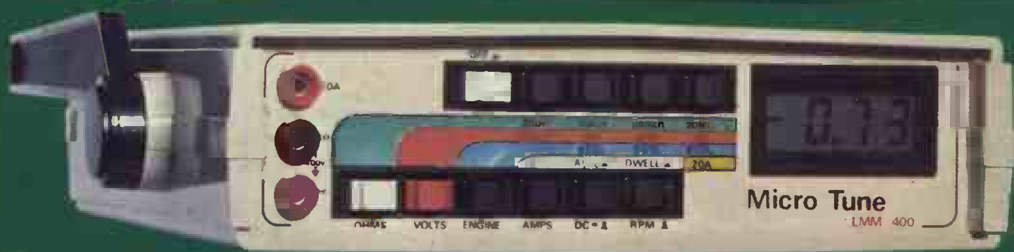
Australia $1.10 New Zealand $1.20 Malaysia $4.50

PRACTICAL ELECTRONICS

DECEMBER 1980

65p

PE ENGINE TUNE-UP UNIT



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PRACTICAL
ELECTRONICS

VOLUME 16 **No. 12** **DECEMBER 1980**

CONSTRUCTIONAL PROJECTS

GENERAL FEATURES

NEWS AND COMMENT

OUR JANUARY 1981 ISSUE WILL BE ON SALE FRIDAY, 12 DECEMBER 1980
(for details of contents see page 31)

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WATFORD ELECTRONICS

33/35, CARDIFF ROAD, WATFORD, HERTS, ENGLAND
MAIL ORDER, CALLERS WELCOME. Tel. Watford 40588/9

ALL DEVICES BRAND NEW. FULL SPEC. AND FULLY GUARANTEED. ORDERS DESPATCHED BY RETURN OF POST. TERMS OF BUSINESS: CASH/CHEQUE/P.O.s OR BANKERS DRAFT WITH ORDER. GOVERNMENT AND EDUCATIONAL INSTITUTIONS OFFICIAL ORDERS ACCEPTED (TELEPHONE ORDERS BY ACCESS NOW ACCEPTED Minimum order £10.00 please). TRADE AND EXPORT INQUIRY WELCOME; P & P ADD 40p to ALL ORDERS UNDER £10·00. OVERSEAS ORDERS POSTAGE AT COST.

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

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

ULTRASONIC TRANSDUCERS
40KHz 350p pr.

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

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

MYLAR FILM CAPACITORS
100V: 0.001, 0.002, 0.005, 0·01µF 6p
0.015, 0.02, 0.03, 0.04, 0.05, 0.056µF 7p
0.1µF 8p; 50V: 0·47µF 12p.

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

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

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

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

SLIDER POTENTIOMETERS
0.25W log and linear values 60mm track

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

PRESET POTENTIOMETERS

0.1W 50Ω-2.2M Mini. Vert. & Horiz.	7p
0.25W 100Ω-3.3MΩ Horiz. larger	10p
0.25W 250Ω-4.7MΩ Vert.	10p
Precision Cermet 1W 100Ω-100K	90p

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

TRIMMERS miniature
2.5pF: 3-10pF:
3-30pF: 3-50pF 28p
5-25pF: 65pF 88pF 35p

COMPRESSION

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

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

RANGE		Val	1-99	100+
0.25W	2Ω2-4M7	E24	2p	1p
0.5W	2Ω2-4M7	E12	2p	1p
1W	2Ω2-10M	E12	5p	3p
2% Metal Film 10Ω-1M			6p	4p
1% 0.5W 51Ω-1M		E24	8p	6p

