORIES			
		21L02	85p	2516	2185p
		2112	175p	2716	2185p
6800	550p	2114	390p	AY5-1013	
8080A	390p	4116	570p		360p
Z80	950p	2708	590p		

TTL

		7473	20p	74145	55p
		7474	22p	74148	90p
7400	10p	7475	25p	74150	55p
7402	10p	7476	20p	74154	65p
7404	12p	7486	20p	74157	40p
7408	12p	7490	25p	74164	55p
7410	10p	7492	30p	74165	55p
7413	22p	7493	25p	74174	55p
7414	39p	7496	45p	74177	50p
7420	12p	74121	25p	74190	50p
7430	12p	74123	38p	74191	50p
7432	18p	74125	35p	74192	50p
7442	38p	74126	35p	74193	50p
7447	45p	74132	45p	74196	50p
7448	50p	74141	55p	74197	50p

FULL DETAILS IN CATALOGUE!

TRANSISTORS

				TIP32C	80p
				TIP2955	65p
				TIP3055	55p
		BC548	10p	ZTX107	14p
AC127	17p	BCY71	14p	ZTX108	14p
AC128	16p	BCY72	14p	ZTX300	16p
AC176	18p	BD131	35p	ZTX500	16p
AD161	38p	BD132	35p	2N3053	18p
AD162	38p	BD139	35p	2N3054	50p
BC107	8p	BD140	35p	2N3055	50p
BC108	8p	BFY50	15p	2N3442	135p
BC108C	10p	BFY51	15p	2N3702	8p
BC109	8p	BFY52	15p	2N3704	8p
BC109C	10p	MJ2955	98p	2N3706	9p
BC147	7p	MPSA06	20p	2N3819	15p
BC148	7p	MPSA56	20p	2N3905	8p
BC177	14p	TIP29C	60p	2N3906	8p
BC178	14p	TIP30C	70p	2N5459	32p
BC182	10p	TIP31C	65p	2N5777	50p
BC182L	10p				
BC184	10p				
BC184L	10p				
BC212	10p				
BC212L	10p				
BC214L	10p				

DIODES

1N914	3p	1N4006	6p
1N4148	2p	1N5401	13p
1N4002	4p	BZY88ser.	8p

ITT product
1N4148 – £1.40/100.

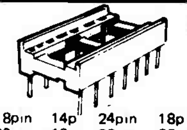
OPTO

LED's	0.125in	0.2in	each	100+
Red	TIL209	TIL220	9p	7.5p
Green	TIL211	TIL221	13p	12p
Yellow	TIL213	TIL223	13p	12p
Clips	3p	3p		

DISPLAYS

DL704	0.3 in CC	130p	120p
DL707	0.3 in CA	130p	120p
FND500	0.5 in CC	100p	80p

SKTS



Low profile by Texas

8pin	8p	18pin	14p	24pin	18p
14pin	10p	20pin	16p	28pin	22p
16pin	11p	22pin	17p	40pin	32p

3 lead T018 or T05 socket 10p each
Soldercon pins: 100:50p 1000:370p

PCBS

VEROBOARD

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2.5 x 1	14p	–	Vero Cutter 80p.
2.5 x 3.75	45p	45p	
2.5 x 5	54p	54p	Pin insertion tool 108p
3.75 x 5	64p	64p	
3.75 x 17	205p	185p	
Single sided pins per 100	40p	40p	

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4.7, 6.8, 10uF @ 25V 13p
22 @ 16V, 47 @ 6V, 100 @ 3V 16p

MYLAR FILM

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0.068, 0.1 . . . . 4p

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0.33, 0.47 . . . . 10p
0.68 . . . . 14p
1.0uF 17p

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	100					13p
			220			20p
25V	10	22	33	47		5p
	100					8p
		220				10p
				470		15p
	1000					23p

CONNECTORS

JACK PLUGS AND SOCKETS

	unscreened	screened	socket
2.5mm	9p	13p	7p
3.5mm	9p	14p	8p
Standard	16p	30p	15p
Stereo	23p	36p	18p

DIN PLUGS AND SOCKETS

	plug	chassis socket	line socket
2pin	7p	7p	7p
3pin	11p	9p	14p
5pin 180°	11p	10p	14p
5pin 240°	13p	10p	16p

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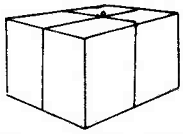

Set of 4 AA (HP7) Rechargeable Cells . .	~~500p~~	450p
PP3 Rechargeable cell	~~450p~~	410p
Pack of 10 miniature slide switches . . .	~~150p~~	120p
Pack of 10 push to make switches . . .	~~150p~~	120p
Pack of 10 push to break switches . . .	~~200p~~	150p
Murata Ultrasonic Transducers, per pair .	~~350p~~	300p
Resistor Development packs.		
10 off, each value from 4.7 ohm to 1M ¼w	~~570p~~	500p
½w	~~750p~~	650p
Polyester Development packs.		
5 off, each value from 0.01 to 3u2 . . .	~~620p~~	520p
Preset Potentiometer pack		
5 off, each value 100 ohm to 1M, 65 presets	~~395p~~	305p
Ceramic Development pack		
10 off, each value 22pF to 0.1uF, 310 caps.	~~595p~~	525p
LED pack, 10 off,		
each type 0.2 Red, green, yellow	~~350p~~	300p
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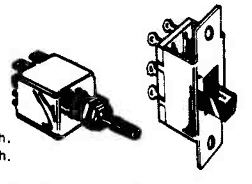
Pack of 10 LM301AN Op. amp.	~~260p~~	230p
Pack of 10 LM380N 2W Audio Amp . .	~~750p~~	620p
LM380 + LM381 and data	~~235p~~	180p
Pack of 3 LM3909 LED flasher	~~185p~~	150p
Pack of 10 TL081 Jfet Op. amp. . . .	~~450p~~	320p
MM57160 Stac. Timer + data	~~600p~~	550p
SN76477 Sound generator + data . . .	~~240p~~	200p
Pack of 2 ZN414 AM chips	~~160p~~	130p
SS-2 Breadboard	~~1085p~~	990p
Expo Reliant Drill	~~665p~~	570p
Expo Titan Drill	~~1030p~~	920p
Drill stand for above	~~1200p~~	1100p
Pack of 8 2708 Eprom	~~4720p~~	4500p
Pack of 8 2114 Ram LP 300ns	~~3125p~~	3000p
Pack of 8 4116.	~~4560p~~	4300p

SWITCHES



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MICRO-BUS

Compiled by DJD.

Appearing every two months, Micro-Bus will present 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 will probably come from readers working on their own microcomputer systems, and payment will be made for any contribution featured here. This is also the place to air your views, in general, on this new technology, so let's be hearing from you!

THE main topic in this month's Micro-Bus is a design for an extremely simple SC/MP-based microprocessor system which, while using a minimum of components, makes it possible to run and debug programs. Also included are designs for a hex keyboard and a two-digit hex display which can be added to the system.

NINE PROBLEMS

But first, here are nine light-hearted problems each to do with some aspect of programming micros, and gathered from a variety of sources. Solutions to all the problems will be presented in the next Micro-Bus.

One. National Semiconductor has just developed a micro with four registers, labelled A, B, C and D, and an instruction set consisting of the following five instructions (where X and Y stand for any of the four registers, and L represents a label):

LD X, Y	Load X with the value in Y
DEC X	Subtract 1 from the value in X
JZ L	Jump to L if result of previous DEC was zero
JNZ L	Jump to L if result of previous DEC was non-zero
DIS X	Display value of X

Write a progam for this rudimentary microprocessor, using as few instructions as possible, to display the highest prime factor of a number in the A register. For example, for 91 it should give the result 13, and for 19 the result 1.

When you have reached a solution you are advised to translate it into BASIC, or the machine code of a more reasonable micro, and run it to check that it really does work.

Two. The following problem has no possible practical application, but it should nevertheless cause some head-scratching among SC/MP programmers:

On SC/MP the obvious way to load zero into the accumulator is by executing 'LDI O' (C4 OO). Without making any assumptions about the contents of any of the registers, can you find four other ways of clearing the accumulator in just two bytes?

Three. It is very easy, in BASIC, to print the larger of two numbers by using an 'IF' statement and a 'GOTO', but how can it be done in a single statement, and without using 'IF'? In other words we want the equivalent of:

PRINT MAX (A, B)

without, of course, using the functions MAX or MIN.

Four. For a certain application using a 6800 system the programmer needed to reverse the order of bits in a byte in less than 10 cycles. One attempt is shown in Fig. 1; this routine shifts bits from A to B via the carry bit, and in the process sets B to the reverse of A as required. Unfortunately the routine takes 99 cycles to execute, and at this point the programmer gave up!

```
0000 CE 0008  REVERS LDX    £8
0003 44       LOOP   LSR A
0004 59              ROL B
0005 09              DEX
0006 26 FB           BNE    LOOP
```

Fig. 1. Program for the 6800 to reverse the order of bits in the accumulator; see problem 4.

In fact the problem can be solved, although the approach is somewhat unconventional, and the solution can be extended to more general applications.

Five. There are three things that you might want to do to the carry bit of a micro, namely set it, clear it, or complement it. The Z80 provides instructions to set it (SCF) and complement it (CCF), and clearing it is no problem: you must do SCF, CCF. On the other hand the SC/MP, 6502, and 6800 micros provide the clear carry and set carry instructions, and leave you to work out how to complement the carry. Without affecting the contents of the other registers, what is the shortest way to complement the carry bit on these three micros?

Six. A very pleasing feature of the high-level language Pascal is the 'CASE' statement, illustrated by the example in Fig. 2 (a) which prints one of three values, A, B or C,

```
'CASE' N 'OF'
     1: WRITE(A);
     2: WRITE(B);          (a)
     3: WRITE(C)
'END'
10 IF N = 1 THEN PRINT A
20 IF N = 2 THEN PRINT B   (b)
30 IF N = 3 THEN PRINT C
```

Fig. 2. Two programs which print one of three values depending on the value of N, written in (a) Pascal, or (b) BASIC.

depending on whether N is equal to 1, 2 or 3 respectively. To do the same in BASIC one might use three 'IF' statements, as shown in Fig. 2 (b). Can the same effect be achieved with a single BASIC statement, and if so, how?

Seven. The effect of the SC/MP instructions 'LDI O, CAI O' is to set the accumulator to X'FF if the carry bit is clear, and to X'OO if the carry bit is set. How, without making any assumptions about the contents of any of the registers, can the same be achieved in half the number of bytes?

Eight. The 6800 micro provides two types of instructions to shift the accumulator right; a logical shift right (LSR A) which shifts a zero into the top bit of the accumulator, and an arithmetic shift right (ASR A) which preserves the sign bit, for working with signed twos-complement binary numbers. Unfortunately the 6502 micro only provides us with an LSR A instruction; what is the shortest way of implementing an ASR A using the existing 6502 instructions?

Nine. Finally, a problem for all 6800 owners who wish they had a 6809. One of the great improvements of the 6809 over its predecessor is that its instruction set makes it easy to write relocatable programs. If you did not realise that it is difficult to write relocatable programs on the 6800, try finding a set of instructions with the same effect as:

HERE LDX £HERE

but which will work correctly wherever they are loaded into memory.

LOW-COST SC/MP SYSTEM

The following SC/MP system can be built with a small number of readily available components, and it works without the need for a monitor ROM or EPROM of any kind. It was designed by *Andrew Aitken* who submitted the following details about its operation.

"The full circuit, shown in Fig. 3, includes a single-cycle facility comprising a flip-flop and a few gates. The system has 256 bytes of RAM, at addresses OOOO to OOFF, and the states of the address and data lines are shown on 18 l.e.d.s. The whole circuit needs a 5 volt supply of about $\frac{1}{2}$ amp, and two or three 0·1μF capacitors should be added across the power rails at various points for decoupling.

PROGRAMMING

"Programs and data are entered into the memory as follows: With S1 set to 'PROGRAM' and S4 set to 'SINGLE CYCLE' press 'RESET'. The MPU will then be halted while it is fetching the first word from memory, and NRDS will be low thus enabling the data buffer. Whatever is now set on the data switches will be present on the data bus, and will be read by the MPU. Set the data switches to C4 (the op-code for the Load Immediate instruction) and switch the 'CYCLE' switch S2 up and then down. The instruction is then executed, and the MPU will again set NRDS low, waiting for the data which forms the second byte of the instruction. This is likewise entered at the data switches, and the programs in any sequence, and to change the contents of any location at will. When the program has been entered set S1 to 'RUN', leave S4 on 'SINGLE CYCLE', 'RESET', and cycle through the program by toggling S2. If everything seems fine 'RESET', set S4 to 'CONTINUOUS', toggle S2 once, and the program will run. A particularly pleasing aspect of the system is the ability to stop a program in mid run, by setting S4 back to 'SINGLE CYCLE', change an instruction, and then allow the program to continue so as to see the effect of the change immediately.

"S1 is a double-pole switch to ensure that when the system is in 'RUN' mode the data switches are disconnected from the data bus. Alternatively the data buffer EN line could be corresponding to that key is presented to the inputs of the CMOS inverters by a diode matrix. The outputs of these inverters are connected to the inputs of both of the 4-bit latches. The CMOS inverters were used as buffers because the key switches could only tolerate small currents. If more robust switches are available it would be possible to connect the outputs of the diode matrix directly to the latch inputs; in this case the 12k resistors should be changed to 1k and the data should be taken from the Q outputs of the latches.

"A key-press is detected by a diode gate which charges up a 4·7μF capacitor. This causes the output of the second Schmitt trigger to go high, which clocks the flip-flop

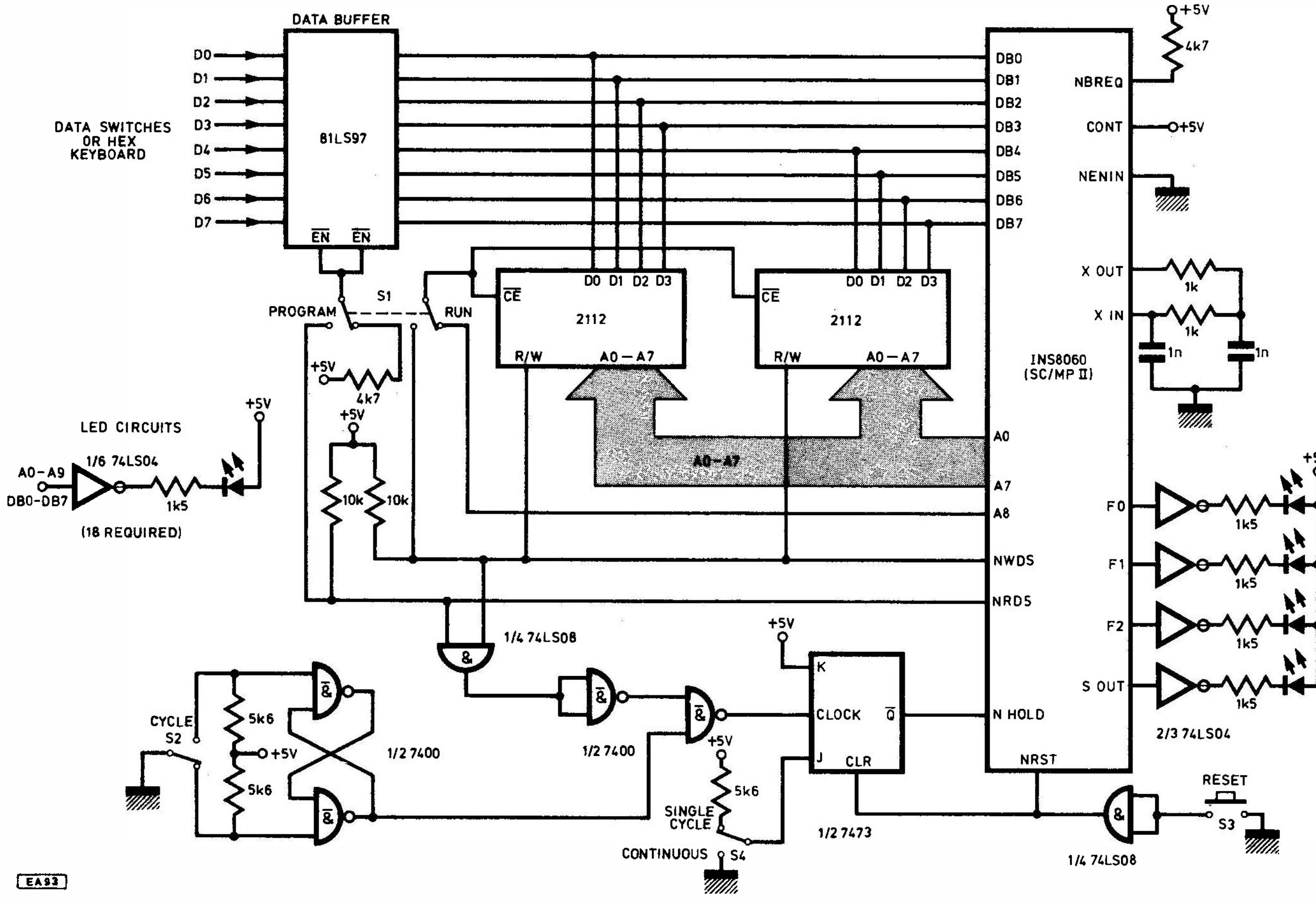


Fig. 3. Complete circuit of the simple SC/MP microprocessor system.

MPU will load this data into the accumulator.

"Now enter C9 (Store relative to pointer register P1) followed by the required memory address. Pointer P1 was set to zero on reset, so on the next cycle the MPU will store the contents of the accumulator, the required data, at this address. When the MPU writes to memory NWDS goes low which will enable the RAM.

For example, to enter 8F at location 0002 the full sequence is:

RESET, C4, CYCLE, 8F, CYCLE, C9, CYCLE, 02, CYCLE.

"The sequence is repeated to enter data at a different address and although the sequence looks quite long, in practice programs can be loaded into RAM fairly easily. The beauty of the system is that it is possible to enter connected to an inverted address line so that the data switches could be read from a program.

HEX KEYBOARD

"Although data for the SC/MP system can be entered by means of eight toggle switches at the input of the data buffer, a far more convenient method is to use the hex keyboard circuit shown in Fig. 4. The keyboard is based on a circuit in the *September 1978 PE* and would be useful in any application requiring hex data entry.

CIRCUIT OPERATION

"The keyboard circuit buffers two hex keypresses to give an 8-bit value at the output. When a key is pressed the binary code and triggers the monostable. The flip-flop steers the pulse from the monostable to enable the appropriate latch, and this latches the key's value.

"When the key is released the 4·7μF capacitor will discharge through the 1k resistor, and the output of the second Schmitt trigger will return low. The capacitor thus serves to debounce the keys both when they are pressed and when they are released. The next key-press will load data into the other latch, and the pulse from the monostable will be available on the strobe line to signal that a full 8-bit word is ready at the outputs of the latches. When loading a program this strobe line is not required, but it can be tied to SC/MP's Sense-B input so that programs can detect when data has been entered.

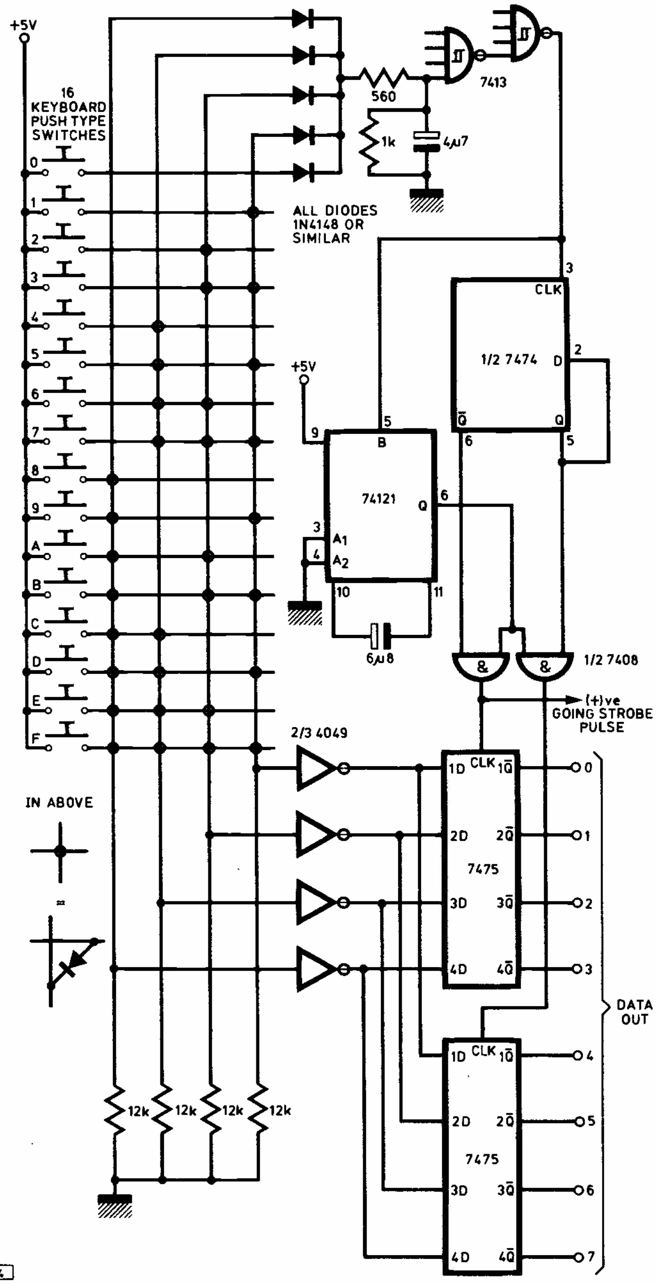


Fig. 4. Hex keyboard circuit which can be added to the SC/MP system to make data entry easier.