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

TRANSISTORS

AC107	36
AC125	35
AC126	25
AC127	25
AC128	25
AC141	30
AC142	30
AC176	28
AC187	28
ACY17	70
ACY18	70
ACY19	75
ACY20	75
ACY21	75
ACY22	60
ACY28	75
ACY39	85
AD149	79
AD161	42
AD162	42
AF118	95
AF139	40
AF178	75
BC107	10
BC107B	12
BC108	10
BC108B	12
BC108C	12
BC109	10
BC109B	12
BC109C	12
BC140	30
BC142	30
BC143	30
BC147	9
BC147B	10
BC148	9
BC148B	10
BC148C	10
BC149	9
BC149C	27
BC153	27
BC154	13
BC157	10
BC158	10
BC159	11
BC160	45
BC167A	10
BC168C	10
BC169C	10
BC170	15
BC171	11
BC172	11
BC173	11
BC177	20
BC178	20
BC179	20
BC181	20
BC182	10
BC183	10
BC184	10
BC182L	10
BC183L	10
BC184L	10
BC187	26
BC212	10
BC212L	10
BC213	10
BC213L	10
BC214	10
BC214L	10
BC237	14
BC238	14
BC307B	14
BC308B	16
BC327	15
BC328	15
BC337	15
BC338	15
BC441	34
BC461	34
BC477	40
BC516	40
BC517	40
BC547	14
BC548	14
BC549C	14
BC557	15
BC558	15
BC559	15
BCY70	16
BCY71	18
BCY72	20
BD121	95
BD123	98
BD124	115
BD131	48
BD132	48
BD133	60
BD135	45
BD136	40
BD137	40
BD138	40
BD139	40
BD140	40
BD144	198
BD205	110
BD245	45
BD378	70
BD434	55
BD517	75
BD695A	85
BD696A	85
BDY56	180
BDY60	160
BDY61	160
BF115	35
BF167	29
BF177	25
BF178	30
BF179	35
BF180	38
BF194	12
BF195	12
BF196	12
BF197	12
BF198	16
BF199	18
BF224	25
BF244A	28
BF244B	29
BF244	30
BF245	28
BF256	35
BF257	32
BF258	32
BF259	35
BF274	42
BF336	40
BF451	35
BF594	30
BF595	39
BF910	95
BFR39	23
BFR40	23
BFR41	23
BFR79	23
BFR80	25
BFR81	25
BFR98	105
BFX29	28
BFX84	26
BFX85	28
BFX86	28
BFX87	28
BFX88	28
BFY50	23
BFY51	23
BFY52	23
BFY56	32
BFY64	35
BFY81	120
BRY39	40
BSX20	20
BSX29	34
BSY95A	25
BU105	170
BU205	190
BU208	200
E421	250
MD8001	250
MJ2955	90
MJE340	54
MJE370	100
MJE371	100
MJE2955	99
MJE3055	70
MPF102	66
MPF103	36
MPF104	36
MPF105	36
MPF106	40
MPSA05	25
MPSA06	25
MPSA12	32
MPSA55	30
MPSA56	30
MPSU02	58
MPSU05	55
MPSU06	55
MPSU52	65
MPSU55	60
MPSU56	60
OC23	170
OC26	170
OC28	130
OC35	125
OC36	130
OC41	120
OC42	120
OC43	55
OC44	120
OC45	40
OC70	40
OC71	35
OC72	40
OC74	50
OC76	50
OC81	50
OC82	50
OC83	40
OC84	40
OC140	110
OC170	85
OC171	85
OC200	85
TIP29	34
TIP29A	36
TIP29B	56
TIP29C	60
TIP30	40
TIP30A	48
TIP30B	50
TIP30C	58
TIP31A	45
TIP31C	55
TIP32A	48
TIP32C	60
TIP33A	65
TIP33C	78
TIP34A	74
TIP34C	88
TIP35A	160
TIP35C	185
TIP36A	170
TIP36C	199
TIP41A	55
TIP41B	60
TIP42A	60
TIP42B	75
TIP120	90
TIP121	99
TIP141	120
TIP142	120
TIP147	120
TIP2955	60
TIP3055	60
TIS43	32
TIS44	45
TIS45	45
TIS90	30
TIS91	32
UC734	65
ZTX107	11
ZTX108	11
ZTX109	12
ZTX212	28
ZTX300	13
ZTX301	16
ZTX302	20
ZTX303	25
ZTX304	17
ZTX314	25
ZTX320	30
ZTX326	30
ZTX341	30
ZTX500	14
ZTX501	15
ZTX502	15
ZTX503	18
ZTX504	25
ZTX531	25
ZTX550	25
2N697	23
2N698	40
2N699	48
2N706A	19
2N708	19
2N914	32
2N916	32
2N918	35
2N1131	24
2N1132	24
2N1303	65
2N1304	65
2N1305	60
2N1307	66
2N1308	68
2N16718	215
2N2219A	28
2N2220A	26
2N2221A	25
2N2222A	25
2N2369A	18
2N2646	45
2N2784	55
2N2846	80
2N2904	26
2N2905A	28
2N2906	26
2N2907A	26
2N2926G	10
2N3053	26
2N3054	58
2N3055	48
2N3442	140
2N3614	199
2N3615	199
2N3663	17
2N3702	10
2N3703	10
2N3704	10
2N3705	12
2N3706	10
2N3707	10
2N3708	10
2N3709	10
2N3710	10
2N3711	10
2N3771	179
2N3772	195
2N3773	270
2N3819	22
2N3820	45
2N3822	65
2N3823	70
2N3866	90
2N3903	18
2N3904	18
2N3905	15
2N3906	17
2N4037	58
2N4058	15
2N4061	46
2N4062	10
2N4069	10
2N4427	10
2N4829	80
2N4859	78
2N4871	55
2N4922	60
2N5135	20
2N5136	20
2N5138	18
2N5172	18
2N5179	45
2N5180	45
2N5191	75
2N5245	30
2N5305	24
2N5457	36
2N5458	36
2N5459	36
2N5485	36
2N5777	45
2N6027	32
2N6107	60
2S0234	75
3N128	112
3N140	112
40250	85
40251	97
40311	60
40313	130
40315	60
40316	95
40317	60
40319	71
40320	60
40361	50
40362	50
40406	75
40407	80
40408	70
40411	285
40412	65
40467	130
40468	85
40594	105
40595	110
40603	110
40636	175
40673	95