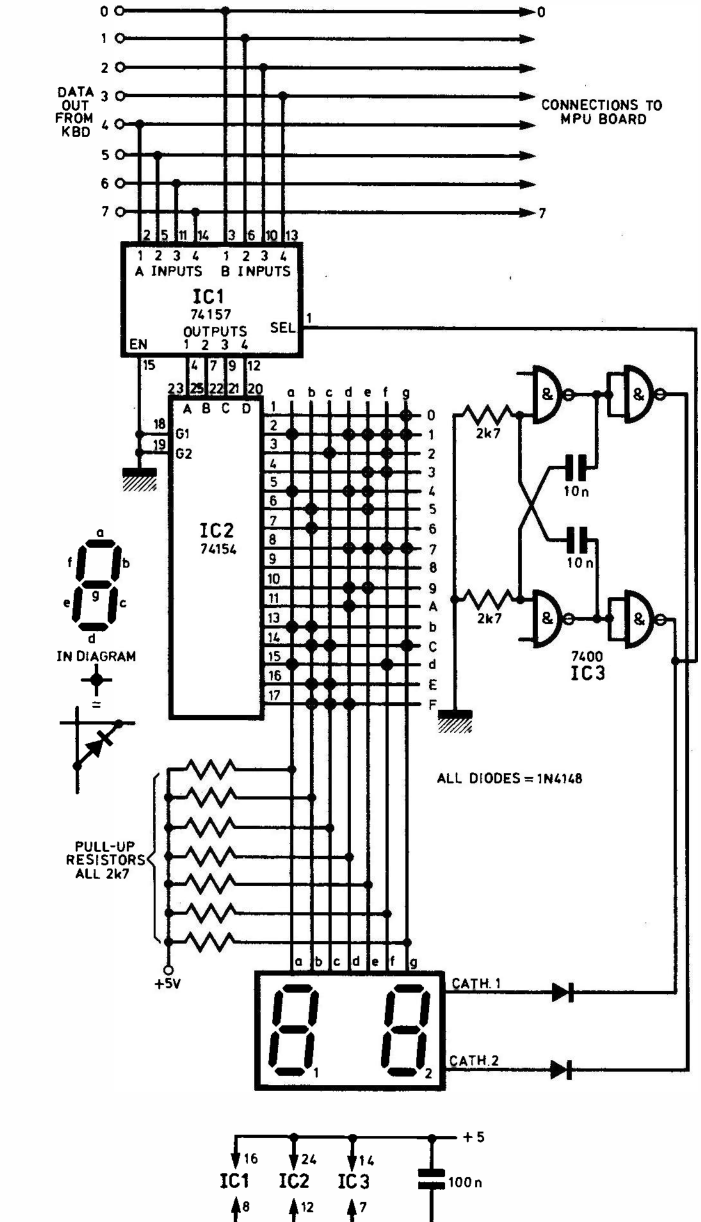


Fig. 5. Circuit which will display the output from the keyboard as two hexadecimal digits.

TWO-DIGIT HEX DISPLAY

"A two-digit hex display of the output from the keyboard is another useful addition to the system. The circuit of Fig. 5 achieves this with few parts, and without the need for an expensive decoder chip. The l.e.d. display is a small common-cathode multiplexed type.

"The four NAND gates form an oscillator that drives the cathodes of the displays in turn. One output of the oscillator is also taken to the select input of a 74157 quad two-input data selector which routes the appropriate 4-bit nibble from the data bus to the decoding circuitry. The 74154 decoder pulls one of its 16 outputs low depending on the code at its inputs. Each output is connected to certain segments of the displays by diodes; when the output is pulled low these segments are turned off to produce the required hex character on the display. Turning segments off is simpler than turning segments on, and results in a considerable saving in the number of diodes required. The 2k7 pull-up resistors may be reduced to 1k5 if the display is not considered bright enough.

"The oscillator thus switches the segment codes for each nibble to each display digit in turn, at high speed, giving a two-digit hex display of the data bus."

I/O PORT TESTER

The Acorn 6502-based computer provides two 8-bit I/O ports, and when these are being interfaced to external circuitry it often becomes difficult to keep track of the logic levels on the 16 lines. In such cases the routine of Fig. 6 should prove useful; it gives a continuous display of the states of the ports, in binary, as two rows of 8 dashes on the l.e.d. displays. The top row corresponds to the 8 bits of port A and the bottom row corresponds to the 8 bits of port B. The leftmost dash in each row is bit 7, and the rightmost dash is bit 0. A particular dash is illuminated if the appropriate input line is high, and blank if the line is low.

The routine can also be incorporated into programs which control the I/O ports, thus providing a continuous visual indication of what they are doing. In this case modify the last instruction of the routine to an RTS instruction, and insert a call to the routine in the most frequently executed section of your program.

```
                     ;         DISPLAY STATE OF I/O LINES
                     ;
                     DISP    =$0010          DISPLAY BUFFER
                     REPEAT  =$000E
                     ABIT    =$0900          TEST A-SIDE BIT
                     BBIT    =$0908          TEST B-SIDE BIT
                     DISPLY  =$FEOC          DISPLAY ROUTINE
                     ;
0000                         .=$0200
0200  A9 1F          TEST    LDA    £$1F     SINGLE SWEEP OF
0202  85 OE                  STA    REPEAT     DISPLAY.
0204  A2 07                  LDX    £7
0206  BD 08 09       LOOP    LDA    BBIT,X   BIT 7 = STATE
0209  OA                     ASL    A        INTO CARRY
020A  7D 00 09               ADC    ABIT,X
020D  95 10                  STA    DISP,X   PUT IN BUFFER
020F  CA                     DEX
0210  DO F4                  BNE    LOOP
0212  20 OC FE               JSR    DISPLAY  SWEEP DISPLAY
0215  10 E9                  BPL    TEST     I.E. ALWAYS

                             .END
```

Fig. 6. Program for a 6502 displays the states of an Acorn's I/O lines.

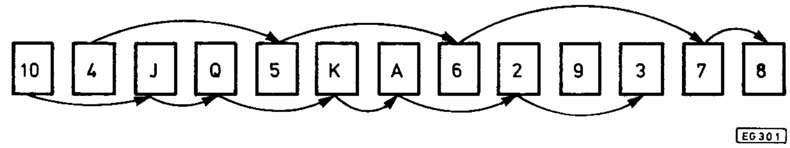


Fig. 7. Diagram to solve the card-trick problem.

CARD TRICK SOLUTION

In the last Micro-Bus you were asked to deduce which card in a series of thirteen cards had been removed, and replaced at a different position. The problem could be solved by entering the sequence of cards into one of the card-trick programs. Alternatively consider the sequence separated into two ascending series as indicated by the lines in Fig. 7. The nine is then clearly anomalous, and so this was the chosen card.

MICRO PROMPT

The hardware and software exchange point for PE computer projects

Yes, we know! This is supposed to be a bimonthly column; it appeared last month, yet here it is again! Well, the Prompt file is full of goodies, some of which we know are anxiously awaited, so we slipped this one in whilst no one was looking.

SAVE IT

Having stated in our first Prompt that the 101 has no cassette file handling firmware, we are now knee-deep in letters explaining various ways of saving raw data on tape. Below is a program which should provide the seed for some rewarding experimentation in cassette file keeping. It is an optimised combination of all the ideas sent in, some crude, some not so crude, plus our own refinements, and allows a named data file to be recorded. The data can be numbers or strings of text, since the technique utilises the SAVE and LOAD commands under program control. This program will take five words from you and record them as "FILE A"

save on tape

```
5 FOR A = 1 to 5 : INPUT
   "WORD ": W$(A) : NEXT
10 PRINT "TURN TAPE TO
   RECORD, & WAIT" : FOR A = 1
   TO 8000 : NEXT
20 PRINT : PRINT "HIT ANY KEY"
25 POKE 11, O : POKE 12, 253 : X =
   USR (X)
30 SAVE : PRINT "FILE A"
40 FOR A = 1 TO 5 : PRINT W$(A) :
   NEXT
50 POKE 517, O
60 END
```

Run the SAVE program, rewind the data tape, and then run the LOAD Program (RUN 120). All data will thus be cleared from memory, and recovery of the words will rely entirely on the tape file.

load from tape

```
120 PRINT "TURN TAPE TO
    REPLAY, AND HIT ANY" :
    PRINT "KEY IMMEDIATELY"
125 POKE 11, O:POKE 12, 253: X =
    USR (X)
130 LOAD
140 INPUT T$
150 IF RIGHT$ (T$, 6) = "FILE A"
    THEN 170
160 GOTO 140
170 FOR A = 1 TO 5 : INPUT W$(A) :
    NEXT
180 POKE 515,O : PRINT : PRINT :
    PRINT
190 PRINT RIGHT$ (T$, 6) : PRINT :
    FOR A = 1 TO 5 : PRINT W$(A) :
    NEXT
```

Advantage is taken of the fact that any PRINT statement after a SAVE command will write to the cassette interface, and any INPUT statement after a LOAD command will take data from the cassette.

To revert to normal operation in each case, it is necessary to POKE the relevant SAVE/LOAD flag off again with a zero (lines 50 and 180).

A delay is included (dead FOR-NEXT loop) to wait for the tape leader to clear and the recorder to settle down etc.,

Lines 150 and 190 use RIGHT$ to look at only these six characters: "FILE A", which may find themselves tacked on the end of some noise characters—*all* of which will think they are T$.

101 LOCATIONS

Here are some useful UK101 scratchpad memory locations which have been discovered by *P. Goodwin* of Southampton.

hex	dec		
0200	512	Cursor position along line	
0206	518	VDU operating speed	
0213	531	Character returned by keyboard input routine	
0130	304	NMI Vector	these are in the middle of the stack
01CO	448	IRQ Vector	
0203	515	LOAD Flag POKE 515, 0 turns Load off	
0205	517	SAVE flag POKE 517, 0 turns Save off	
0218	536	Input Vector	
021A	538	Output Vector	
000F	15	Terminal Width	
0300		Program End pointer (POKE this at your peril)	

HEAT POLLUTION

We received a letter from *Mr. J. Briggs* of Malton, N. Yorks, describing a problem with his 101 concerning video stability. The machine worked fine with the family television, but when used with a portable (PYE Model 191) the picture broke up as if incorrectly tuned, after about 10 minutes. Heat from the 5V regulator seemed to be affecting the modulator capsule, and anyone experiencing the same difficulty should note that the problem was cured by mounting the regulator and heatsink separately from the p.c.b.

The 3300μF reservoir capacitor has on some 101 boards suffered from excessive heat too. We have been told this can produce video *and* keyboard problems.

Next month's Prompt will include a table of handy and unexpected characters available direct from the 101 keyboard, and a review of some software which enables line editing and programmable cursor movement in *all* directions. We shall also publish that promised CHAMP program.

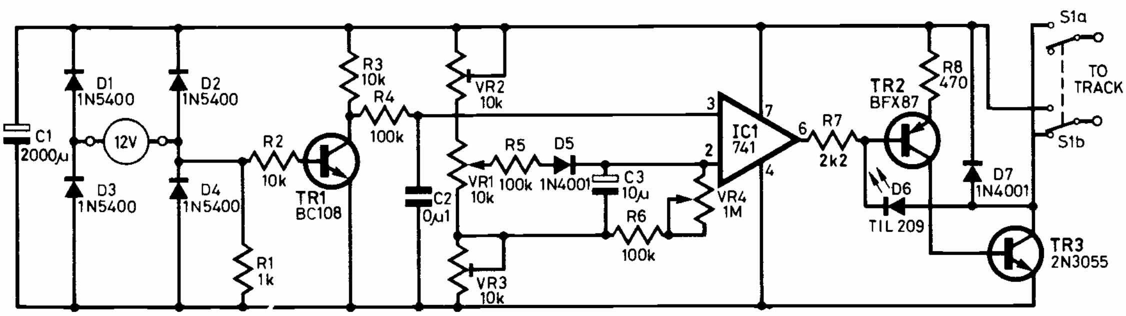
A selection of readers' original circuit ideas. It should be emphasised that these designs have not been proven by us. They will at any rate stimulate further thought.

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 is the original work of the undersigned, and that it has not been accepted for publication elsewhere.

MODEL RAILWAY CONTROLLER



The circuit shown is a pulsed power speed controller which includes simulated inertia and brake effects. It can also be used as a conventional pulsed power controller or as one in which both inertial acceleration and braking effects are controlled by the same potentiometer. I personally find this latter mode very satisfactory.

The controller will supply 1A at 12V and since the full output voltage is supplied to the motor during even the shortest pulses, the best possible control is achieved at slow speeds.

The half wave rectified output from the bridge rectifier is squared up by TR1 and integrated by R4 and C2 to produce an approximate saw-tooth waveform at the non-inverting input of the op-amp IC1.

The potentiometer VR1 and its associated presets VR2 and VR3 provides a reference voltage which can be varied over the range of the saw-tooth waveform. When this reference voltage at the inverting input is higher than the saw-tooth, the output of the op-amp goes low, switching on TR2 and TR3.

If all the components R5, R6, VR4, D5, C3 are omitted, the controller will be a conventional one with a very linear output.

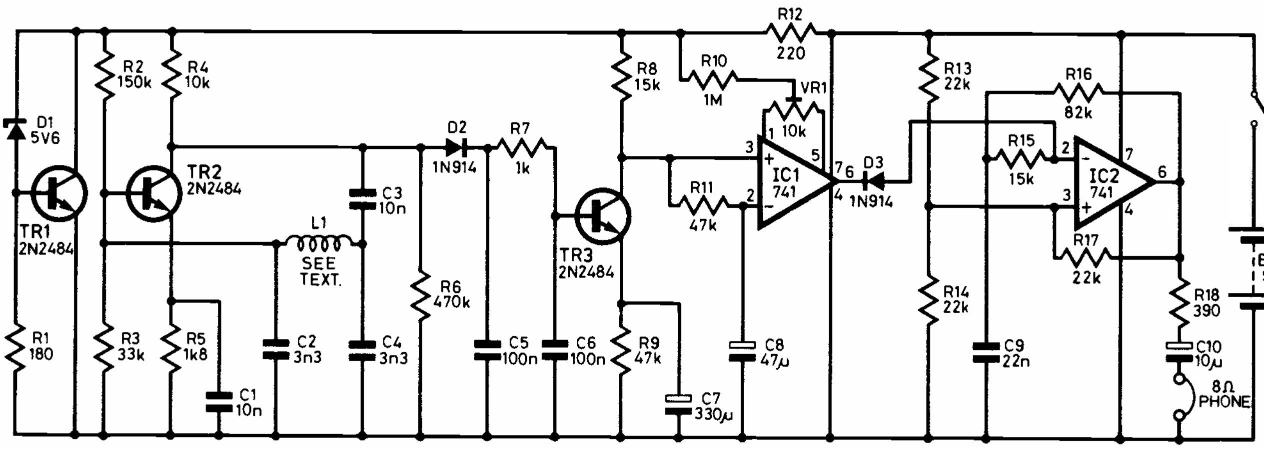
If only R5 and C3 are included, the output will rise and fall exponentially giving exceptionally smooth starting and stopping and calling for some skill from the operator when shunting! The value of R5 may be adjusted for individual preference.

With all the above mentioned components, VR1 acts as the regulator and VR4 the brake. D6 acts as a current limiter and visual warning in the event of a short circuit.

To set up the preset potentiometers, connect a small loudspeaker in series with a 1 kilohm resistor across the output terminals. Turn VR1 to maximum and adjust VR2 until the 50 cycle note from the loudspeaker just disappears. Turn VR1 to minimum and likewise adjust VR3. Repeat this procedure once or twice until the note just disappears at both maximum and minimum ends. The controller is now ready for use.

J. O. Linton,
Harrogate.

METAL DETECTOR



THE operating principle of this unusual metal detector relies on the fact that the high frequency field generated by the search coil, L1, produces eddy currents in any nearby metallic object. The energy used to produce these eddy currents is taken from the oscillator, formed around TR2. This is a Colpitts oscillator running at 140kHz; just inside the legal limit for metal detectors. This drain of energy, which finally produces heat in the metal, results in a reduction in the amplitude of the oscillations.

The signal at the collector of TR2 is rectified by D2; the peak value being stored in C5. Any change in the d.c. voltage will be amplified by TR3. A positive-going voltage at the collector of TR3, resulting from metal detection, will cause the output of the comparator, IC1 to switch positive, since the inverting input is for a time held more negative than the non-inverting input by C8. The audio oscillator, IC2, which was previously inhibited by D3, now oscillates at 400Hz, driving the earpiece.

Stability of the circuit is ensured by the shunt regulator around TR1. The comparator, IC1, uses a rather unusual method of offset control, VR1, to enable a fairly large adjustment range. This is to null out any noise, interference and instability which could arise in this very sensitive circuit.

Since the circuit detects changes in voltage rather than absolute values, it needs no re-adjustment once VR1 has been initially set. Furthermore, the operator has no variable controls to manipulate, making the unit very simple to operate. This is also true of the detection signal, which is of the tone/no tone type. An operator would need no skill in detecting a 10p piece at a depth of 6 inches, or larger objects up to 3 feet deep.

When the unit is switched on, it needs 60 seconds to stabilise. Once a metallic object is brought into the field, the detection signal remains for about 2 seconds, after which the circuit re-adjusts to the new value of oscillator amplitude.

L1 is a rectangular coil 3in by 6in wound with 55 turns of 5A flexible wire. A PP3 battery would give about 20 hours of continuous operation.

P. R. Williams,
Stevenage,
Herts.

LOW NOISE MIC PRE-AMP

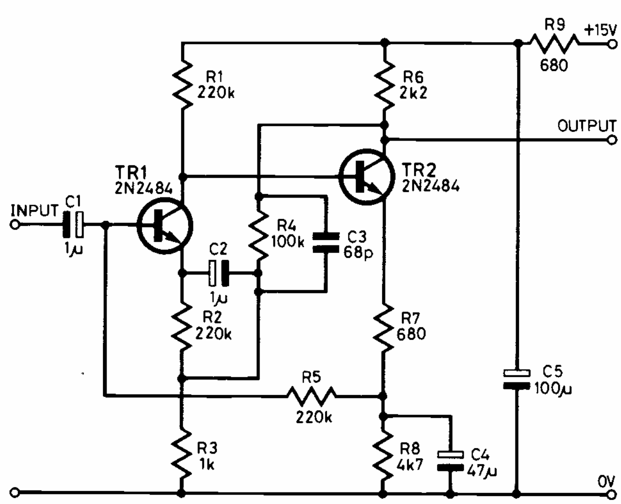
THE circuit shown was designed to fulfil the need for a very high quality microphone amplifier such as is essential for serious tape recording and in studios.

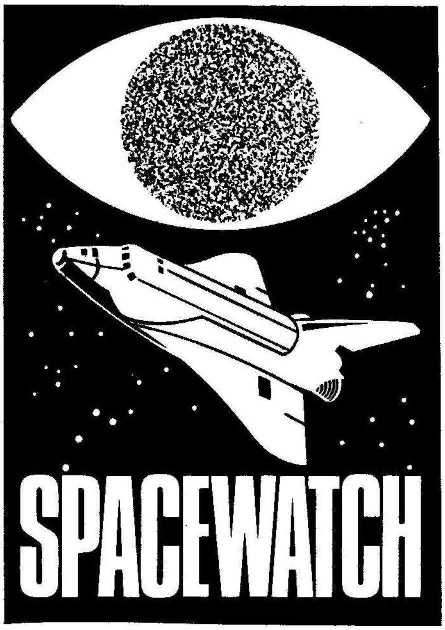
The signal to noise ratio is 78dB for an output of 1V r.m.s. and a source impedance of between 600 ohms and 50 kilohms. This very high signal to noise ratio is achieved by operating TR1 at a collector current of just 25µA, and a V_{ce} of 2V.

The frequency response is 25Hz-24kHz (−3dB), the upper limit being due to C3, which ensures high frequency stability. The amplifier is very stable due to the use of multiple feedback paths. R5 completes a d.c. feedback path, and also provides the correct bias for TR1. R4 and C2 complete an a.c. feedback path, providing negative feedback to the emitter of TR1 to control the overall gain. Negative feedback also reduces distortion and lowers the output impedance to just 800 ohms. The input impedance is 200 kilohms.

The purpose of R7 is to decrease the voltage/gain of TR2 such that TR1 has to work at a high gain, aiding the signal to noise ratio. The overall voltage gain is 35dB, but this can be altered by changing the value of R4. Inputs of up to 100mV can be accepted without undue distortion.

F. R. Williams,
Stevenage,
Herts.





FRANK W. HYDE

INTERNATIONAL ULTRAVIOLET EXPLORER (IUE)

In January last the IUE satellite completed two years of outstanding operation as an orbiting astronomical observatory. The satellite was originally designed for a useful life of three years. Now it is reasonably certain to exceed that period. It is fortunate that this is so, for the demand for time is beyond the capability as originally supposed. Already there is request for more than double the present time available.

The mission is a joint venture by the Science Research Council, the eleven member countries of the European Space Agency and the National Aeronautics and Space Administration of America. All three participants have agreed to continue the operation of the satellite so long as justified by the scientific return of data.

The Science Research Council provided the ultraviolet sensitive television cameras and image processing software. The European Space Agency provided the solar arrays and the ground station which is situated near Madrid. The National Aeronautics Space Administration supplied and launched the spacecraft and also operates the ground station in America at Maryland. More than 500 scientists from 20 different countries are in the process of studying 12,000 ultraviolet spectra of planets, stars, the interstellar medium and the galaxies. The strongest characteristics of light emission of the common atoms and ions lie in the region of the ultraviolet wavelengths of 115 nanometres to 320 nanometres. A vast amount of information can be obtained about the composition and physical state of astronomical objects.

IUE has pioneered a new method of operating a space telescope. When astronomers visit a ground station they are able to operate and direct the telescope as if it were at a ground based observatory. The satellite telescope is small compared with the equivalent ground based instrument for this work, but because the satellite telescope is outside atmosphere the efficiency is much greater. There are no cloud problems, no background light haze and much less turbulence to consider. Long exposures, which are essential to this work, can be carried out with great precision. An example of this was found when exposures of 14 hours were made and used to study the spectra of distant quasars of the order of magnitude 17. New information has thus been made available about these somewhat enigmatic objects.

Some of the discoveries are worth noting specifically. For example the stellar winds, which are caused by the radiation of matter from stars, have been found to exist around some of the very hot stars, something not previously known in connection with particular objects. New results show that the shockwave from an old supernova interacts with the interstellar material. Gas forming a high temperature halo around the galaxy with which the Solar System is associated (popularly called nowadays the Milky Way Galaxy) has been assessed and it is surmised that other galaxies may exhibit the same phenomenon. Observations have also been made of other galaxies, distant and active and other bodies such as quasars which emit vast amounts of energy. Studies were made of X-ray binary stars which are thought to be a normal star orbiting an object which could be a white dwarf, a neutron star or even a black hole.

The flexibility of the operating facilities of IUE has made it possible to allow for the unexpected, such as a new comet or the advent of a supernova, when the discovery could be followed by continuous observation.

These activities have already been widely discussed at some of the Conferences round the world. Perhaps the most succinct remark at a meeting of the International Astronomical Union Conference in Montreal, sums up the situation—"It is the first time that a whole day of the General Assembly has been devoted to the results of an 18 inch telescope only 18 months after its inception."

LASER COMMUNICATION SYSTEM (LASERCOM)

A Lasercom package carried on a space platform test satellite contains a transmitter as well as a low data rate receiver. The transmitter has been added to allow real-time telemetry data as the satellite passes over the White Sands missile range and gathering information on the performance of laser transmissions down through the atmosphere. The main aim of the tests is to evaluate the expected potential of space applications for high speed data transmission, increased transmission security and the ability to resist jamming.

The transmitter will be operated at a data rate of 800 bits/sec. This will enable the research team at the ground station to ensure that the transmissions are accurately pointed at the satellite. The satellite is to be placed in a 400 naut/mile orbit so that the ground station will have about 10 minutes of contact with the lasercom equipment aboard the spacecraft at each orbital pass.

The experimental module contains a multiple access receiver which is capable of acquiring several messages simultaneously. This receiver has a field of view of 4 degrees. In order to assess the spread of the laser beam over long distances and the effects of atmospheric variations, the transmissions will be at varying rates. That is, there will be data rates of 100 bits/sec. to 20 kilobits/sec. Ground testing of the high rates has already been undertaken since 1978. The test set-up was made with the receiver and transmitter at one point and a 24 in. diameter reflector set up about a kilometre away. Already flight testing at 30,000 ft. has shown significant results at 100 bits/sec.

NEW THEORY FOR THE SOLAR SYSTEM

It was to be expected that someone would want to set up another model for the Solar System. This time, needless to say, the computer is being used to provide evidence. It is certain that the Velikovsky myths will be put forward as having prior claims to the authorship of the new suggestions.

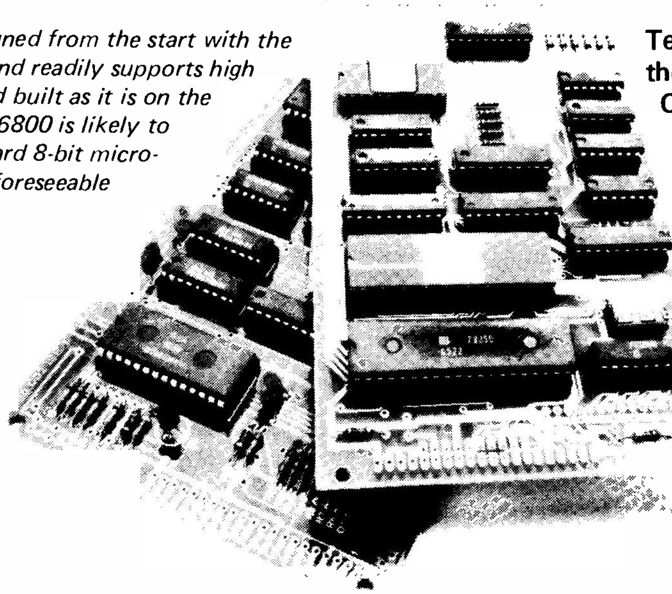
The details so far available are based on the fact that the computer has offered a conclusion that large planets were stable at an earlier date in the evolution of the Solar System. It is natural that there would be an immediate assumption from some quarters that Jupiter is the planet in question. The reason? Because Jupiter is the largest planet in the Solar System. The reason could be that Velikovsky claimed that around 1500 BC a comet erupted from Jupiter and formed the planet Venus. Aside from the timing, the lack of understanding of basic facts by Velikovsky has set many fantasies and claims among the gullible. It is often the bizarre that attracts a very large number of people to these ideas and they cannot be persuaded that most of the statements have no basic credibility.

Some years ago the writer and a few more astronomers speculated that in one hypothesis it could be said that the original body, or bodies, assuming a binary system, could by some process which caused imbalance result in the separation of a large portion of the original matter which by the momentum changes left the remnants (very small mass) which became the planets, leaving the larger mass to become the centre of mass with the remnant balancing the system. Space does not permit more than this brief note.

Coming back to the new report it is quite conceivable that there was a transition period where large bodies formed and became stable. The size is not easily suggested for such bodies, nor is the suggestion from the team at the Ames Spaceflight Centre and California University that stability necessarily means a rocky core in the centre of such bodies. While it is true that there is no absolutely concrete data about the present physical conditions deep inside planets, yet a model which postulates a solid interior of rock would raise more problems than can be answered at the moment. Indeed the tremendous increase in our knowledge of the planets that has resulted from the latest pictures and other data from Jupiter and Saturn will change many preconceived ideas. These, however, will not and do not support a composition of double evolution. Nor is it the case that such details of ageing which are generally accepted at the present time give any support to such an idea.

Maintain the lead with Acorn 6809

... the 6809 designed from the start with the programmer in mind readily supports high level languages and built as it is on the experience of the 6800 is likely to become the standard 8-bit microprocessor for the foreseeable future. . . .



Technology leader in microprocessors the 6809 is now available from Acorn Computer with full supporting hardware on a eurocard paired with the Acorn VDU interface at a special introductory price.

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Acorn is offering their two most powerful modules as the basis for a 6809 development system requiring the addition of keyboard, power supply and monitor. For existing owners of Acorn Systems, the 6809 CPU card is a direct plug-in replacement for the 6502 CPU and can be used with all the supporting cards presently consisting of 8K memory, tape interface, VDU interface, Floppy disc drive, Analogue to digital/digital to analogue and Universal interface.

For newcomers to Acorn the two card system can readily be linked to terminals printers, etc., the operating system firmware is designed for modularity and has disc bootstrap.

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We believe this is an exceptional loudspeaker and that we are offering it at an exceptional price—we urge you to compare it with any advertised price or any other "offer"! The phrase "Value for money" is used in the Practical Hi-Fi and Audio review quoted below—that phrase was based on a normal retail price of approximately £80 (yes eighty)—need we say more?

The GB3 is a two-way bookshelf loudspeaker of very compact dimensions which is based on the extremely successful Minimax. However, all the design and development work for the GB3 has been completed by Videotone engineers in the U.K.

As in the Minimax, the bass unit utilised is a high performance, 5 inch unit which incorporates a lightweight, rigid paper cone with rubber roll surround and a one inch double wound voice coil. These combined with the high density magnet give the unit a very long throw with good linerity and this results in a powerful, clean bass and very good power handling.

The tweeter used is a brand new one inch dome developed specially for the GB3. This unit has a smooth frequency response which extends beyond 20kHz and the use of it in the GB3 gives the speaker a good polar response, enabling the listener to listen off axis from the speaker without undue loss of extreme high frequency sound.

The crossover that combines the woofer and tweeter together is also of a new design, incorporating mylar capacitors and top quality air cored inductors to ensure a well intergrated and smooth response throughout the crossover region. The drive units and crossover are contained in a very high quality cabinet. This is constructed from reinforced plywood (which is better than chipboard for the absorption of unwanted rear-radiated sound) and filled with a measured quantity of acoustic wadding to further absorb cabinet resonances. The cabinet is covered, both back and sides, in a high quality wood veneer of either polished teak or walnut.

The use of more sophisticated and expensive components and drive units in the GB3 have resulted in a sound quality that is superior to the highly regarded Minimax in almost every way.

Typical Specification:

Type:	Two way, sealed box (infinite baffle) enclosure
Impedance:	8 Ohms nominal
Recommended amplifiers:	Those delivering between 15 and 40 watts (r.m.s. into 8 Ohms)
Frequency response:	50-20,000 Hz (80-20,000 Hz ± 4dB)
Efficiency:	3 watts (r.m.s. into 8 Ohms) gives 88dB S.P.L. at 1 metre
Crossover:	12dB per octave network, utilising high quality components, and crossing over at 3·4kHz
Size:	260mm ($10\frac{1}{4}$in) high, 150mm ($5\frac{7}{8}$in) wide, 220mm ($8\frac{1}{4}$in) deep

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Extracts from review by Bill Anderton in the October Issue of Practical Hifi and Audio.

When under test, the GB3s were compared with a monitor loudspeaker system costing four times as much and this should be borne in mind when evaluating comments.

Initial impression: excellent.

Mid range and high frequencies very good and clear. No over emphasis of record surface noise. Excellent overall—no immediately obvious distortion.

Percussion: stereo image solid and well defined. Top end good—cymbals clean, accurate sound, not tinny. Realistically high listening levels obtainable despite relative inefficiency. Mid-range very good. Electric guitar has bite and depth to its sound quality.

Orchestral with solo violin: solo violin reproduced accurately—no unnecessary harshness. Upper mid-range excellent. Overall an excellent high-quality performance, very impressive.

Orchestral with piano: top end well controlled and impressions, realistic reproduction.

Rock and jazz: brass excellent accurate sound, reproducing reedy, raspy timbre accurately. Very impressive and will reproduce high sound levels without introducing any noticeable distortion.

Organ: considering the size of these loudspeakers, bass performance is excellent. Mid-range and high frequencies accurate.

Choral: excellent stereo separation between sound images, male voice speech. Tonal quality can sound thin but overall performance excellent.

White noise: very smooth—no obvious level difference between drive units and no obvious suck-outs or peaks. Low frequencies missing but otherwise accurate.

Drums: cymbals clear and accurate.

Electric bass and bass drum: remarkable performace for such a low priced speaker.

Guitar 12 string: excellent reproduction of transients.

Piano: same comments as for 12-string guitar.

Bass acoustic: very good. Transient response accurate.

Cello: excellent. No loudspeaker resonances evoked by this instrument.

Violin: very good.

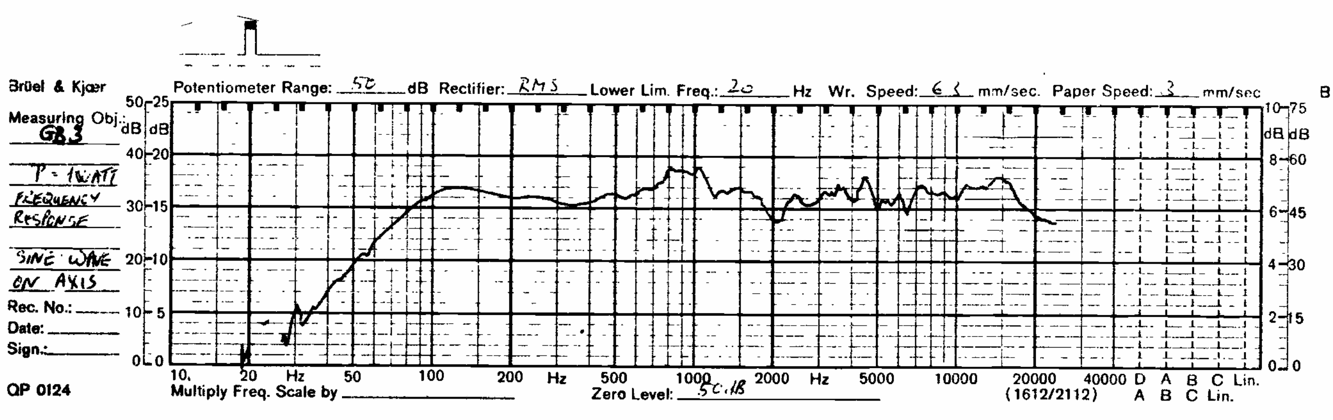
Bass flute: very accurate reproduction. Breath tones clear without over-emphasis.

Alto flute: same comment as for bass flute.

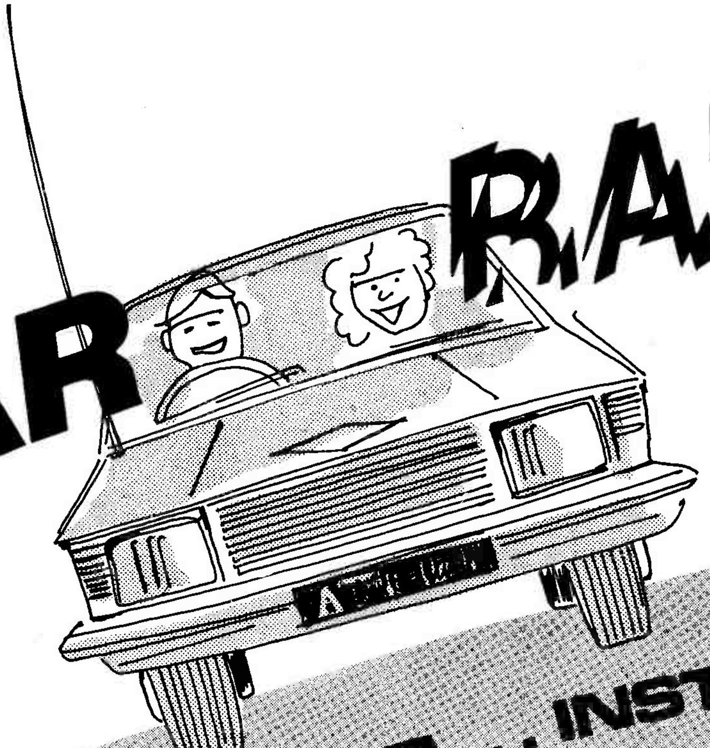
Oboe: characteristic timbre accurately reproduced. Performs well in this frequency range.

English horn: excellent, accurate reproduction of the tonal quality of this instrument.

"Comparison with Minimax 2: smoother upper mid-range and high frequency reproduction. Slightly less efficient but general tonal clarity has been improved—not quite so lively as the Minimax but overall the sound quality has been improved by quite a major degree." "Distortion measurement results were excellent." "Value for money is certainly the phrase I would use to describe the diminutive GB3s. They are styled simply and attractively and have a performance quality that surpasses all expectations from a loudspeaker of this nature. Full marks to Videotone and the GB3."



CAR RADIO



PE TRAVELLER . . . INSTALLATION

AFTER the Traveller has been assembled and aligned a piece of cardboard should be fitted over the track of the p.c.b. to improve the insulation. If a multimeter is available check that a short does not exist between the two feed through capacitors and the chassis. The current consumption of the set is very low without a signal and should not exceed 1 amp. at full volume.

Under no circumstances should the cores of the tuner or the r.f.-i.f. module be adjusted as the unit is pre-aligned and tuned for optimum results.

SETTING THE PUSH BUTTONS

The push buttons can be set by tuning the receiver to the medium wave and pulling out the first button, next to the volume control, which should move approximately 6mm from its static position. The station required should then be selected using the manual tuning knob and when the set is accurately tuned in the push button should be pressed firmly home.

AERIAL

A suitable aerial for the Traveller should have a total capacity (aerial and lead) of 70-80pF. If a high capacity aerial is used there will be problems in adjusting the aerial trimmer. Ensure that there is a good earth between the aerial and the car body.

With all the connections made to the set but before the escutcheon is fitted the aerial trimmer should be adjusted. It is best to use a weak station at the h.f. end of the medium waveband. There should be a point where the volume peaks with a clear drop either side. The two square trims can then be fitted to the escutcheon along with the printed tuning scale.

INSTALLATION

If a dashboard cut-out for a radio is provided then the volume, tuning control knob and the escutcheon should be removed. The two remaining distance nuts can then be adjusted to the correct gap between the set and the escutcheon.

With all the connections made to the set it should be fitted into the dashboard from behind and the knobs and escutcheon refitted. After the set has been fitted check that there is sufficient clearance for the push buttons to operate correctly.

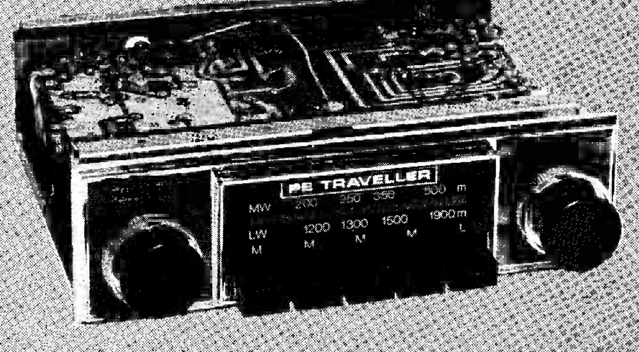
If there is no aperture the set can be mounted either on the parcel shelf or under the dashboard. The set should not be fitted near the heater outlet as frequency shift due to extreme temperature may occur.

Two 2BA tapped fixing holes are provided either side of the casing and these can be used to mount the set (max. length of screws 12mm). Two 'L' shaped brackets should be formed (Fig. 1) and fitted to the car and then the radio screwed into position.

INTERFERENCE SUPPRESSION

After the set has been installed it should be checked for any interference. To ensure that the interference is not from any outside source the following checks should be carried out away from any building, power lines, etc..

Tune the radio to the medium wave away from any station



and with the volume turned up only a background hiss should be audible. If there are any crackles re-check the aerial and earthing points for loose or dirty connections. If an electric clock is fitted this can be suppressed with a 1µF capacitor between its 12V supply and earth. With the ignition turned on the electric fuel pump (if fitted) may cause a whine or tick in which case another 1µF capacitor should be across its supply to earth.

With the engine running there might be a trace of interference. If however there is a whine which increases with engine revs this will be the generator. A 1µF capacitor should be connected across the live output terminal to earth. *Do not* connect it to the field terminal. Alternators should be suppressed using 2µF capacitors connected across the output lead and the nearest earth.

If the interference is a crackle which varies with engine revs then the ignition coil should be suppressed with a 1µF capacitor connected across the switch terminal (SW,+) and earth. *Please note* that if your car has electronic ignition then you must check with the manufacturer's instructions otherwise the system may be damaged.

In most cases the procedure outlined above should give interference-free suppression. Should the interference continue, however, then check that the bonnet top is firmly closed and that it makes a good electrical connection to the body of the car. Also check the outer screen of the aerial lead is well earthed at the base of the aerial and the aerial plug makes a good contact in the socket. ★

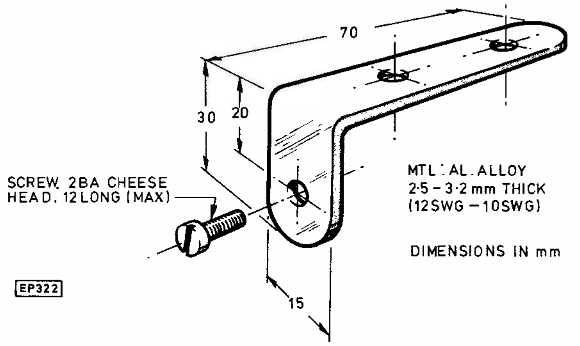


Fig. 1. Mounting bracket details (2 off)

Countdown

Computermarket Mar. 11-13. Manchester. **U1**
Computermarket Mar 18-20. Glasgow. **U1**
Keyboards And Switches (mini) Mar. 18-20. National Microprocessor and Electronics Centre, London. **L1**
Computermarket Mar. 25-27. London. **U1**
Electro-Optics/Laser International March 25–27. Metropole Convention Centre, Brighton. **T1**
Viewdata Mar. 26-28. Wembley Conference Centre, London. **O**
Computer-Aided Design (conference & exhibition) Mar. 31-April 2. Metropole, Brighton. Details: CAD 80/0483-31261
Small ATE April 1-3. National Microprocessor and Electronics Centre, London. **L1**
Applying Microprocessors April 8-10. National Microprocessors and Electronics Centre, London.
Seminex April 14-18. Dept. Physics, Imperial College, London. **H1**
Communications 80 April 14-18. National Exhibition Centre. **I**
Calibration April 15-17. National Microprocessor and Electronics Centre, London. **L1**
Peripherals 80 April 16-17. London. **L**
Welsh Amateur Mobile Rally April 20. Memorial Hall. **C**
Electronic Test & Measuring Information April 22-24. Wythenshaw Forum, Manchester. **T**
International Conference On The Electronic Office April 22-25. London Penta Hotel. Organised principally by the Institute of Electronics & Radio Engineers. 99 Gower St., London WC1E 6AZ
North Midlands Mobile Rally April 27. Drayton Manor Park, Tamworth, Staffs. Details: Norman Gutteridge, 68 Max Rd., Quinton, Birmingham
All-Electronics Show April 29-May 1. Grosvenor House, London. **E**
The Mersey Micro Show April 30-May 2. Adelphi Hotel, Liverpool. **O**
Compec Europe May 6-8. Centre International Rogier, Brussels. **L**
International Word Processing (Exhibition and Conference) May 20–23, Wembley Conference Centre. **O**
East Suffolk Wireless Revival May 25. Grounds of Ipswich Area Civil Service Sports Association, Straight Rd., Bucklesham. There should be a good variety of happenings to interest both radio addicts and non addicts, including, it is hoped, a demonstration of a PO television detector van. **V1**
Satellite Communications (Conference) June 18–19. London Press Centre. **O**
Great British Electronics Bazaar June 20-22. Alexandra Palace. **E**
Intel Fair June 24. Wembley Conference Centre, London. **U**
Tempcon July 1-3. Wembley Conference Centre. Exhibition devoted to temperature control & measurement. **T**
Transducer July 1-3. Wembley Conference Centre. **T**
Microsoftware (symposium) July 7-10 University of Sussex. **S1**
The 1980 Microcomputer Show July 10-12. Royal Lancaster Hotel, London. **O**
BAEC Amateur Electronics Exhibition July 12–19. The Esplanade Shelter, Penarth, near Cardiff, S. Glam. **B**
Computer Graphics (exhibition & conference) Aug. 12–14. Metropole, Birmingham. **O**
Harrogate International Festival of Sound Aug. 16-19 (18 & 19 trade). The Exhibition Centre + hotels. **X**
Avionics (symposium) Sept. University of Surrey. **S1**
BEX (Business Equipment Exhibition) Oct. 1–2. The Guildhall, Plymouth. **K**
BEX Oct. 15–16. Assembly Rooms, Edinburgh. **K**
BEX Nov. 5–6. Sophia Gardens, Cardiff. **K**
Semiconductor International 80 November 25–27. Metropole Convention Centre. **T1.**

B British Amateur Electronics Club, 26 Forrest Road, Penarth, S. Glamorgan.
C Barry College of F.E. Radio Society, College of Further Education, Colcot Rd., Barry, S. Glam. CF6 8YJ
E Evan Steadman, 34-36 High St., Saffron Walden, Essex. ✆ 0799 22612
I Industrial Trade Fairs. ✆ 021-705 6707
K Douglas Temple Studios, 1046 Old Christchurch Rd., Bournemouth, Dorset BH1 1LR. ✆ 020 20533
L Iliffe Promotions. ✆ 01-261 8437/8
O Online Conferences. ✆ 0895 39262
T Trident International Exhibition. ✆ 0822 4671
U Brian Crank Associates, 58 London Rd., Southborough, Kent. ✆ 0892-31812 38414
X Exhibition & Conference Services, Claremont Ho., Victoria Ave., Harrogate, Yorks. ✆ 0423-62677
H1 Seminex Ltd. ✆ 0892 39664/5
L1 P. Smith, London World Trade Centre, Europe House, London E1 9AA. ✆ 01-488 2400
S1 Society of Electronic & Radio Technicians, 57-61 Newington Causeway, London SE1 6BL. ✆ 01-403 2351
T1 Kiver Communications U.K., Millbank House, 171/185 Ewell Road, Surbiton, Surrey KT6 6AX.
U1 Couchmead Ltd. ✆ 01-437 4187
V1 Jack Tootill, G4IFF, 76 Fircroft Rd., Ipswich, Suffolk IP1 6PX. Send s.a.e. (9 × 5 ins.) for details.