ANTEX Soldering Irons

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

DIL SOCKETS (TEXAS)

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

SPECIAL OFFER

2114-450ns	225
2114-300ns	295
2707	445
2716-5V	650
4116-16k	299

Access

LINEAR IC's

702	75
709C 8 pin	35
710	67
741	17
747C 14 pin	78
748C 8 pin	36
753 8 pin	185
810	159
AY-1-0212	595
AY-1-1313A	660
AY-1-1320	225
AY-1-5050	99
AY-1-5051	160
AY-1-6721/6	210
AY-3-1270	840
AY-3-8500	390
AY-3-8910	850
AY-3-8912	
AY-5-1224A	235
AY-5-1230	450
AY-5-1315	595
AY-5-1317A	630
AY-5-8100	735
CA3011	110
CA3014	157
CA3018	68
CA3019	70
CA3020	186
CA3023	191
CA3028A	80
CA3035	235
CA3036	115
CA3043	275
CA3045	365
CA3046	70
CA3048	214
CA3059	195
CA3075	213
CA3080E	65
CA3081	190
CA3089E	215
CA3090AQ	375
CA3123	150
CA3130	90
CA3140	48
CA3160	95
ICL7106	795
ICL7107	975
ICL8038CC	340
ICL8211	150
ICM7205	1150
ICM7207	475
ICM7207A	550
ICM7215	1080
ICM7216A	1950
ICM7216B	1950
ICM7217A	790
ICM7224	785
LD130	452
ICM7555	89
LF356	90
LM10	395
LM301A	23
LM308	95
LM311	70
LM318	200
LM324	50
LM339	68
LM348	90
LM349	115
LM379	415
LM380	80
LM381N	145
LM382	125
LM384	140
LM386	99
LM387	120
LM389	99
LM733	75
LM3900	60
LM3909	70
LM3911	125
LM3914	240
LM3915	240
LM13600	135
M252AA	625
M253AA	1150
MC1303	88
MC1304P	260
MC1310P	150
MC1458	45
MC1494	694
MC1495	350
MC1496L	92
MC1596	225
MC1710	79
MC3302	150
MC3340P	120
MC3360P	120
MC3401	52
MC3403	135
MC3405	150
MFC6040	97
MK50398	635
MM5303	635
MM5307	1275
MM57160	620
MSM5526	820
NE529	225
NE543	210
NE544	186
NE555	22
NE556DB	55
NE560	325
NE561	395
NE562B	410
NE564	435
NE565A	120
NE566	180
NE567	170
NE570	450
NE571	420
RC41360	110
S5668	275
SAB3209	425
SAB3210	275
SG3402	295
SN76003N	240
SN76013N	170
SN76018	148
SN76023N	170
SN76033N	195
SN76115N	215
SN76131	125
SN76227N	95
SN76477	175
SN76660	120
SP8629	299
TAA621AX1	250
TAA661A	165
TAD100	159
TBA120S	70
TBA540	220
TBA550Q	330
TBA641-A12/BX1 or BX11	250
TBA651	190
TBA800	90
TBA810S	95
TBA820	70
TBA920Q	260
TBA990Q	270
TCA965	120
TDA1004	290
TDA1008	310
TDA1022	575
TDA1024	105
TDA2020	320
TDA2030	300
TL061	48
TL064CN	159
TL071CP	45
TL072CP	90
TL074CN	140
TL081CP	42
TL082CP	70
TL083CP	95
TL084CP	120
UAA170	170
UAA180	170
XR2206	380
XR2266	750
ZN414	95
ZN423	195
ZN424E	130
ZN425E	415
ZN427	660
ZN1034	200
ZN1040E	685