2 WIRE TRAIN CONTROLLER

PART 1

J. MILNE

THIS article describes the principles, and construction, of a control system for model locomotives, which allows independent operation anywhere on an interconnected rail layout.

The construction of a four channel controller is described, but it should be possible to expand the system to at least ten channels, including point and signal control.

PRINCIPLES OF OPERATION

The rails are supplied with 20V a.c. from a transformer. Regulation of the current flow through each of the motors, is carried out in a unit attached to the motors. How this occurs can be explained more easily, if the following simple examples are considered first.

A d.c. motor will run with an a.c. supply, of suitable voltage, if it is half wave rectified, with a diode, as in Fig. 1(a).

If the motor speed is required to be variable, the diode can be replaced with a thyristor, as in Fig. 1(b). By adjusting the triggering point of the thyristor, in the supply cycle, the motor speed can be altered from zero, to maximum.

To allow the motor to run in either direction, a second thyristor can be fitted in parallel with the first, but inverted, as in Fig. 1(c).

Only one of the thyristors is triggered at any time, and the speed control is similar to the previous example.

The two thyristors can be replaced by a single triac, as in Fig. 1(d), which simplifies the triggering arrangement, but controls the motor current in exactly the same way.

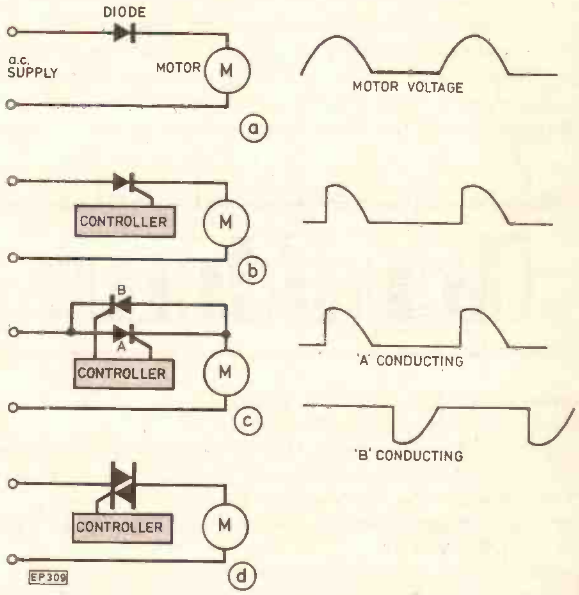


Fig. 1 Variants on motor speed control from an a.c. input (a) half wave rectified (b) phase controlled (c) phase control with back-to-back thyristors (d) triac equivalent

The characteristics of a triac, are very similar to that of the thyristor. Once triggered, it will continue to conduct, regardless of its gate current, until the load current falls below the minimum holding current, when it will switch off. When the

device is in an a.c. circuit, this will occur at the end of each half cycle, at or near zero voltage. The main difference between the triac and the thyristor is that it will conduct in either direction, and that it can also be triggered by a gate current in either direction.

A triac is fitted in each of the units attached to the locomotive motors, and is the main working component in the system. The rest of the circuits are there only to ensure that the triacs are turned on at the right time.

Fig. 2 shows a block diagram for the system. For each of the channels, a logic circuit working at supply frequenc, gives an output varied by the position of a potentiometer, which is then used to operate a switch in the output of an oscillator. The outputs of all channels are then combined by a summing amplifier, before being passed to the output stage, and so to the rails. In the receiver unit, at each locomotive, a tuned amplifier sorts out its own control signal from the others, and the supply frequency. On detecting the control frequency, a trigger amplifier causes a pulse of current to flow in the triac gate circuit, so turning it on.

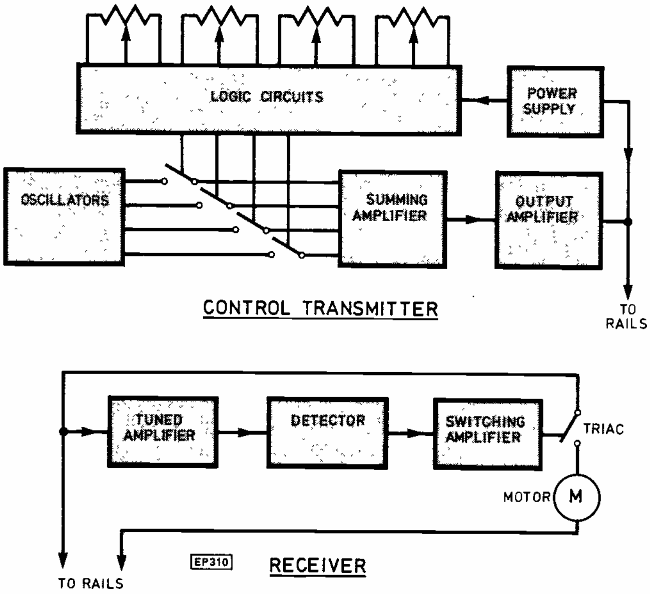


Fig. 2 Block diagram of system

DESIGN CONSIDERATIONS

The choice of control frequencies, was a matter of some compromise. It is convenient, and simple, to use chokes to contain the control signals within the rail system. The chokes must have a low impedance at supply frequency, or they will restrict the motor load current. For an impedance of less than one ohm an inductance of 1mH to 2mH appeared suitable.

It also appeared desirable to keep the control frequencies as low as practical, and well clear of the radio frequency range. This then has the advantage that the wide range of audio frequency components can be used.

A 2mH choke has an impedance of over 100Ω at 10kHz, and by using a low output impedance amplifier to supply the control signals, at least ten circuits with their chokes, can load the amplifier without causing a significant drop in signal level. 10kHz appears to be the lowest usable frequency, and was used in my initial experiments.

The control oscillators should give a reasonably pure sine wave output, to prevent interference with channels at higher frequencies, through the generation of harmonics, and be free of significant temperature drift, to prevent interference with adjacent channels.

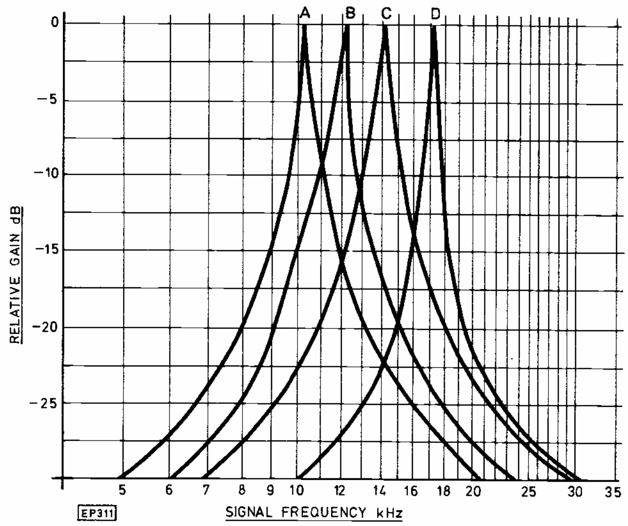


Fig. 3 Response curves for tuned amplifiers

The tuned amplifier stage in the locomotive receivers should also be drift free, as well as having a reasonable Q value, and be physically small. The Q value also has to be considered when deciding the spacing of the frequencies. Fig. 3 shows the response curves for the prototype RC tuned amplifiers, which confirmed that a spacing of less than about 20%, was impracticable for this type of amplifier.

Small d.c. motors generate wide band electrical noise, and in quantities out of proportion with their size. Precautions have to be taken to prevent, not only the effects this can cause on the reliable operation of the locomotives, but also to prevent the possibility of causing annoyance to others through radio frequency interference.

These are some of the factors taken into consideration during the development of this controller, and will be referred to in the description of the individual parts of the circuits, together with the other significant features.

PERFORMANCE

In use, the system is very similar to the pulsed d.c. systems, and has the same advantages and disadvantages. Starting with the good points, the low speed control is very good, and a reliable creep speed down to about one inch per minute is possible. Even at low speed settings, the motor torque is high, and the wheels tend to slip on heavy loads, rather than stall the motor. Because the full supply voltage is on the rails, all the time, the locomotives are more tolerant of oil and dirt on the track.

There are two disadvantages, caused by the discontinuous flow of current through the motors. The first is that because of the high a.c. component, the motor eddy current loss is increased, causing the motor to run hotter. I have not had any difficulty through this cause, but some manufacturers issue a warning not to run their locomotives for prolonged periods on half wave current, and the same must apply here. The second is that the torque produced by the motor is also discontinuous, and with wear on the reduction gearing, can cause an unrealistic rattle. This is not so offensive if the model is of a diesel, but one of the "high mileage" steam locomotives used for testing the system required quite a bit of attention to make it acceptable.

The other point that must be made at this stage is that most commercial model controllers are "instrinsically safe", and can withstand a short circuit for indefinite periods, and limit the short circuit current to a safe value. In this design, of necessity, the rail supply transformer is connected almost directly on to the rails, so the potential fault current is high. A fast and reliable circuit breaker must be fitted in the transformer secondary circuit, and the primary circuit fused.

CONTROL TRANSMITTER

This unit houses all the electronics to produce the control signals, the rail supply transformer, and the power supplies. The electronic components are accommodated on two circuit boards: the logic board and the oscillator amplifier board.

The signals produced, and the effect on the motor voltage, is illustrated for one channel, in Fig. 4. The logic circuit produces a negative pulse, of variable width, starting at some point during one half cycle of the supply voltage, but always ending at the end of that half cycle. The logic circuit output is used to operate an f.e.t. switch in the oscillator output, allowing the signal to pass on to the rails. The signal is then detected by the locomotive receiver, and the triac switched on. The control signal is transmitted throughout the triac conducting period, even though only a few milliseconds at the start of the period should be necessary to trigger the triac. However, poor rail contact, etc, could cause a short signal to be missed, so on the principle of "better late than never", the longer signal pulse is used.

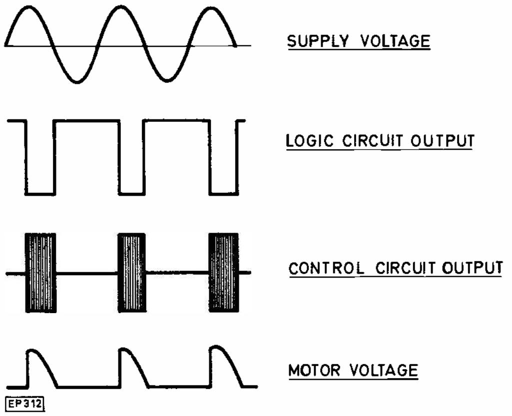


Fig. 4 Signal processing from logic circuit to motor

LOGIC CIRCUITS

As referred to previously, the function of these circuits is to produce an output suitable to switch on and off the control signals. The required output from one channel is shown in Fig. 5 with various locomotive speed settings.

The circuit diagram for this part of the circuit, is shown in Fig. 6. This has been drawn, showing only one channel for simplicity, but is marked with the component numbers for all the channels.

A 20V a.c. input is connected through R18 and C14 to D1, to give a near square wave representation of the supply voltage. C14 gives a few degrees of phase advance to compensate for delays later in the circuit. TR1 amplifies the leading and trailing edges of the square wave, and gives a TTL compatible output. From here the circuit divides, first into two, then into four parallel paths, so again for simplicity, only the channel with the lowest component reference numbers is used in the following explanation.

IC1 NOR gate (c), and IC3 gate (c) are both connected as inverters. IC5 and IC9 are monostables, used to provide the variable length pulses. With the connections used, pin 6 voltage is normally low, but will go high when pin 5 is switched from the low to high states. Pin 6 will then remain high for a period $t = Ct\ Rt\ \log_e 2$ seconds where: Ct is the value of the timing capacitor, connected between pins 10 and 11 and Rt is the sum of the internal and the external resistors connected between pin 9 and the positive supply.

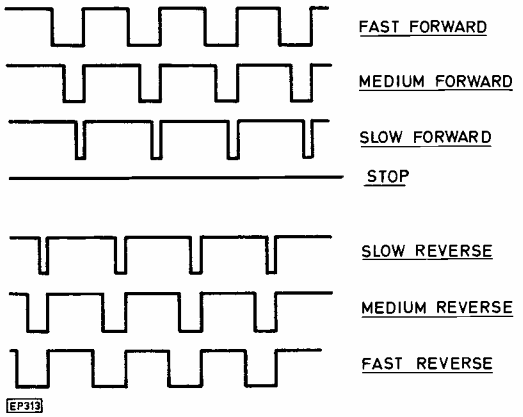


Fig. 5 Logic Board control output signals

IC1 (c) output connects to IC9 input, and IC3 (c) to IC5. Referring to Fig. 7, it will be seen that the timing period of IC9 starts at the beginning of the supply positive half cycle, and IC5 for the negative half cycle. IC5 and IC9 share the same variable timing resistor VR1, so when this is set at mid travel, and with a suitable value of timing capacitor, the timed period can be equal to a half cycle period, that is 10ms. This is shown in Fig. 7 (d) and (e). IC9 output, and IC3 output, shown in Fig. 7 (c), connect to the inputs of gate IC1 (b), and similarly, the outputs of IC5 and IC1 (c), Fig. 7 (b), to IC1 (a). By inspection, it can be seen that the output of both gates, IC1 (a) and (b), will be low at all times and that the output of IC1 (d) will remain high.

If VR1 is moved from the mid position, so that the timing period of IC9 increases, Fig. 7 (f), and IC5 decreases, Fig. 7 (g), IC1 (b) output will be low continuously, but IC1 (a) output, Fig. 7 (h), will be high from the end of the timing period, to the end of that half cycle. One input of IC1 (d) is low continuously, so the output will be the inverse of the other output. It should also be noted that if VR1 is moved further in the same direction, IC5 timing period will be reduced again, and the start of IC1 (a) output pulse will move to a new position earlier in the half cycle.

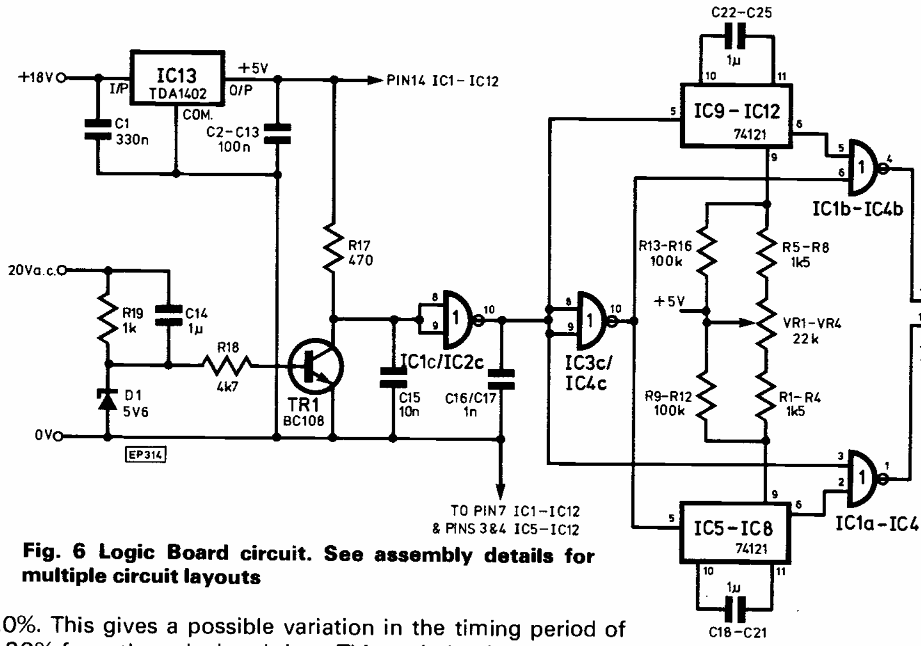
If VR1 is now moved in the opposite direction, so that IC9 is near to the minimum, Fig. 7 (i), and IC5 near to maximum, Fig. 7 (j), by analogy with the previous example, the output of IC1 (b) will be high from the end of the timing period to the end of the positive half cycle, Fig. 7 (k), and will again be inverted by IC1 (d).

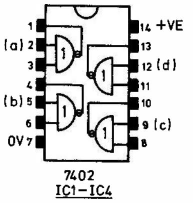
Effectively, the timing period derived from IC9 controls the locomotive speed in one direction, and that from IC5 in the opposite direction. Fixed value resistors are fitted in series, and in parallel with VR1. The series resistors prevent the timing period becoming too short, when maximum speed is selected, as this can result in erratic triggering of the triac, caused by low instantaneous supply voltage and high motor back e.m.f. The parallel, or shunt resistors, R9 and R13, compensate for the variations in the actual values of VR1, and the timing capacitors, C18 and C22.

CONSTRUCTION

The circuit layout is not critical, and all the usual precautions when using TTL devices should be taken. A suitable circuit board, and the component layout is shown in Figs. 8 and 9. Extra decoupling capacitors have been used in the supply to the devices, because of high electrical noise in the circuits near to the board.

It is desirable that the components that effect the timing periods are subject to some selection. Readily available capacitors have a tolerance of 10%, and potentiometers





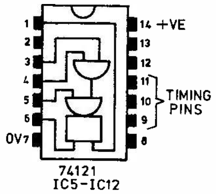


Fig. 6 Logic Board circuit. See assembly details for multiple circuit layouts

20%. This gives a possible variation in the timing period of ±30% from the calculated time. This variation is acceptable for the minimum time period, but when the maximum exceeds the supply periodic time the logic of the circuit breaks down and an erratic output is produced. To prevent this occurring, the maximum timing period should be between 17 and 18ms, to allow for changes in potentiometer slider contact resistance. If the facilities are available, measure the values of the timing capacitors, C18 to C22, and the track resistance of the potentiometers VR1 to VR4. Each potentiometer should be grouped with a pair of similar valued capacitors, such that a high value potentiometer is assigned to a low value pair of capacitors, and vice versa. Multiply the value of the capacitors, in µF, to the value of the potentiometer track resistance in kilohms, and if the resultant exceeds 23, shunting resistors will be required, and fitted in the positions marked for R9 to R16. For resultants less than 23, the resistors are not required, and their positions left unused. The required values of shunting resistors can be calculated from:

$$Rs = \frac{18\,(Rv + 1{\cdot}5) - 1{\cdot}4Ct\,(Rv + 1{\cdot}5)}{0{\cdot}7Ct\,(Rv + 3{\cdot}5) - 18}\ \text{kilohms}$$

Where Ct is the measured value of the timing capacitor in µF and Rv is the measured track resistance of the potentiometer in kilohms. When it is impracticable to measure the capacitors, they could be assumed to be of reasonable value, and just the potentiometer track resistance measured. For values over 23kΩ, the previous equation can be simplified, and the appropriate value of shunting resistor found from:

$$Rs = \frac{23{\cdot}7\,(Rv + 1{\cdot}5)}{Rv - 22{\cdot}2}\ \text{kilohms}$$

If it is impracticable to do any of this, a 100kΩ resistor could be fitted which will compensate for all but the extreme values.

I used one of my own heat sinks for the 5V regulator, and Fig. 11 shows how it can be made; however, a commercial component could be fitted. Referring to the board layout, shown in Fig. 9, fix into position the thirteen links in the positive rail, drawn as a double line on the component side diagram. 22 s.w.g. p.v.c. covered single core copper, or similar wire, should be used for this. Then fix the twenty two signal links, using 26 s.w.g. single core p.v.c. covered, or similar. The use of d.i.l. sockets is recommended, and these should be fitted next, followed by the resistors and the capacitors. Fit the 5V regulator (IC13) and its heat sink into position, using a small quantity of silicon grease on the contact surface. Finally, fix into place TR1 and D1.

TESTING

Before fitting the i.c.s into their sockets, connect a variable voltage power supply to the positive and negative

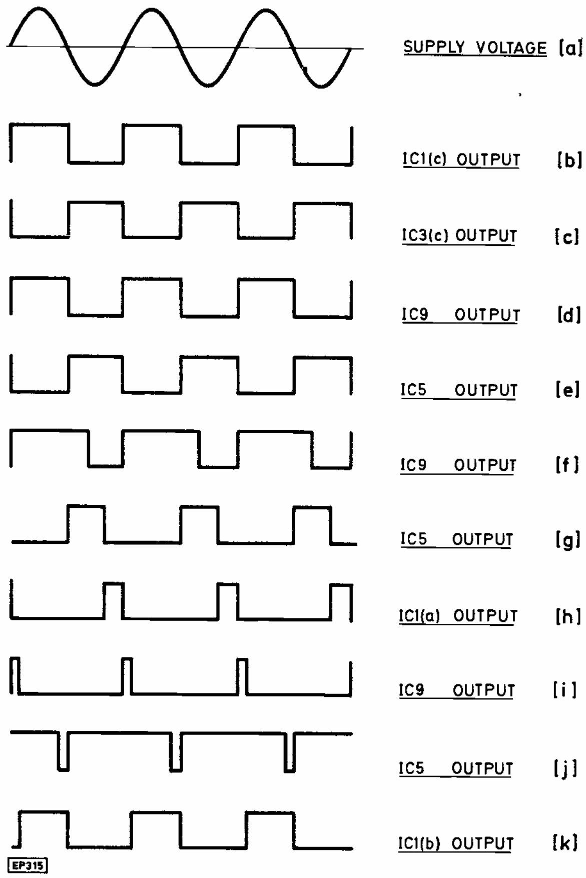


Fig. 7 Oscillograms for i.c. outputs

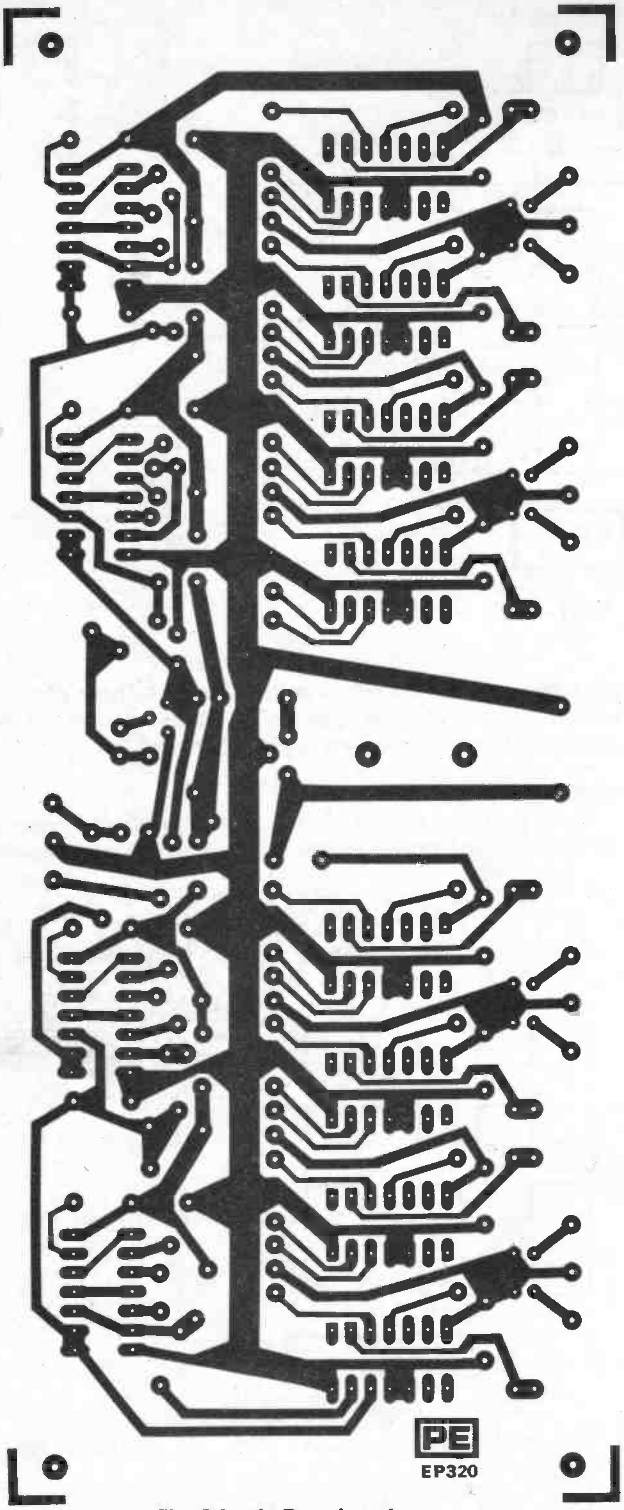


Fig. 8 Logic Board p.c.b.

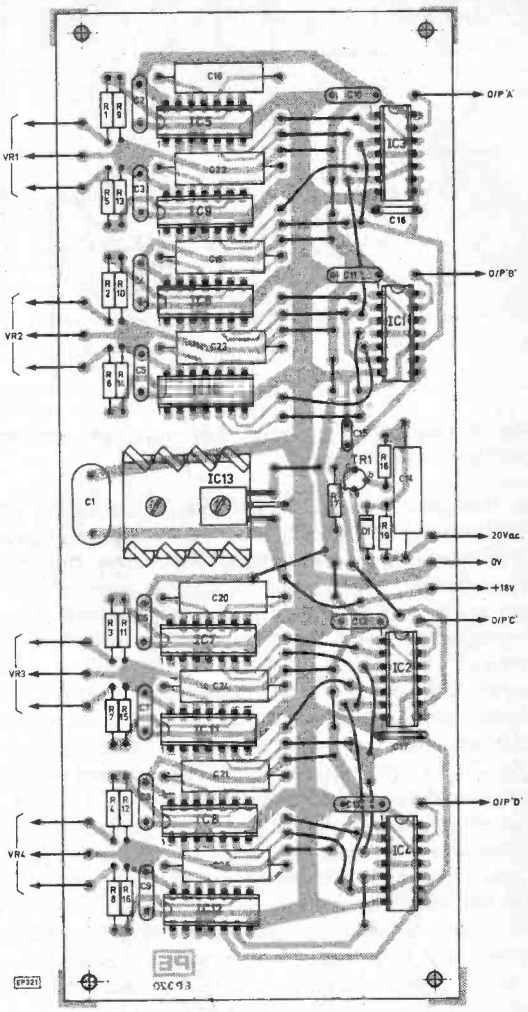


Fig. 9 Component layout

supply points on the board. Slowly increase the voltage from zero, checking the output of the 5V regulator to ensure it stabilises between 4·8V and 5·2V when the supply voltage exceeds 8V. If this is satisfactory, reduce the voltage to zero, fit the i.c.s into their sockets, and repeat. The current supply to the board should be approximately 180mA.

To carry out any further checks an oscilloscope is necessary. Temporarily connect the speed control potentiometers VR1 to VR4 to their selected channels, the d.c. test supply, and a 20V a.c. supply. Connect the oscilloscope to each of the board output terminals, in turn, and observe the change in output as the potentiometers are rotated. This should be similar to that shown in Fig. 5, with negative pulses occurring only in one half cycle period, at any time. If the output becomes erratic when the potentiometer approaches the end of travel, the maximum time period of the monostables should be checked, and probably a lower value shunt resistor fitted. With the potentiometer at mid position, there should either be no output, or very short pulses, at the end of both positive and negative half cycles. If these are shorter than about 0·5ms, because of the time delay in the locomotive receivers, they can be ignored. Longer pulses should be corrected by increasing the timing periods.

OSCILLATOR AND AMPLIFIER CIRCUIT

This part of the circuit contains the control oscillators, the f.e.t. switches, and the amplifiers. The circuit diagram is shown in Fig. 10, and for simplicity has been drawn showing one channel, but is marked with the component numbers for

COMPONENTS

LOGIC BOARD

Resistors

R1 to R8	1·5kΩ
R9 to R16	100kΩ see text
R17	470
R18	4k7
R19	1k

¼W carbon film 5%

Potentiometers

VR1 to VR4	22k

Capacitors

C1	330n polyester or mylar
C2 to C13	100n ceramic disc 20v
C14	1·0µ polyester
C15	10n mylar
C16	1·0n mylar or ceramic
C17	1·0n mylar or ceramic
C18 to C25	1·0µ polyester

Semiconductors

IC1 to IC4	7402
IC5 to IC12	74121
IC13	5V regulator, TO126 case, TDA 1405, or similar
TR1	BC 108, or similar
D1	5V6 400mW Zener diode

AMPLIFIER/OSCILLATOR BOARD

Resistors

R20	12k
R21	10k
R22	8k2
R23	6k8
R24	12k
R25	10k
R26	8k2
R27	6k8
R28 to R31	270
R32 to R35	1M
R36 to R47	47k
R48 to R51	100k
R52, R53	10k
R54 to R57	2k2
R58, R59	1k
R60	4k7
R61 to R63	10k
R64	2·7

¼W carbon film 5%

Potentiometers

VR5 to VR12	4k7
VR13 to VR16	470
VR17	10k

miniature preset, vertical mounting

Capacitors

C26 to C33	1n polystyrene
C34 to C41	10n mylar or polyester
C42 to C45	1n mylar or ceramic
C46 to C49	10n mylar or polyester
C50, C51	100n mylar or ceramic disc
C52	470µ 10V electrolytic
C53	10n mylar of polyester
C54	1n mylar or ceramic
C55	680n mylar or polyester
C56	100n mylar or polyester
C57	1µ polyester 250V
C58	330n mylar or polyester
C59	100n mylar or ceramic disc

Semiconductors

IC14 to IC18	741
IC19	LM380
IC20	12V Regulator, TDA1412, T0126 case
TR2 to TR5	2N3819
TR6 to TR9	BC108A or similar
TR10 to TR13	2N3819
D1 to D4	1N914 general purpose silicon diode

RECEIVER BOARDS

Resistors

	A	B	C	D
R1	47k			
R2	1k			
R3	10k			
R4	10k			
R5	10k			
R6	1M			
R7	47k	39k	33k	27k
R9	22k	18k	15k	1
R10	100k			
R11	3k9			
R12	10k			
R13	12k			
R14	1k			
R15	10k			
R16	2k2			
R17	47			
R18	1k			

All ¼W 5% carbon film

Capacitors

C1	2n2	mylar
C2	10µ	35V tantalum
C3	10p	polystyrene
C4	330p	polystyrene 5%
C5	330p	polystyrene 5%
C6	680p	polystyrene 5%
C7	1n	mylar
C8	10n	mylar
C9	1µ	35V tantalum
C10	10,	35V tantalum
C11	10n	mylar
C12	10n	mylar
C13	1µ	35V tantalum

POWER SUPPLY

Transformers

T1	20V. 55VA minimum
T2	12V to 14V. 500mA minimum
T3	18V to 24V. 30mA minimum

Choke

L1 1mH to 2mH ⅜ in. or ½ in. dia. 2 in. length ferrite rod. 24 s.w.g. enamelled copper wire

Resistor

R65 To suit indicator lamp

Capacitors

C60	1500µ 25V electrolytic
C61	47n 300V a.c. rating

Miscellaneous

REC 1 1A 100V S1 Double pole, single throw. 240V a.c. 1A Panel mounting fuse holders, and fuses. FS1–1A FS2–100mA FS3–50mA Indicator lamp unit miniature circuit breaker 2A (R.S. 338–333), knobs 4 off, cabinet feet, cabinet.

Semiconductors

D1 to D8	General purpose silicon diode, 1N914, 1N4148, etc.
D9	12V 400mW Zener diode, BZY88, etc.
IC1	748 8 pin d.i.l.
IC2	741 8 pin d.i.l.
IC3	Darlington optoisolator RS 307–963, 897
CSR1	TAG302/400

Choke

L1 14mm pot core Mullard, FX2236. 34s.w.g. enamelled copper wire

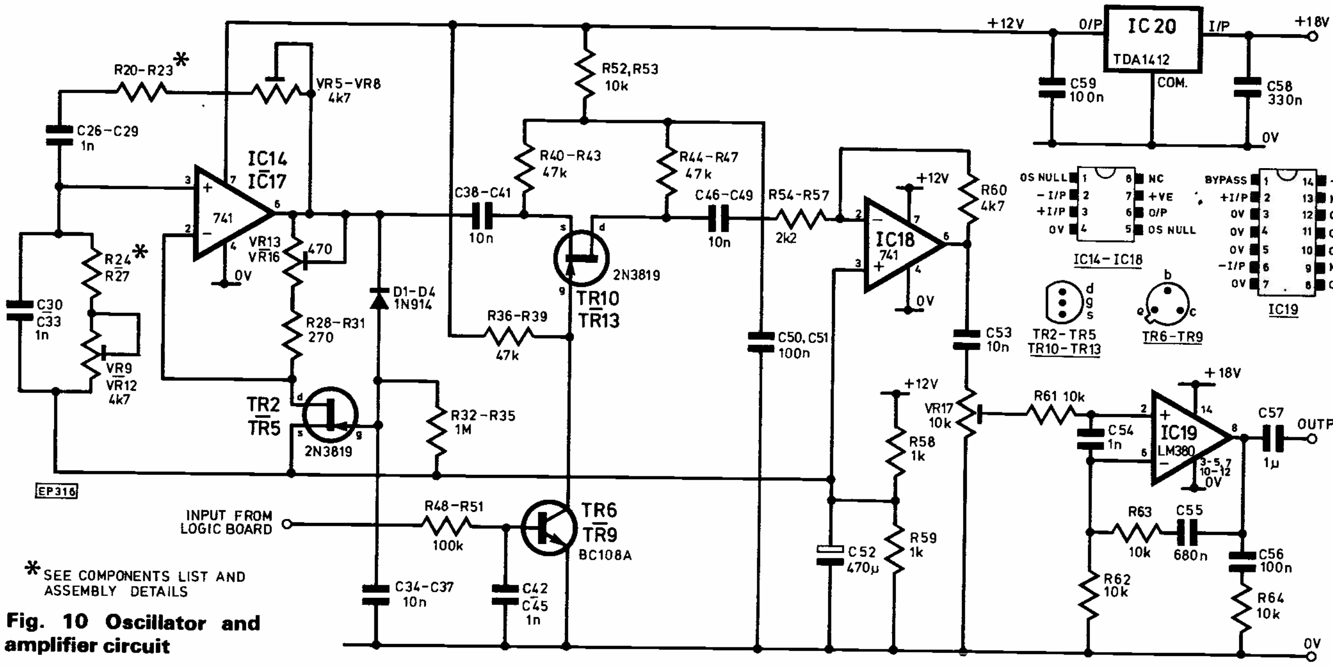


Fig. 10 Oscillator and amplifier circuit

all channels. In the following explanation, only the channel with the lowest component reference numbers is referred to.

IC14 is connected as an oscillator, and TR6 with TR10 form a switch in its output, controlled by the logic circuit. The outputs from the four oscillators are combined at the input of IC18, which adds or mixes them. IC19 is the output stage amplifier, which delivers the combined signal on to the rails.

The requirements for the oscillator used in this circuit are that it should give a sinusoidal output and have a low temperature drift. Several types were tested, but the Wien bridge gave the best results, and is used, but it is less simple than some of the alternatives. The basic circuit for the oscillator is shown in Fig. 11, and the frequency of oscillation is given by:

$$fo = \frac{1}{2\pi RC} \quad Hz$$

Where R and C are the values of the resistor and capacitor in the two arms of the bridge.

The disadvantages of this circuit are that the impedance of the two arms of the bridge should be kept in balance, that is adjusted together, and that for a stable output the amplifier gain has to be exactly three.

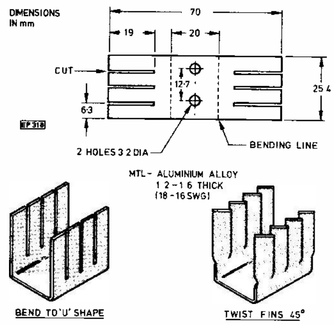
The first appears to cause little difficulty, as long as the two potentiometers used for frequency adjustment are seen to be in similar positions.

For the second point, referring again to Fig. 12, the voltage gain for the amplifier in this configuration, will be given by:

$$Av = \frac{R1 + R2}{R2}$$

When Av = 3, R1 = 2R2.

Unfortunately, the use of fixed value resistors is not accurate enough, so some form of automatic gain control must be used. R2 is replaced by an f.e.t. and its gate voltage is derived, through a diode, from the peak negative swing of the oscillator output. If the oscillator output increases, the f.e.t. gate voltage is driven more negative, increasing its effective drain to source resistance, so reducing the amplifier gain. R1 has been replaced by a fixed and a variable resistor, to allow for variations in f.e.t. characteristics.



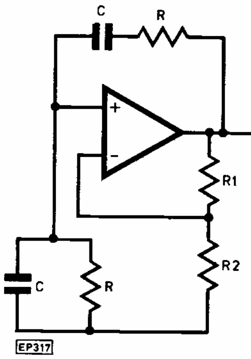


Fig. 11 Heat sink constructional details for the 5V regulator.

Fig. 12 (Right) Basic oscillator circuit

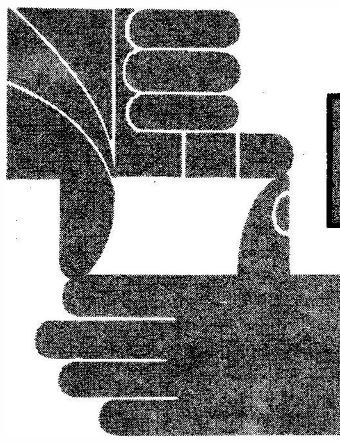
Referring to Fig. 10, the oscillator output is connected by C38 to the switching stage. The input from the logic circuit connects to the base of TR6, and its collector is connected to the gate of TR10. When the logic input is high, TR6 is driven on, so that the gate of TR10 is negative of its drain and source voltage. TR10 will then present a high impedance in the signal path, between C38, and C46. When the logic input is low, TR6 is turned off, TR10 gate increases to the same voltage as that of its source and drain, so its impedance falls, typically to about 250.

The control signals from the four channels are combined in the summing amplifier, IC18, which has a voltage gain of about 1·5.

The combined signal is then passed to the output stage, by way of C53 and VR17. The output amplifier, IC19, is a standard audio amplifier, to give a low impedance signal drive on to the rails. It has an internally connected negative feedback circuit and a voltage gain of 50. This gain is too high in this application, and R61 R62 R63 C54 and C55 form an additional feedback loop, to reduce the gain to less than 2. R64 and C56 reduce the possibility of r.f. instability.

IC20 is a 12V regulator and supplies the oscillators and the summing amplifier. The output amplifier is supplied directly from the unregulated supply.

Next Month: More construction and setting up procedure



PATENTS REVIEW...

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

MOUNTING CAR SPEAKERS

Although the idea claimed by two Swedish inventors Per Persson and Leo Koppelomaki, in recent British old law patent No 1 555 409, is hardly a world shattering invention, it could stimulate a useful train of thought for electronic hobbyists. As the inventors so rightly comment, it is always awkward to fit a stereo pair of loudspeakers in a motor car. If mounted on the rear window shelf they will play too loud for the back seat passengers and if mounted in the side doors they will beam their sound too low for ideal listening. The ideal position, argue the Swedes is the roof.

FIG. 1

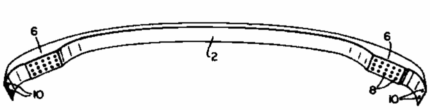
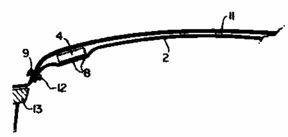


FIG. 2



But how to effect easy fitting? The proposed answer is a cross beam moulded to follow the contours of the car roof, or of sufficiently flexible material to follow it. In the drawings the cross beam 2 has a box chamber 6 at each end in which a loudspeaker 4 is mounted to beam sound out through grille 8. The cross beam can be either open at the top and of U cross section, or closed at the top to provide a sealed acoustic cavity. In either case acoustic damping material is ideally loaded into the beam interior.

To fit the beam it is held loosely against the car roof and moved backwards and forwards until an ideal position is found for stereo imaging and sound balance between front and rear passengers. The beam is then secured to the roof by drilling holes at 10, and bolting at 9, 12.

AID FOR THE DUMB

Atari Inc. of California has patented (BP 1 550 996), issued under the old laws) a hand-held communications aid for the dumb. This can be used either for direct face-to-face "conversation" or over the telephone.

Figure 1 shows how the device resembles a calculator with an l.e.d. to l.c.d. display at one end of an alpha-numeric keypad, so that the device is handled like a torch. Words typed into the keypad move across the display to spell out a message for the benefit of anyone looking at it. An alert tone at the start of the message draws attention to the display.

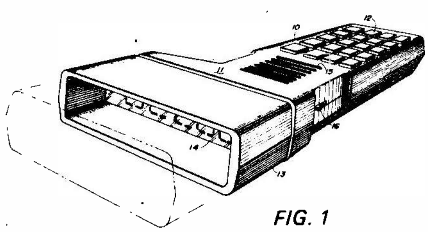


FIG. 1

Figure 2 shows the basic circuit layout. Alpha-numeric keypad (with 20 dual function keys) is timed by oscillator 23. The column and row information is encoded at 24, processed at 27 and stored in accumulating register 28. This register drives ROM 29 and display 14. Blanking logic 32 extinguishes the display after a few seconds unless shunted by switch 34.

In many respects therefore the circuit resembles that used in some modern calculators. However the idea of interfacing with a telephone line appears more novel.

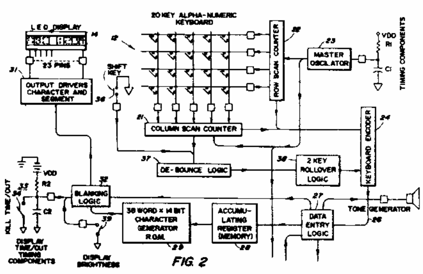


FIG. 2

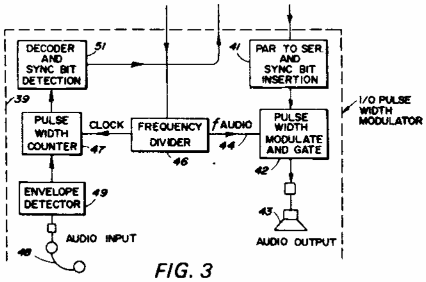


FIG. 3

Figure 3 shows an interface for converting the digitally encoded keypad output into a pulse-width modulated format for transmission over normal telephone lines. A parallel-to-serial converter and synchronisation bit inserter 41 drives a pulse width modulation and gating unit 42 with an audio output 43 which couples acoustically with a telephone handset. Simultaneously, frequency divider 46 (driven by oscillator 23) provides an audio frequency and clocks a pulse width counter 47 which receives the audio output 48 from the telephone. Detector 49 senses the envelope width which is decoded at 51 to drive display 14 through logic 27.

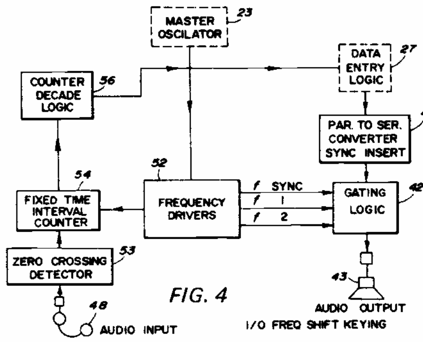


FIG. 4

Figure 4 shows an alternative interface, based on frequency shift keying. With either interface circuit an alpha numeric message keyed into the local unit reads out on the remote display and a message keyed into the remote pad reads out on the local display, thereby enabling pairs of dumb people to communicate by telephone. The idea behind the invention could perhaps stimulate electronic hobbyists to experiment with the modification of existing equipment to interface with a telephone line by acoustic coupling of the type permitted by the British Post Office.

Readout...

A selection from our Postbag

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

Iron Controller

Sir—With regard to the article in your February edition of *Practical Electronics* relating to 'Soldering Iron Controller', we regret to inform you that we find this article somewhat detrimental to soldering equipment manufacturers generally and Adcola Products Limited in particular. The two illustrations on pages 30 and 32 bear an almost exact resemblance to a soldering station manufactured by Adcola Products Limited. This soldering station, known as the Unit 101, incorporates the features which the writer indicated controlled soldering equipment does not have, and in fact the Unit 101 has many other features that reduce the problems which modern soldering has created with regard to voltage and temperature sensitive components.

We should like to draw your attention to the fact that the method of controlling our Unit 101 is by proportional control using a zero-crossing i/c. We would also argue against the sensing device suggested, namely a diode. This diode is to be positioned against the tube of the tool where the heat does not exceed 150°C. The diode would therefore have the major part of its surface exposed to free air and only line contact with the soldering iron tube. But more important is the heat limitation of 150°C; to obtain this, the diode will have to be positioned at a reasonable distance from the bit face. This will, in our opinion, cause a considerable time lag from drop in bit/tip temperature until the soldering iron tube reflects this temperature drop and so the control circuit can increase the power supply to the heating element. Adcola Products Limited uses a thermocouple positioned in the end of the tube, immediately behind the bit/tip face.

By use of an illustration which is so comparable to our Unit 101, your readers may feel that your researchers have based their findings of circuits on a Unit 101. Obviously this is not the case.

R. T. Lamb,
Managing Director,
Adcola Products Limited.

The resemblance between our illustrations and the Adcola 101 was completely unintentional and we would not like readers to gain a wrongful impression of any Adcola product as a result. We have a high regard for most soldering products available in this country and appreciate the extensive design and development work that is behind them. As you have pointed out, the comments in the article were not based on the Adcola 101 unit.—Ed.