COMPUTER IC's

2102	125
2112-2N	250
2114-250ns	225
2114-300ns	299
2708	445
4116 16K	299
6502	650
6505	850
6520	350
6522	650
6530	1350
6532	850
6545	1450
6551	850
6592	2572
6800	700
74L00	68
74S132	138
74S138	240
74S158	240
74S188	210
74S189	158
74S194	360
74S195	795
74S241	540
74S262	850
74S287	325
74S288	210
74S470	325
74S472	1150
74S475	825
75150	140
75154	150
75450	95
75451	70
75452	70p
75454	225
75491/2	93
8080A	499
8085A	1195
8251	700
8253	1275
8T26AN	235
8T28N	280
8T95N	160
8T97N	150
81LS95	135
81LS96	135
81LS97	140
AY-3-1015	550
AY-5-1013	399
AY-5-2376	980
DM8123	195
IM6402	420
MC1488	90
MC1489	90
MC14411	1020
MC14412	1520
MK4027-2	470
MK4027-4	350
MM1702	299
RO-3-2513	650
SFF96364E	1050
SFC71301	820
SFS80102	205
TMS2516	650
TMS2716	1250
TMS 4035	250
TMS 4039	250
TMS 4047	775
TMS 6011	355
Z80CPU 2.5	650
Z80A 4M	825
Z80 P10	450
Z80 CTC	450
Z80A P10	550
Z80A CTC	550

TTL 74 (TEXAS)

7400	11
7401	11
7402	11
7403	14
7404	14
7405	18
7406	36
7407	36
7408	17
7409	20
7410	17
7411	32
7412	38
7413	30
7414	30
7416	31
7417	31
7420	19
7421	38
7422	25
7423	28
7425	28
7426	43
7427	32
7428	35
7430	19
7432	27
7433	36
7437	35
7438	32
7440	68
7441	58
7442	71
7443	120
7444	114
7445	105
7446	132
7447	72
7448	75
7450	40
7451	30
7453	20
7454	20
7460	20
7470	41
7472	31
7473	36
7474	34
7475	56
7476	40
7480	62
7481	120
7482	75
7483	90
7484	99
7485	105
7486	33
7489	205
7490	42
7491	84
7492	50
7493	67
7494	85
7495	70
7496	60
7497	176
74100	130
74104	62
74105	62
74107	34
74109	60
74110	54
74111	68
74112	150
74116	170
74118	180
74119	85
74120	120
74121	75
74122	35
74123	50
74125	65
74126	50
74128	45
74132	66
74136	65
74141	75
74142	185
74143	250
74144	250
74145	90
74147	150
74148	125
74150	130
74151	70
74153	70
74154	120
74155	75
74156	75
74157	70
74159	165
74160	99
74161	99
74162	99
74163	99
74164	120
74165	120
74166	130
74167	205
74170	205
74172	375
74173	110
74174	100
74175	82
74176	80
74177	85
74178	110
74179	150
74180	90
74181	280
74182	85
74184	130
74185	130
74188	310
74190	130
74191	120
74192	120
74193	120
74194	102
74195	75
74196	99
74197	88
74198	160
74199	160
74221	150
74246	150
74247	151
74248	189
74249	189
74251	110
74265	66
74273	270
74278	267
74279	249
74283	149
74284	350
74285	350
74290	107
74293	135
74297	238
74298	185
74365	90
74366	90
74367	90
74368	90
74390	185
74393	185
74490	185