Club Meetings

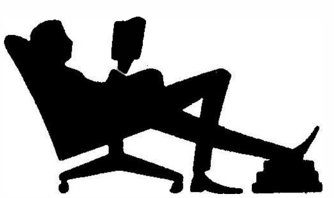
Sir—As you know, the British Amateur Electronics Club is the only national amateur electronics club in this country, and we have an obligation to offer all the help we can to our members, particularly beginners. We have a special Beginners' Section and also a very large library of technical books and magazines which are available to members free of charge (apart from postage), and many of your advertisers are allowing B.A.E.C. members special prices for their products.

However, there is one very important way in which we could help our members, and that is to provide meetings in various parts of the country, so that B.A.E.C. members can go to them and benefit by being able to meet and work with other electronics enthusiasts. We have held meetings at Penarth, S. Glam, since we started in 1966, but whilst several of our members have tried to start meetings in other parts of the country, the main snag has been obtaining a suitable room at a reasonable charge.

I am writing to ask if you would be kind enough to ask in your popular magazine, *Practical Electronics,* for your readers who belong to local Electronics Groups to let me know if they would be willing for B.A.E.C. members who live nearby to go to their meetings. Naturally, our members would be prepared to pay an affiliation fee, and I would be happy to send further information to any of your readers who may be kind enough to contact me regarding this matter.

If suitable arrangements can be made this would benefit both the local Groups and the B.A.E.C., and I would be grateful for any help you are able to give to help amateur electronics.

Cyril Bogod, B.A.E.C.,
26 Forrest Road,
Penarth, S. Glamorgan.



BOOK REVIEWS

PERSONAL COMPUTING
by Jim Huffman
Published by Reston Publishing Co. Inc.
Available from Prentice/Hall International
262 pages, 180 × 240 mm. Price £7·75

A thorough and concise survey of the 6800 microprocessor family, which is pleasantly presented and easy to read. The book takes you through a brief history of computing, which serves the purpose of defining the all important differences between mainframe and home computing. Assuming you have a fundamental knowledge of electronics, the book steers you to an understanding of the hardware involved, I/O, peripheral interfacing principles and memory. Even in the absence of a knowledge of electronics in depth, it should be possible to follow the logic in Chapter 7 *Putting It All Together With Programming,* although it is assumed you have the use of a machine at this stage.

To correct the situation if you have no computer, Chapter 6 gives details for the construction of a small system called the PC–68, which comprises the common hexadecimal keypad and four seven-segment display format.

The appendices include a list of American personal computer manufacturers, numbering systems, an ASCII conversion table, and 78 pages of specification sheets for the 6800 family, including the MCM6830L7 MIKBUG/MINIBUG ROM data sheet giving the MIKBUG REV.9 listing.

The most outstanding feature of this book is undoubtedly the chapter on building your own system with its "talk-through" of the design stages, and argument for the choice of the 6802 micro'. Good value for money by today's standards. M.A.

POINTS ARISING

4 CHANNEL DIGITAL MEMORY ***(March 1980)***

There should be a link between pin 1 (IC12) and pin 13 (IC15). It has been suggested that a 10n capacitor be connected from pin 3 to ground and experimental values of from 10–100n be connected from pin 11 to ground. These capacitor additions apply to IC16.

Your Commodore PET System

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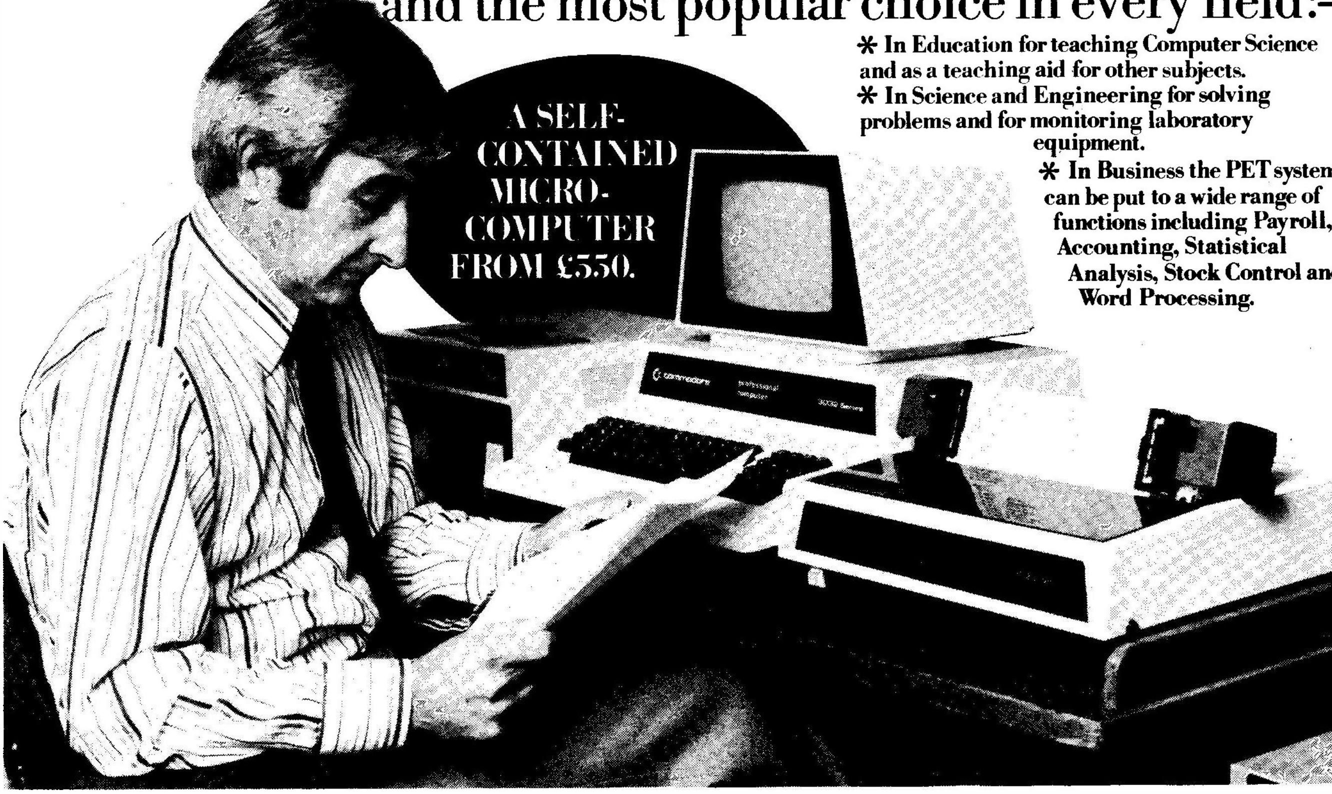

Not least of its attractions is the price of a PET – from £550 for a self contained unit, to under £2,500 for the complete system including Floppy Disk Unit and high-speed Printer. Ask your nearest Commodore dealer below for details about Commodore hardware, software and training courses.

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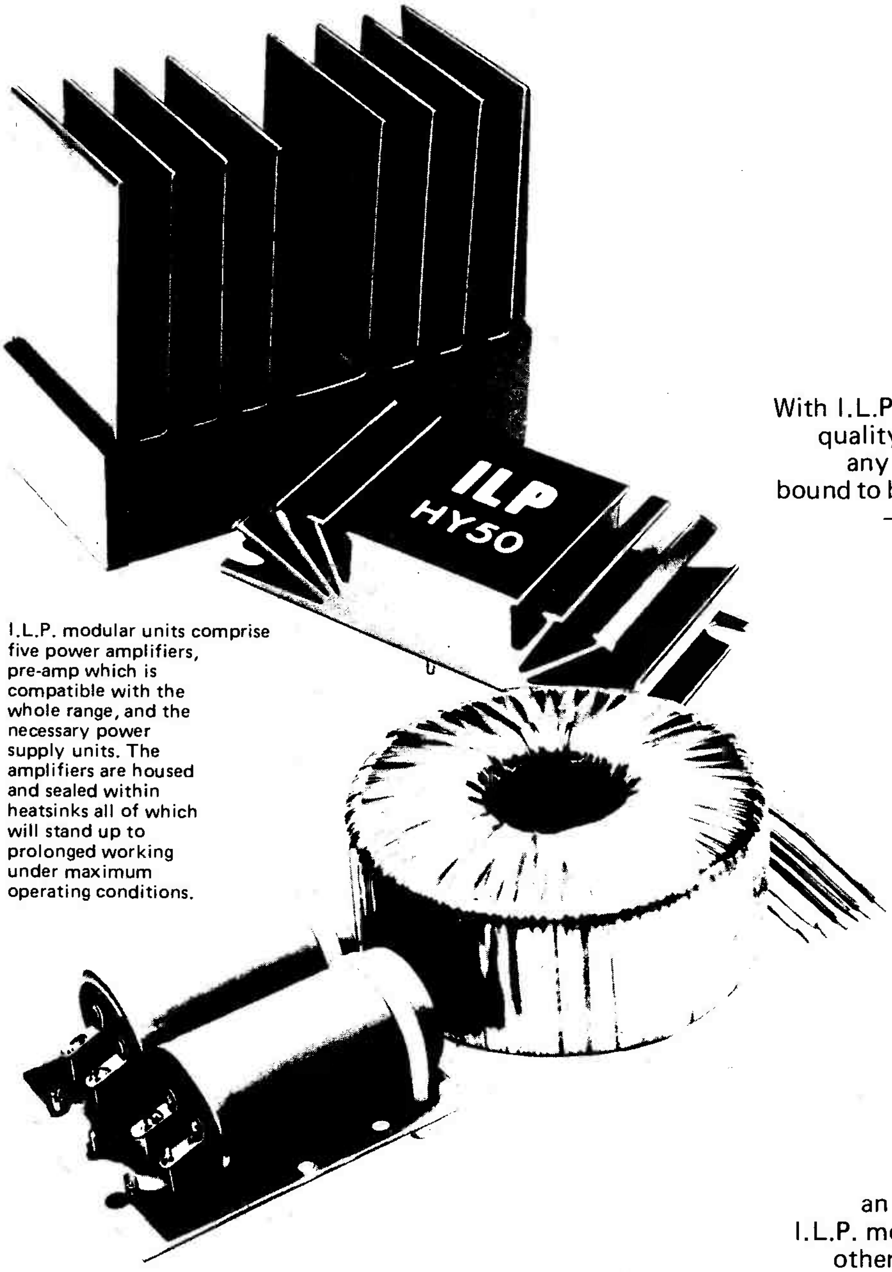

I.L.P. modular units comprise five power amplifiers, pre-amp which is compatible with the whole range, and the necessary power supply units. The amplifiers are housed and sealed within heatsinks all of which will stand up to prolonged working under maximum operating conditions.

With I.L.P. performance standards and quality already so well established, any advances in I.L.P. design are bound to be of outstanding importance — and this is exactly what we have achieved in our new generation of modular units. I.L.P. professional design principles remain — the completely adequate heatsinks, protected sealed circuitry, rugged construction and excellent performance. These have stood the test of time far longer than normally expected from ordinary commercial modules. So we have concentrated on improvements whereby our products will meet even more stringent demands such, for example, as those revealed by vastly improved pick-ups, tuners, loudspeakers, etc., all of which can prove merciless to an indifferent amplifier system. I.L.P. modules are for laboratory and other specialised applications too.

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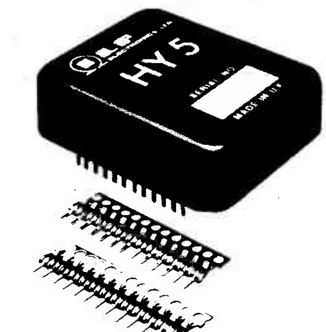
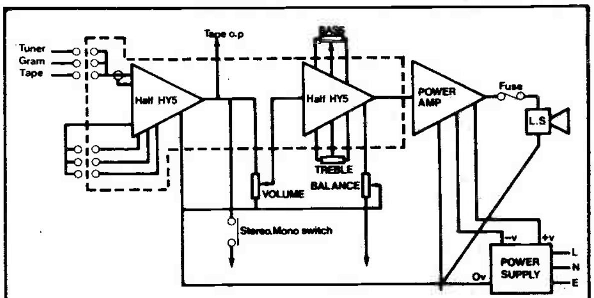
and staying there

PERFORMANCE MODULAR UNITS

HY5 PRE-AMPLIFIER



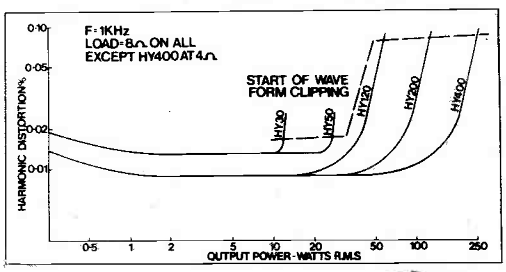


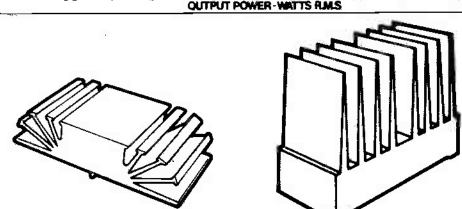
VALUES OF COMPONENTS FOR CONNECTING TO HY5
Volume – 10K Ω log.
Bass/Treble – 100K Ω linear. Balance – 5K Ω linear.

The HY5 pre-amp is compatible with all I.L.P. amplifiers and P.S.U.'s. It is contained within a single pack 50 x 40 x 15 mm. and provides multi-function equalisation for Magnetic/Ceramic/Tuner/Mic and Aux (Tape) inputs, all with high overload margins. Active tone control circuits; 500 mV out. Distortion at 1KHz–0.01%. Special strips are provided for connecting external pots and switching systems as required. Two HY5's connect easily in stereo. With easy to follow instructions.

£4.64 + 74p VAT

THE POWER AMPLIFIERS

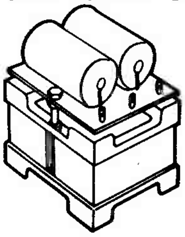




Model	Output Power R.M.S.	Distortion Typical at 1KHz	Minimum Signal/Noise Ratio	Power Supply Voltage	Size in mm	Weight in gms	Price + V.A.T.
HY30	15 W into 8 Ω	0.02%	80dB	-20 -0- +20	105x50x25	155	**£6.34** + 95p
HY50	30 W into 8 Ω	0.02%	90dB	-25 -0 +25	105x50x25	155	**£7.24** + £1.09
HY120	60 W into 8 Ω	0.01%	100dB	-35 -0- +35	114x50x85	575	**£15.20** + £2.28
HY200	120 W into 8 Ω	0.01%	100dB	-45 -0- +45	114x50x85	575	**£18.44** + £2.77
HY400	240 W into 4 Ω	0.01%	100dB	-45 -0- +45	114x100x85	1.15Kg	**£27.68** + £4.15

Load impedance – all models 4 - 16Ω
Input sensitivity – all models 500 mV
Input impedance – all models 100KΩ
Frequency response – all models 10Hz - 45KHz - 3dB

THE POWER SUPPLY UNITS



I.L.P. Power Supply Units are designed specifically for use with our power amplifiers and are in two basic forms – one with circuit panel mounted on conventionally styled transformer, the other with toroidal transformer, having half the weight and height of conventional laminated types.

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Auditorium	8, 16	12	45	Hi-Fi	£20
Auditorium	8, 16	15	60	Hi-Fi	£30
Group 35	8, 16	12	40	PA	£12
Group 45	4, 8, 16	12	45	PA	£15
Group 50	4, 8, 16	12	60	PA	£20
Group 50	8, 16	15	75	PA	£30
Group 75	4, 8, 16	12	75	PA	£24
Group 100	8, 16	12	100	PA	£29
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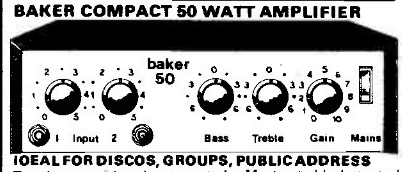

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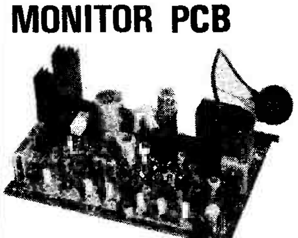

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74LS04	14p	74LS95	85p	74LS192	100p
74LS05	25p	74LS107	40p	74LS193	100p
74LS08	30p	74LS109	50p	74LS196	100p
74LS09	20p	74LS112	50p	74LS221	100p
74LS10	16p	74LS113	50p	74LS244	220p
74LS11	23p	74LS114	50p	74LS245	290p
74LS12	25p	74LS123	80p	74LS247	100p
74LS13	30p	74LS125	30p	74LS248	100p
74LS14	40p	74LS126	30p	74LS249	90p
74LS20	17p	74LS132	50p	74LS251	90p
74LS21	21p	74LS136	45p	74LS273	165p
74LS26	30p	74LS138	75p	74LS279	50p
74LS27	15p	74LS139	80p	74LS283	100p
74LS28	30p	74LS151	45p	74LS290	90p
74LS30	15p	74LS153	65p	74LS293	100p
74LS32	17p	74LS155	90p	74LS298	93p
74LS37	20p	74LS156	90p	74LS352	110p
74LS38	30p	74LS157	70p	74LS353	110p
74LS40	17p	74LS158	70p	74LS366	50p
74LS47	52p	74LS160	100p	74LS367	60p
74LS49	52p	74LS161	100p	74LS368	55p
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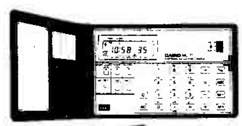

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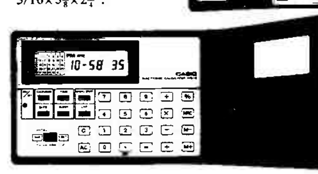

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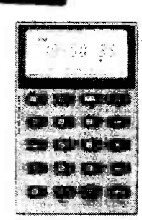

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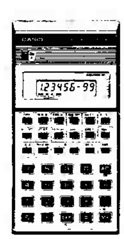

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As FX-80 but without standard deviations and R-P, P-R conversions.

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Hours, minutes, seconds. Alpha day and date on upper display; And day, date, month. Alarm and hourly chimes. Countdown alarm (upper display). Stopwatch from 1/100 sec to 12 hours; net, lap and 1st and 2nd place times.

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Hours, minutes, seconds, day; And day, date, month, am/pm. Alarm (2 tones), hourly chimes. 8 digit calculator with constants, delta %. Water resistant. 2 year battery with hatch. Approx 9mm thick +0.5mm for keys.

S/Steel £79.95
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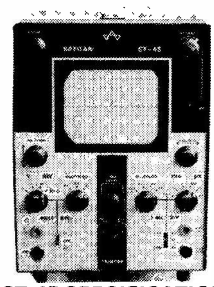

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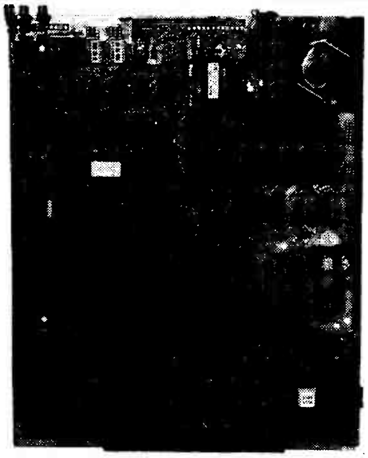

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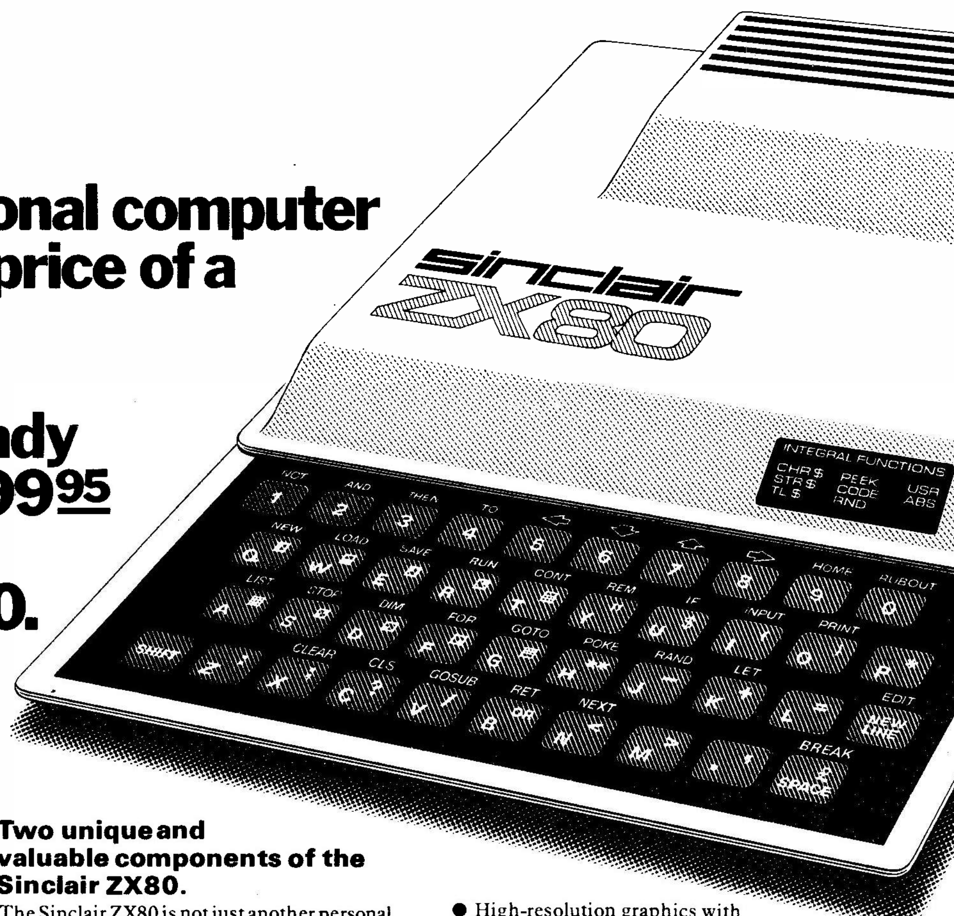

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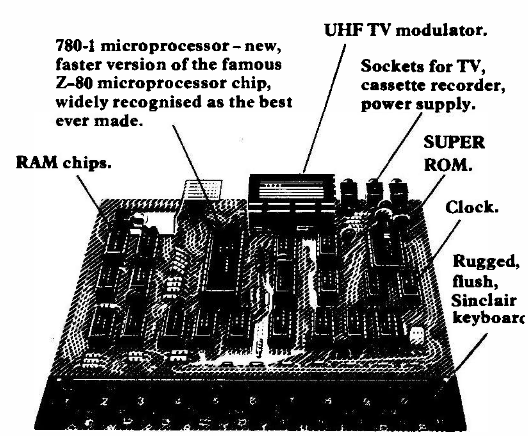

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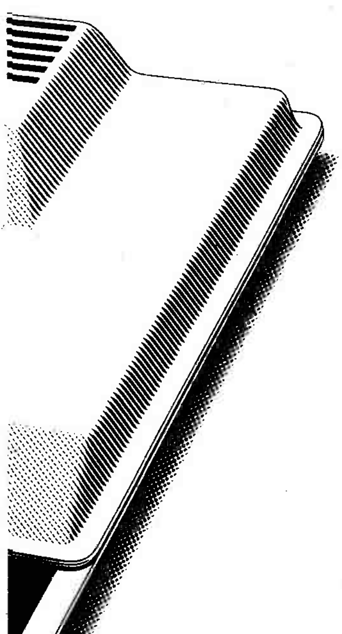

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30 VOLT RANGE

Pri 220/240 sec 0-12-15-20-24-30V Voltages available 3, 4, 5, 6, 8, 9, 10, 12, 15, 18, 20, 24, 30V or 12V-0-12V or 15V-0-15V.

Ref	Amps	Price	P & P
112	0.5	**2.90**	0.90
79	1.0	**3.93**	1.10
3	2.0	**6.35**	1.10
20	3.0	**6.82**	1.31
21	4.0	**8.79**	1.31
51	5.0	**10.86**	1.52
117	6.0	**12.29**	1.67
88	8.0	**16.45**	1.89
89	10.0	**18.89**	1.89
90	12.0	**21.09**	2.24
91	15.0	**24.18**	2.39
92	20.0	**32.40**	O.A.

60 VOLT RANGE

Pri 220/240V Sec 0-24-30-40-48-60V. Voltages available 6, 8, 10, 12, 16, 18, 20, 24, 30, 36, 40, 48, 60 or 24V-0-24V or 30v-0-30v.

Ref	Amps	Price	P&P
124	0.5	**4.27**	1.10
126	1.0	**6.50**	1.10
127	2.0	**8.36**	1.31
125	3.0	**12.10**	1.31
123	4.0	**13.77**	2.12
40	5.0	**17.42**	1.89
120	6.0	**19.87**	2.12
121	8.0	**27.92**	O.A.
122	10.0	**32.51**	O.A.
189	12.0	**37.47**	O.A.

12 OR 24V OR 12-0-12V

Pri 220-240 volts

Ref	12V Amps	24V Amps	Price	P&P
111	0.5	0.25	**2.42**	0.52
213	1.0	0.5	**2.90**	0.90
71	2	1	**3.86**	0.90
18	4	2	**4.48**	1.10
85	5	2.5	**6.16**	1.10
70	6	3	**6.99**	1.10
108	8	4	**8.16**	1.31
72	10	5	**8.93**	1.31
116	12	6	**9.89**	1.52
17	16	8	**11.79**	1.52
115	20	10	**15.38**	2.39
187	30	15	**19.72**	2.39
226	60	30	**40.41**	O.A.

AUTO TRANSFORMERS

Voltage for step up or step down

Ref	VA (Watts)		£	P&P
113	15	0-115-210-240	2.73	0.81
34	75	0-115-210-240	4.41	1.10
4	150	0-115-200-220-240	5.78	1.10
67	500	0-115-200-220-240	12.89	1.91
84	1000	0-115-200-220-240	20.84	2.39
93	1500	0-115-200-220-240	25.81	O.A.
95	2000	0-115-200-220-240	38.31	O.A.
73	3000	0-115-200-220-240	65.13	O.A.
80S	4000	0-10-115-200-220-240	84.55	O.A.
57S	5000	0-10-115-200-220-240	98.45	O.A.

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50W	(AL120)	**£11.95**
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50 VOLT RANGE

Pri 220/240V Sec 0-20-25-33-40-50V Voltages available 5, 7, 8, 10, 13, 15, 17, 20, 33, 40 or 20V-0-20V or 25V-0-25V.

Ref	Amps	Price	P & P
102	0.5	**3.75**	0.90
103	1.0	**4.57**	1.10
104	2.0	**7.88**	1.31
105	3.0	**9.42**	1.52
106	4.0	**12.82**	1.73
107	6.0	**16.37**	1.89
118	8.0	**22.29**	2.39
119	10.0	**27.48**	O.A.
109	12.0	**31.79**	O.A.

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Amps	Ref	Price	P.&P.
0.5	430	**4.88**	0.76
1.0	431	**8.12**	0.99
2.0	432	**13.35**	1.31
3.0	433	**16.17**	1.40
4.0	434	**20.65**	2.11
5.0	435	**29.30**	2.47
6.0	436	**36.69**	O.A.
8.0	437	**40.03**	O.A.

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175	4A	**6.30**	1.10

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PM 120/240 Sec 120/240V CT

Ref	VA	Price	P & P
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149	60	**7.37**	1.10
150	100	**8.38**	1.31
151	200	**12.28**	1.31
152	250	**14.61**	1.73
153	350	**18.07**	2.12
154	500	**22.52**	2.47
155	750	**32.03**	O.A.
156	1000	**40.92**	O.A.
157	1500	**56.52**	O.A.
158	2000	**67.99**	O.A.
159	3000	**95.33**	O.A.

*Pri 0-220-240V Sec 115 or 240V. State sec. volts required.

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Ref	mA	Volts	£	P&P
238	200	3-0-3	**2.82**	0.63
212	1A, 1A	0-6, 0-6	**3.14**	0.90
13	100	9-0-9	**2.35**	0.44
235	330, 330	0-9, 0-9	**2.19**	0.44
207	500, 500	0-8-9, 0-8-9	**3.05**	0.85
208	1A, 1A	0-8-9, 0-8-9	**3.88**	0.90
236	200, 200	0-15, 0-15	**2.19**	0.44
214	300, 300	0-20, 0-20	**3.08**	0.90
221	700(DC)	20-12-0-12-20	**3.75**	0.90
206	1A, 1A	0-15-20-0-15-27	**5.09**	1.10
203	500, 500	0-15-27-0-15-20	**4.39**	1.10
204	1A, 1A	0-15-27-0-15-27	**6.64**	1.10
239	50	12-0-12	**2.88**	0.43
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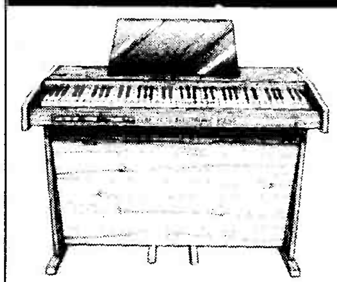

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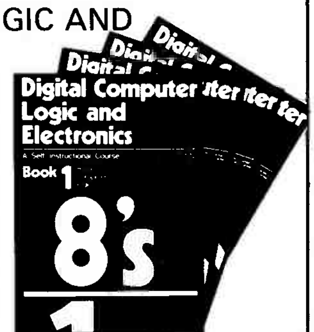

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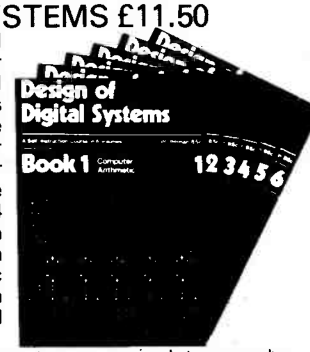

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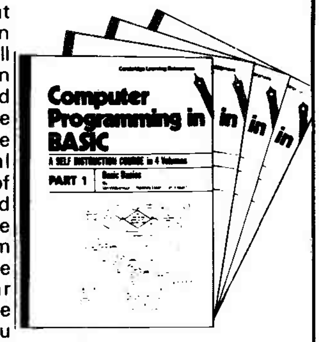

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BC108	7p
BC108A	7p
BC108C	7p
BC136	15p
BC140	28p
BC141	30p
BC142	25p
BC143	28p
BC147	6p
BC147B	6p
BC149	7p
BC149C	7p
BC159	9p
BC160	35p
BC167A	10p
BC178	12p
BC179	12p
BC182	8p
BC182L	9p
BC183	9p
BC183L	9p
BC184L	9p
BC186	20p
BC212	9p
BC212L	9p
BC213B	9p
BC327	13p
BC328	13p
BC337	16p
BC338	11p
BC440	32p
BC547	9p
BC548	9p
BC550	14p
BC558	12p
BCY33	99p
BCY34	99p
BCY39	299p
BCY58	16p
BCY70	12p
BCY71	12p
BCY72	12p
BF179	25p
BF183	25p
BF200	29p
BF336	33p
BFX30	32p
BFX86	26p
BFX88	22p
BFY50	13p
BFY51	13p
BFY64	28p
BFY90	56p
BSX19	80p
BSY95A	16p
BU204	149p
BU208	150p
OC29	89p
OC43	50p
2N696	15p
2N930	20p
2N1132	19p
2N1304	40p
2N1613	12p
2N1711	15p
2N2217	20p
2N2219A	20p
2N2221	18p
2N2368	15p
2N2369	14p
2N2894A	20p
2N2904	15p
2N2904A	15p
2N2905	15p
2N2906	15p
2N2926Y	10p
2N29260	10p
2N2926R	10p
2N3442	102p
2N3702	8p
2N3704	8p
2N3705	8p
2N3708	8p
2N3709K	8p
2N3866	35p
2N3906	10p
2N4058	12p
2N4427	60p

DIODES

AA119	10p
IN4001	4p
IN4002	4p
IN4003	5p
IN4005	5p
IN4148	5p
IS44	3p

DPTD

Led's

.125 Red	10p
.125 Orange	10p
.125 Yellow	10p
.2 Red	10p
.2 Green	10p
.2 Clear	10p

Displays

704	110p
727	160p
741	160p
747	160p
750	180p

REGULATORS

7805	57p
7812	57p
7815	57p
7818	57p
7824	57p
LM340T5	74p
LM340T8	74p
LM340T15	74p
LM340T18	74p
7905	140p
7912	140p
7915	140p
7918	140p
7924	140p
LM320T5	149p
LM320T8	149p
LM320T15	149p
LM320T18	149p

TRIACS

		with internal trigger diac.
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4A 600V	60p	75p
6A 400V	60p	75p
6A 600V	66p	90p
8A 400V	66p	90p
8A 600V	72p	95p
10A 400V	72p	95p
10A 600V	84p	100p
15A 400V	108p	120p
15A 600V	126p	138p

TTL

		7472	25p
		7474	20p
7400	9p	7475	27p
7401	9p	7480	40p
7402	9p	7482	60p
7403	9p	7486	25p
7404	10p	7491	63p
7405	14p	7492	35p
7406	30p	7493	28p
7407	30p	7494	63p
7408	17p	7495	63p
7409	17p	74100	110p
7410	12p	74107	30p
7412	17p	74121	25p
7413	25p	74122	36p
7414	45p	74123	44p
7416	25p	74145	72p
7417	25p	74154	80p
7420	14p	74157	60p
7427	28p	74161	85p
7430	14p	74175	63p
7432	22p	74180	84p
7438	26p	74181	151p
7442	48p	74191	80p
7447	50p	74192	80p
7450	15p	74193	80p
7451	15p	74194	80p
7470	30p	74LS00	11p

74LS01	11p
74LS02	12p
74LS03	12p
74LS04	12p
74LS10	19p
74LS11	20p
74LS20	18p
74LS30	18p
74LS32	24p
74LS42	89p
74LS51	24p
74LS55	28p
74LS74	39p
74LS75	46p
74LS76	39p
74LS85	99p
74LS90	36p
74LS93	79p
74LS114	49p
74LS122	65p
74LS123	65p
74LS124	115p
74LS132	89p
74LS139	79p
74LS151	89p
74LS155	91p
74LS156	89p
74LS157	69p
74LS165	69p
74LS168	139p
74LS174	99p
74LS175	99p
74LS190	110p
74LS192	115p
74LS194	115p
74LS195	115p
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14 pin	12p
16 pin	13p
20 pin	25p
24 pin	30p
40 pin	40p

MEMORIES

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2114	400p
4027	275p
4116	750p

EPROM

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2716	3200p

CPU'S

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Mk 3881	750p
Mk 3882	750p

CMOS

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4001	14p	4071	19p
4002	14p	4072	19p
4006	79p	4073	19p
4007	14p	4075	19p
4008	79p	4076	75p
4009	36p	4077	36p
4010	36p	4081	19p
4011	19p	4082	19p
4012	16p	4402	36p
4014	75p	4404	110p
4015	79p	4412	86p
4016	42p	4445	174p
4017	79p	4446	148p
4018	79p	4502	99p
4019	45p	4511	132p
4020	89p	4512	89p
4021	89p	4514	229p
4022	79p	4515	229p
4023	19p	4516	109p
4024	49p	4520	99p
4025	17p	4522	129p
4026	159p	4526	125p
4027	39p	4531	125p
4028	79p	4555	92p
4029	89p	4556	69p
4030	49p	4581	269p
4034	169p	4582	115p
4035	99p	4584	59p
4042	69p	4585	99p
4043	86p		
4044	86p		
4046	119p		
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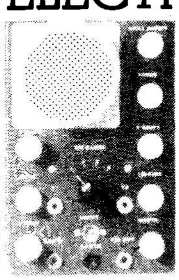

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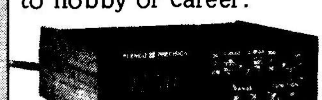

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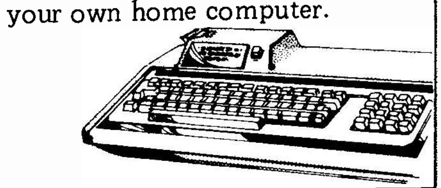

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4011/2	18p
4013	40p
4014	85p
4015	75p
4016	44p
4017	57p
4018	80p
4019	45p
4020	90p
4021	85p
4022	82p
4023	18p
4024	58p
4025	18p
4027	70p
4028	45p
4029	82p
4030	60p
4035	107p
4041	75p
4042	70p
4043	88p
4044	84p
4047	87p
4048	55p
4049	35p
4050	44p
4066	50p
4069	18p
4070/1	18p
4072/3	18p
4081/2	18p
4510	100p
4511	100p
4516	100p
4518	100p
4520	100p
4528	100p

TTL

7400	13p
7401/2	13p
7403/4	13p
7405	13p
7406/7	24p
7408/9	13p
7410	13p
7411	18p
7412	15p
7413	27p
7414	31p
7416/7	25p
7420	14p
7421/2	17p
7427	20p
7428	25p
7430	14p
7432	20p
7433	24p
7437/8	20p
7440	13p
7441	56p
7442	51p
7443/4	80p
7445	75p
7446	65p
7447	55p
7448	62p
7450/1	13p
7453/4	13p
7460	13p
7470	28p
7472	21p
7473	28p
7474	24p
7475	34p
7476	30p
7480	32p
7486	25p
7490	36p
7491	65p
7492	40p
7493	36p
7494	57p
7495	46p
7496	56p
74100	90p
74105	43p
74107	26p
74109	44p
74110	40p
74121	26p
74122	40p
74123	45p
74125	37p
74126	37p
74132	48p
74141	60p
74145	55p
74150	78p
74151	48p
74153	43p
74154	90p
74155/6	46p
74157	43p
74160/1	64p
74162/3	64p
74164/5	78p
74166	85p
74173	77p
74174	75p
74175	60p
74176	64p
74177	65p
74180	57p
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BC149	10p
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BC159	12p
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BC169C	13p
BC173	8p
BC177/8	18p
BC179	20p
BC182/3	12p
BC184	12p
BC209	13p
BC212/3	12p
BC214	12p
BC261B	14p
BC461	40p
BC477/8	27p
BC479	27p
BC547/8	14p
BC549	14p
BC557/8	15p
BC559	15p
BCY70	18p
BCY71/2	18p
BD115	58p
BD131 to BD140	42p
BF180	30p
BF184/5	25p
BF194/5	12p
BF196/7	12p
BF244B	35p
BF259	40p
BFR39	32p
BFR79	32p
BFX29	25p
BFX84	25p
BFX87/8	25p
BFY50	22p
BFY51/2	22p
BRY39	60p
BU208	210p
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MJE340	70p
MJE2955	110p
MJE3055	85p
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MPF104/5	40p
MPF106	50p
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MPSA56	26p
MPSU06	61p
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TIP30B	48p
TIP31/2	40p
TIP33C	80p
TIP34A	90p
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TIP41A	60p
TIP3055	55p
ZTX107	13p
ZTX109	13p
ZTX300	18p
ZTX301	18p
ZTX302	20p
ZTX303	24p
ZTX304	27p
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ZTX502	21p
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2N696	36p
2N697	25p
2N698	35p
2N706	14p
2N914	20p
2N918	35p
2N1131	20p
2N1302	35p
2N1303	40p
2N2222A	25p
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2N3903	10p
2N3904	10p
2N3905	10p
2N3906	10p
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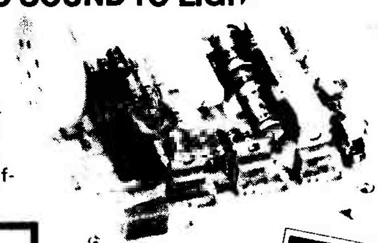

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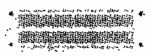
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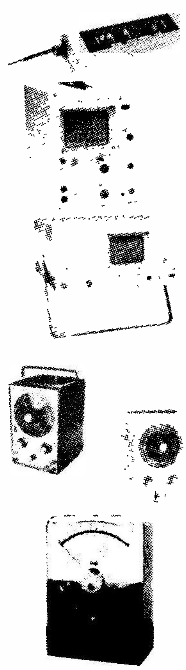

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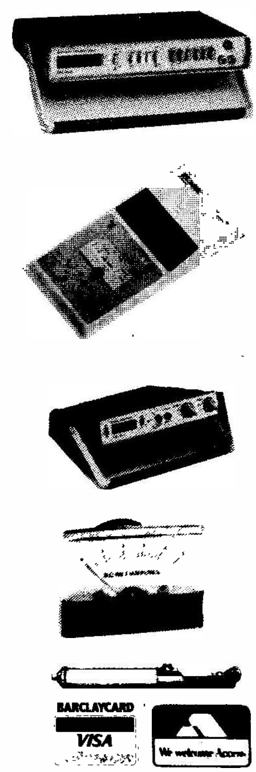

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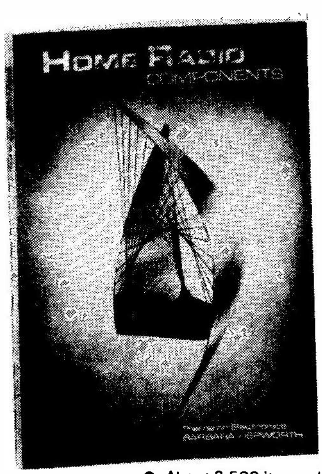

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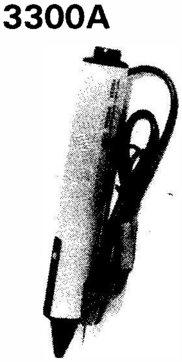

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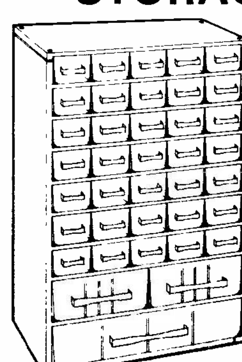
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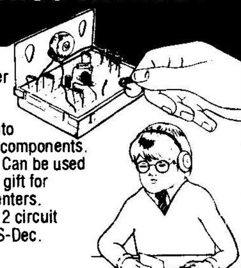

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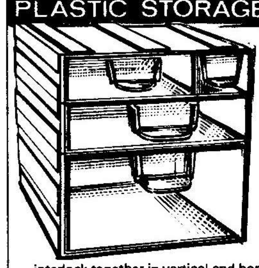

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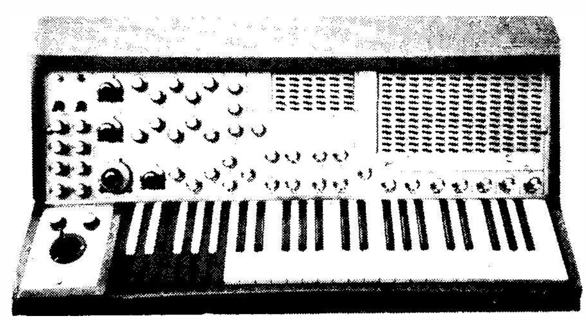

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74193	90p
74194	90p
74195	95p
74196	95p
74197	80p
74198	150p
74199	150p
74221	160p
74C221	150p
74251	140p
74259	250p
74265	90p
74278	290p
74279	110p
74283	160p
74284	400p
74285	400p
74290p	150p
74293	150p
74294	200p
74298	200p
74365	150p
74366	150p
74367	120p
74368	150p
74390	160p
74393	160p
74490	225p

74LS SERIES

74LS00	14p
74LS02	14p
74LS04	14p
74LS05	25p
74LS08	25p
74LS10	20p
74LS11	30p
74LS13	90p
74LS14	60p
74LS20	20p
74LS21	40p
74LS27	38p
74LS30	20p
74LS32	27p
74LS42	70p
74LS47	70p
74LS55	30p
74LS73	50p
74LS74	38p
74LS75	40p
74LS76	45p
74LS83	110p
74LS85	100p
74LS86	40p
74LS90	40p
74LS93	60p
74LS107	45p
74LS112	100p
74LS123	60p
74LS124	180p
74LS125	80p
74LS126	60p
74LS132	95p
74LS133	60p
74LS136	50p
74LS138	75p
74LS139	75p
74LS151	100p
74LS153	60p
74LS154	200p
74LS155	90p
74LS157	50p
74LS158	90p
74LS160	130p
74LS161	100p
74LS162	140p
74LS163	100p
74LS164	120p
74LS165	130p
74LS166	180p
74LS173	110p
74LS174	90p
74LS175	90p
74LS181	320p
74LS190	90p
74LS191	90p
74LS192	90p
74LS193	90p
74LS195	90p
74LS196	90p
74LS221	140p
74LS240	175p
74LS241	175p
74LS242	170p
74LS243	170p
74LS244	195p
74LS245	250p
74LS251	140p
74LS253	90p
74LS257	120p
74LS259	160p
74LS266	100p
74LS273	130p
74LS279	90p
74LS324	200p
74LS367	100p
74LS373	180p
74LS374	195p
74LS378	200p
74LS393	200p

4000 SERIES

4000	18p
4001	25p
4002	20p
4006	95p
4007	25p
4008	80p
4009	40p
4010	50p
4011	25p
4012	18p
4013	50p
4014	84p
4015	84p
4016	45p
4017	80p
4018	89p
4019	45p
4020	100p
4021	110p
4022	100p
4023	25p
4024	50p
4025	20p
4026	130p
4027	50p
4028	84p
4029	100p
4030	55p
4031	200p
4033	180p
4034	200p
4035	110p
4040	100p
4041	80p
4042	80p
4043	90p
4044	90p
4046	110p
4047	100p
4048	55p
4049	40p
4050	49p
4051	80p
4052	80p
4053	80p
4054	150p
s4055	125p
4056	160p
4059	600p
4060	115p
4063	120p
4066	55p
4067	450p
4068	22p
4069	25p
4070	30p
4071	22p
4072	22p
4073	22p
4075	22p
4076	107p
4081	25p
4082	22p
4093	80p
4094	175p
4098	120p
4099	130p
4412	1100p
4502	120p
4503	70p
4507	55p
4510	99p
4511	150p
4514	250p
4516	110p
4518	100p
4520	100p
4521	250p
4528	120p
4532	140p
4538	140p
4543	180p
4553	450p
4560	250p
4569	180p
4583	90p
4584	90p
40014	90p
40085	200p
40097	90p
14433	1100p
14500	700p
14599	290p

INTERFACE ICs

MC1488	100p
MC1489	100p
75107	160p
75182	230p
75322	275p
75324	375p
74325	375p
75361	300p
75363	225p
75362	350p
75451	72p
75491/2	96p
8T26	250p
8T28	300p
8T95	200p
8T97	200p
81LS95	140p
81LS96	140p
81LS97	140p
81LS98	140p
9601	120p
9602	220p

93 SERIES

9301	160p
9302	175p
9308	316p
9310	275p
8311	275p
9312	160p
9314	165p
9316	225p
9321	225p
9322	150p
9334	340p
9368	200p
9370	200p
9374	200p

LINEAR ICs

*AY1-0212	600p
*AY1-1313	668p
*AY1-1320	320p
*AY1-5050	140p
AYS-1224A	240p
*AY5-1315	600p
*AY5-1317A	775p
*CA3019	80p
CA3028A	90p
*CA3046	70p
*CA3048	225p
CA3080E	72p
*CA3089E	225p
*CA3090AQ	375p
CA3130E	100p
CA3140E	50p
CA3160E	100p
CA3161E	140p
CA3162E	450p
FX209	750p
ICL7106	850p
ICL8038	340p
LF356	95p
LM301A	30p
LM311	120p
LM318	200p
LM319	200p
LM324	50p
LM339	75p
LM348	95p
*LM377	175p
*LM380	75p
*LM381AN	160p
LM709	36p
LM710	50p
LM725	350p
LM733	100p
LM741	20p
LM747	70p
LM748	35p
LM2917	250p
LM3900	60p
LM3909	70p
LM3911	130p
LM3914	250p
LM4136	120p
*MC1310P	150p
MC1458	40p
MC1495L	350p
*MC1496	100p
*MC3340P	120p
*MC3360P	120p
MK50398	750p
MM57160	620p
NE531	130p
NE555	20p
NE556	70p
NE561B	425p
NE562B	425p
NE565	130p
NE566	155p
NE567	175p
*NE571	425p
RC4151	400p
RC4195	120p
*SAD1024A	1250p
SFF96364	1100p
*SN76003N	175p
*SN76013N	140p
*SN76013ND	120p
*SN76023N	140p
*SN76023ND	120p
SN76477	250p
*SP8515	750p
*TAA621	275p
*TBA641B11	225p
*TBA651	200p
*TBA800	90p
*TBA810	100p
*TBA820	90p
*TCA940	175p
TCA4500A	250p
*TDA1004A	300p
TDA1008	320p
TDA1010	225p
*TDA1022	600p
TDA1024	120p
TDA1034B	250p
TDA1170	250p
TDA2002V	325p
*TDA2020	320p
TL064	150p
TL071	60p
TL072	95p
TL074	150p
TL081	40p
TL082	90p
TL084	130p
TL170	50p
UAA170	250p
UAA180	250p
UDN6118	320p
UDN6184	320p
ULN2003	100p
XR2206	350p
XR2207	400p
XR2211	600p
*XR2216	675p
XR2240	400p
*ZN414	90p
ZN419	200p
ZN424E	135p
ZN425E	400p
ZN1034E	200p
95H90	800p

VEROBOARD

(copper clad)	0.1	0.15
2½ x 3¾	41p	33p
2½ x 5	49p	45p
3¾ x 3¾	49p	45p
3¾ x 5	56p	60p
2½ x 17	180p	150p
3¾ x 17	225p	190p
4¾ x 17	340p	—

Pkt of 100 pins 50p
Spot face cutter 85p
Pin insertion tool 99p

VERO WIRING PEN

Plus spool 325p
Spare spool (wire) 80p
Combes 7p each

VOLTAGE REGULATORS Fixed Plastic TO-220

1A	+ve		-ve	
5V	7805	60p	7905	65p
12V	7812	60p	7912	65p
15V	7815	60p	7915	65p
18V	7818	60p	7918	65p
24V	7824	60p	7924	65p
100mA	TO-92			
5V	78L05	30p	79L05	70p
12V	78L12	30p	79L12	70p
15V	78L15	30p	79L15	70p

OTHER REGULATORS

LM309K	135p	TBA625B	120p
LM317T	200p	TL430	65p
LM323K	550p	78H05KC	625p
LM723	37p	78MGT2C	140p

OPTO-ELECTRONICS

2N5777	45p	OCP71	130p
ORP12	90p	ORP60	90p
ORP61	90p	TIL78	70p

LEDS

0.125"		0.2"	
TIL32	75p	TIL220 Red	16p
TIL209 Red	13p	TIL222 Gr	18p
TIL211 Gr	20p	TIL228 Red	22p
TIL212 Ye	25p	MV5491 TS	120p
TIL216 Red	18p	Clips	3p

DISPLAYS

3015F	200p	FND500	120p
DL704	140p	FND507	120p
DL707 Red	140p	MAN3640	175p
707 Gr	140p	MAN4640	200p
DL747 Red	225p	TIL311	600p
747 Gr	225p	TIL312/3	110p
FND357	120p	TIL321/2	130p
		TIL330	140p

DRIVERS

9368	200p	7750	200p
9370	200p	7760	200p
		NSB5881CC	570p

TRANSISTORS

AC126	25p
AC127/8	20p
AC176	25p
AF116/7	30p
AO149	70p
AD161/2	45p
AU107	250p
BC107/8	11p
BC109	11p
*BC117	20p
*BC147/8	9p
*BC149	10p
*BC157/8	10p
*BC159	11p
*BC169C	12p
*BC172	12p
BC177/8	17p
BC179	18p
*BC182/3	10p
*BC184	11p
BC187	30p
*BC212/3	11p
*BC214	12p
BC461	36p
BC477/8	30p
*BC516/7	50p
*BC5478	16p
*BC549C	18p
*BC5578	16p
*BC559C	18p
BCY70	18p
8CY71/2	22p
8D131/2	50p
BD135/6	54p
BD139	56p
BD140	60p
BD189	60p
BD242	70p
BDY56	200p
BF115	36p
BF167	30p
BF173	30p
BF178	36p
BF200	32p
*BF244B	35p
*BF256B	70p
BF257/8	32p
BF259	36p
*BFR39	25p
*BFR40	25p
*BFR41	25p
*BFR79	25p
*BFR80	25p
*BFR81	25p
BFX29	30p
BFX30	34p
BFX84/5	30p
BFX86/7	30p
BFX88	30p
BFW10	90p
BFY50	30p
BFY51/2	30p
BFY56	33p
BFY90	90p
BRY39	45p
BSX19/20	20p
BU104	225p
*BU105	190p
*BU108	250p
BU109	225p
*BU205	200p
*BU208	200p
*BU406	145p
*E300	50p
*E308	50p
J310	50p
MJ2501	225p
MJ2955	90p
MJ3001	225p
*MJE340	65p
MJE2955	100p
MJE3055	70p
*MPF102	45p
*MPF103/4	40p
*MPF105/6	40p
MPSA06	30p
*MPSA12	50p
*MPSA13	50p
MPSA43	50p
*MPSA20	50p
*MPSA56	32p
MPSA70	50p
*MPSU06	63p
MPSU65	78p
OC28	130p
OC35	130p
*R2008B	200p
*R20108	200p
*TIP29A	40p
*TIP29C	55p
*TIP30A	48p
*TIP30C	60p
*TIP31A	58p
TIP31C	62p
TIP32A	68p
TIP32C	82p
TIP33A	90p
TIP33C	114p
TIP34A	115p
TIP34C	160p
TIP35A	225p
TIP35C	290p
TIP36A	270p
TIP36C	340p
TIP41A	65p
TIP41C	78p
TIP42A	70p
TIP42C	82p
TIP2955	78p
TIP3055	70p
*TIS43	30p
TIP54	150p
*TIS93	30p
*ZTX108	12p
*ZTX300	13p
ZTX500	15p
*ZTX502	18p
*ZTX504	30p
2N457A	250p
2N696	35p
2N697	25p
2N698	45p
2N706A	20p
2N918	35p
2N930	18p
2N1131/2	20p
2N1613	25p
N1711	25p
2N2102	60p
2N2160	300p
2N2219A	22p
2N2222A	22p
2N2369A	16p
2N2484	30p
2N2646	50p
2N2904/5	25p
2N2906A	24p
2N2907A	30p
*2N2926	9p
2N3053	30p
2N3054	65p
2N3055	48p
2N3442	140p
2N3553	240p
*2N3565	30p
*2N3643/4	48p
*2N3663	20p
*2N3702/3	12p
*2N3704/5	12p
*2N3706/7	14p
*2N3708/9	12p
*2N3773	300p
*2N3819	25p
*2N3820	50p
2N3823	70p
2N3866	90p
*2N3903/4	18p
*2N3905/6	20p
2N4037	65p
*2N4058/9	12p
*2N4060	12p
*2N4061/2	18p
*2N4123/4	27p
*2N4125/6	27p
*2N4401/3	27p
2N4427	90p
*2N4871	60p
*2N5087	27p
*2N5089	27p
*2N5172	27p
2N5179	90p
2N5191	83p
2N5194	90p
*2N5245	40p
*2N5296	55p
*2N5401	50p
*2N5457/8	40p
*2N5459	40p
*2N5460	40p
2N5485	44p
*2N6027	48p
2N6247	190p
2N6254	130p
2N6290	65p
2N6292	65p
3N128	120p
3N140	100p
3N141	110p
3N201	110p
3N204	100p
40290	250p
40360	40p
40361/2	45p
40364	120p
40408	70p
40409	65p
40410	85p
40411	300p
40594	100p
40595	105p
40673	75p
40841	90p
40871/2	90p

DIODES

*BY127	12p
*OA47	9p
*OA81	15p
*OA85	15p
*OA90	9p
*OA91	9p
*OA95	9p
*OA200	9p
*OA202	10p
*1N914	4p
*1N916	7p
*1N4148	4p
1N4001/2	5p
1N4003/4	6p
1N4005	6p
1N4006/7	7p
1N5401/3	14p
1N5404/7	19p
*15920	9p

HEAT SINKS

For TO220 Voltage Regs. and Transistors 22p
For TO5 12p

BRIDGE RECTIFIERS

*1A 50V	19p
*1A 100V	20p
*1A 400V	25p
*1A 600V	30p
*2A 50V	30p
*2A 100V	35p
*2A 400V	45p
*3A 200V	60p
*3A 600V	72p
*4A 100V	95p
*4A 400V	100p
6A 50V	80p
6A 100V	90p
6A 400V	100p
10A 400V	200p
25A 400V	400p

*ZENEERS

2.7V-33V
400mW 9p
1W 15p

TRIACS PLASTIC

3A 400V	60p
3A 500V	65p
6A 400V	70p
6A 500V	90p
8A 400V	75p
8A 500V	95p
12A 400V	85p
12A 500V	105p
16A 400V	110p
16A 500V	130p
T2800D	130p

THYRISTORS

1A 50V	40p
1A 400V	65p
1A 600V	70p
3A 400V	90p
8A 600V	140p
12A 400V	160p
16A 100V	160p
16A 400V	180p
16A 600V	220p
BT106	110p
C106D	45p
*MCR101	36p
2N3525	140p
2N4444	140p
*2N5060	34p
*2N5064	40p

LOUD-SPEAKERS

Size	
2½" 64R	80p
2½" 8R	80p
2" 8R	85p
1½" 8R	85p

MEMORIES

2102-2L	120p
2107B	500p
2111-2	225p
2112-2	250p
2114 (250ns)	560p
2114 (450ns)	450p
4027	375p
4044	900p
4116	700p
5101	510p
6810	350p

ROM/PROMs

71301	700p
74S188	225p
74S287	350p
74S387	350p
74S471	700p
745571	650p
93427	400p
93436	650p
93446	650p
93448	900p

CPUs

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1802	650p
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6502	1200p
6800	900p
6802	1250p
8080A	550p
8085A	£13
INS8060	£10
Z80	1150p
Z80A	1350p

EPROMs

1702A	500p
2708	675p
2716	£21

SUPPORT DEVICES

3245	400p
4002	
6820	500p
6821	550p
6850	500p
8250	320p
8212	225p
8216	225p
8224	400p
8228	525p
8251	700p
8253	1200p
8255	550p
8257	1100p
8259	1400p
Z80P10	650p
Z80CTC	650p
MC14411	1100p
MC14412	1100p

UART

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AY-5-1013P	400p
IM6402	500p
TMS6011NC	400p

CHARACTER GENERATORS

3257ADC	990p
MCM6575	£10
MCM6576	£10
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RO-3-2513LC	650p
SN74S262AN	1350p

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AY-5-2376 £9

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(prim 220-240V)

6-0-6	100mA	88p
9-0-9	75mA	92p
12-0-12	100mA	95p
0-12-0-12	500mA	280p*
0-25V (5VA)		250p
9-0-9 1A		270p*
12V 2A		350p*
0-12-15-20-24-30 1A		340p*
15-0-15 1A		265p*

(Please add 50p p&p charge to all marked* above our normal p&p charge)

*RESISTORS High

*Stab 5% E12 Carbon Film Min
*¼W 10R-1M 7p/5pcs one value
*½W 10R-10M 5p/3pcs one value
*Miniature Presets Hor/Vert 100R-1M 12p
*Carbon Track Pots 5K-1M Log or Lin
*Single 30p
*Single with Switch 60p
*Dual 72p

SUBMINIATURE SWITCHES

TOGGLE	
SPST	55p
SPDT	58p
DPDT	60p
DPDT (Centre off)	85p
Push to make	15p
break	25p
*SLIDE DPDT	18p
*ROCKER SPST	28p
*WAFER	
1P 12W	45p
3P 4W	45p
4P 3W	45p
2P 6W	45p

*CRYSTALS

100KHz	300p
1MHz	370p
3.2768M	350p
4MHz	350p
8.867MHz	350p
10.7MHz	350p
18MHz	300p
26.690M	
27.145M	425p

LOW PROFILE DIL SOCKETS BY TEXAS

8 pin	10p	18 pin	22p	24 pin	30p
14 pin	11p	20 pin	25p	28 pin	40p
16 pin	12	22 pin	27p	40 pin	50p

WIRE WRAP SOCKETS BY TEXAS

8 pin	30p	18 pin	80p	24 pin	100p
14 pin	50p	20 pin	90p	28 pin	110p
16 pin	65p	22 pin	90p	40 pin	120p

ANTEX SOLDERING IRONS

C 15W	350p
CX-17W	400p
CCN 15W	400p
X25	400p

SPARE BITS

C CCN CX	46p
X25	50p

SPARE ELEMENTS

C CX X25	180p
CCN	200p
IRON STAND	150p

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DIP Breadboard 4.15 x 6.15 270p
(Suitable for 20 x 14 pin or 16 x 16 pin DIL ICs) DIP Breadboard as above with tracks for 31 way connector 250p

CONNECTOR PLUGS

31 way Plug	110p
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S 100 Busboard	£12

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2 x 10 way	85p	2 x 22 way	135p
2 x 15 way	100p	2 x 25 way	160p
2 x 18 way	120p		

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ICM7216B	£20
ZN1040E	700p

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96364 £11

• SPECIAL OFFER • (Subject to stocks)

2708	675p	555	£18/100
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2114-3L	£32/8	7805/12/15	£5/10

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TMK500	2100p

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Voltmeter/Ammeter	450p

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8MHz	450p

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EXP350 5x14 pin DIL ICs	315p
EXP600 (28/40 pin DIL IC)	630p

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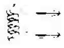
SERVICE TRADING CO

FT3 NEON FLASH TUBE



High intensity multi turn high voltage, neon glow discharge flash tube. Design for ignition timing etc. **£1·50.** P. & P. 25p (**£2·01** inc. VAT) 3 for **£3.** P. & P. 50p (**£4·03** inc. VAT & P).

RODENE UNISET TYPE 71 TIMER

N.M.S.

0-60 sec. 230V a.c. operation. Incorporating a lapsed time indicator and repeat facilities. A precision motorised timer ideal for process timing, photography, welding, mixing, etc. Price **£6.** P. & P. 60p. **£7·89** inc. VAT & P. & P.

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MULTI RANGE METER **Type MF15A** a.c. d.c volts 10 - 50 250 500 1000. Ma 0-5. 0-10. 0 100 Sensitivity 2000V 24 range. diameter 133 by 93 by 46mm including test leads. Price **£7·00** plus 50p P. & P. (**£8·63** inc VAT & P.)

N.M.S.

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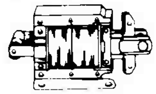

A.C. SOLENOID pye ether type 176/2 240 AC. Approx. 1lb at ½ inch, intermittent rating. Price **£1** p&p 20p (**£1·38** inc VAT + P).

AG/GT 24V. D.C. 70 ohm Coil Solenoid. Push or Pull. Adjustable travel to 3/16 in. Fitted with mounting brackets and spark suppressor. Size: 100 × 65 × 25 mm. Price: 3 for **£2.40** + 30p. P. & P. (min 3 off.) (**£3.11** inc. VAT & P.)

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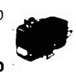
12 volt. 11-way. 4 bank (3 non-bridging 1 homing) **£3·00.**

P. & P. 35p (**£3·85** inc. VAT & P.). N.M.S.

REED SWITCHES. Size 28mm×4mm dia. Price: 10 for **£1.00** +p. & p. 20p. (total incl. VAT **£1.38**). 100 for **£8.00** +p. & p. 30p. (total incl. VAT **£9.55**).

MICRO SWITCHES



Sub. Min. Honeywell Lever m/s type 3115m 906t. 10 for **£3.50** post paid (**£4.37** incl. VAT).
These V3 types.
Button type (Pye) 10 for **£3.00** (**£3.80** incl. VAT)
Short Lever type 16amp. rating (Grouzet) **£4.00** (£4.95 incl. VAT)
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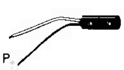
D.P. C/O lever m/switch mfg. by Cherry Co. USA. Precious metal low resistance contacts. 10 for **£2.25** P. & P. 30p. Total inc. VAT **£2.93** (min. 10).

MERCURY SWITCH



Size 27mm × 5mm. 10 for **£5.00** (inc VAT **£6·12**) min quantity 10. 30p P. & P.
Heavy duty type, size 38 × 16 × 10mm, minimum quantity 10. **£7·50** post paid (**£8·63** inc. VAT & P.).

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Crouzet 1 rpm. 115V. A.C. Motor operating 2 Roller Micro switches (4 amp). Can be used on 240V. A.C. with either 0·25 mfd 250V Condensor or 5·6K wirewound Resistor 7 watt (supplied) Price **£2·50** + 50p p. & p. (**£3·45** incl. VAT & P.).

N.M.S.

A.E.G. CONTACTOR

Type LS6/L11. Coil 240V 50 Rs. Contacts – 3 make: 600V: 20amp. 1 break: 600V: 20 amp. Price: **£5·50** + 50p P. & P. (**£6·90** inc. VAT & P.). N.M.S.

ARROW-HART MAINS CONTRACTOR, Cat. No. 130A30. Coil 250V. or 500V. A.C. Contacts, 3 make 50 amp up to 660V. A.C. 20 h.p. at 440V. 3 phase 50 Hz. Price: **£7.75** + p. & p. £1.00 (incl. VAT, total: **£10.06**). N.M.S.

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Type FFB. 1706. Small, quiet, smooth running. 240V. A.C. operation. Output aperture 45×40cm. Overall size 135×165 cm. Flange mounting. Price: **£4.25.** P.&P. 75p. (Total: **£5.75** inc. P. & VAT. N.M.S.
Other types available. S.A.E. for details.

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Precision 24 volt. D.C. 0·8 amp Blower that works well on 12V 0·4 amp D.C. Producing 30 cu.ft. min at normal air pressure. **£4.50** P. & P.75p (inc. VAT £6.04). N.M.S.

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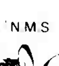
wire ended capacitors. N.M.S. 10 for **£1·50** p&p 50p. (£2·30 inc VAT + p&p) (Min 10)

230V a.c. FAN ASSEMBLY.



Powerful continuously rated a.c. motor complete with 5 blade 6½in. or 4 blade 3in. aluminium fan. Price **£3·00.** P. & P. 65p. (**£4·20** incl. VAT & P.).

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All plus Carriage & V.A.T.

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0-12V at 20 amp or 0-24V at 10 amp **£12·00** P. & P. £1·50 (**£15·53** inc. VAT & P.)
0-6V/12V at 10 amp **£8·25** P. & P. £1·25 (**£10·93** inc. VAT)
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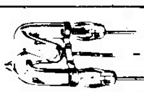
XENON FLASHGUN TUBES



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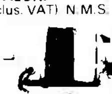
30 rpm. 230/240V a.c. 50lb in mf. **PARVALUX.** Price: **£15·00** + £1·50 P. & P. (**£18·98** inclus. VAT) N.M.S.



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.

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N.M.S.

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

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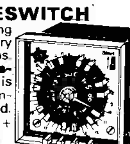
MINIATURE 24-HOUR TIMESWITCH



(German mfr.). 240V. A.C. operation. Spring Reserve. 10 amp contacts, one on-off every 24 hours. Calibrated in two hour steps. Minimum on-off period 6 hours. **Day Omission.** Unusual feature with these Switches is that trips may be removed at will enabling individual days to be programmed as required. Size only 3" × 4". Depth 2¾". Price: **£6·50** + 50p. p. & p. (**£8·05** incl. VAT & P). N.M.S.

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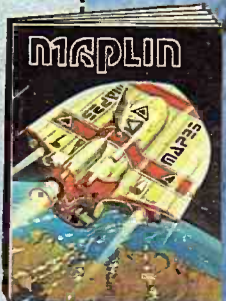

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