74LS

LS00	13
LS01	13
LS02	15
LS03	15
LS04	16
LS05	23
LS08	22
LS09	60
LS10	20
LS11	32
LS12	32
LS13	40
LS14	75
LS15	40
LS20	21
LS21	32
LS22	35
LS26	44
LS27	35
LS28	35
LS30	20
LS32	25
LS33	35
LS37	30
LS38	35
LS40	28
LS42	68
LS47	85
LS48	105
LS49	105
LS51	25
LS54	30
LS55	30
LS63	150
LS73	45
LS74	35
LS75	45
LS76	45
LS78	50
LS83	105
LS85	80
LS86	38
LS90	50
LS91	125
LS92	75
LS93	60
LS95	115
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LS114	40
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LS124	180
LS125	45
LS126	45
LS132	60
LS133	35
LS136	55
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LS139	70
LS145	120
LS147	210
LS148	170
LS151	90
LS153	85
LS155	75
LS156	88
LS157	70
LS158	70
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LS166	175
LS168	210
LS169	210
LS170	288
LS173	105
LS174	147
LS175	110
LS181	295
LS183	298
LS189	120
LS190	128
LS191	95
LS192	95
LS193	95
LS194	99
LS195	130
LS196	120
LS197	85
LS200	345
LS202	345
LS221	120
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LS247	135
LS248	135
LS249	135
LS251	130
LS253	95
LS257	95
LS258	120
LS259	160
LS261	450
LS266	75
LS273	180
LS275	320
LS279	88
LS280	250
LS283	90
LS290	130
LS293	130
LS295	215
LS298	215
LS299	420
LS300	175
LS302	175
LS323	270
LS321	450
LS324	200
LS325	320
LS326	330
LS327	315
LS346	185
LS347	150
LS348	190
LS352	185
LS353	185
LS365	65
LS366	65
LS367	65
LS368	90
LS373	150
LS374	150
LS375	150
LS377	199
LS378	140
LS379	215
LS384	250
LS385	420
LS386	85
LS390	140
LS393	140
LS395	210
LS396	199
LS398	275
LS399	230
LS445	140
LS447	195
LS490	245
LS668	105
LS669	105
LS670	270
LS673	750
LS674	850
LS689	420

CMOS

4000	18
4001	18
4002	24
4006	92
4007	22
4008	82
4009	40
4010	48
4011	24
4012	24
4013	45
4014	85
4015	85
4016	42
4017	82
4018	88
4019	48
4020	99
4021	105
4022	95
4023	25
4024	75
4025	25
4026	180
4027	48
4028	82
4029	105
4030	60
4031	225
4032	125
4033	175
4034	210
4035	125
4036	365
4037	115
4038	118
4039	360
4040	105
4041	80
4042	80
4043	95
4044	95
4045	175
4046	130
4047	98
4048	65
4049	45
4050	48
4051	80
4052	80
4053	80
4054	130
4055	135
4056	135
4057	2850
4059	575
4060	130
4061	1225
4062	995
4063	120
4066	58
4067	430
4068	26
4069	26
4070	30
4071	25
4072	25
4073	25
4075	25
4076	35

CMOS (CONT.)

4077	48
4078	30
4081	28
4082	28
4085	90
4086	90
4089	150
4093	89
4094	240
4095	105
4096	105
4097	350
4098	115
4099	190
4160	125
4161	125
4162	125
4163	125
4174	130
4175	120
4194	125
4408	790
4409	790
4410	790
4411	1020
4412F	1520
4412V	1520
4415F	850
4415V	850
4419	320
4422	570
4432	1050
4435	1050
4440	999
4450	350
4451	350
4452	000
4490F	750
4490V	750
4501	28
4502	125
4503	75
4506	75
4507	60
4508	325
4510	99
4511	150
4512	98
4513	225
4514	265
4515	299
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4528	120
4529	175
4530	89
4531	165
4532	140
4534	575
4536	395
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4539	135
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4543	175
4549	296
4553	440
4554	175
4555	85
4556	75
4557	425
4558	130
4559	290
4560	235
4561	95
4562	595
4566	190
4568	299
4569	250
4572	48
4580	595
4581	350
4582	150
4583	125
4584	65
4585	140

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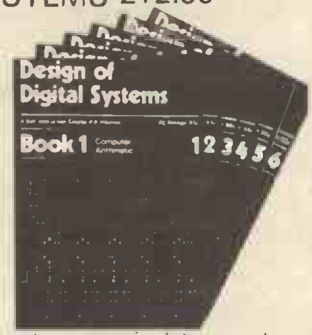

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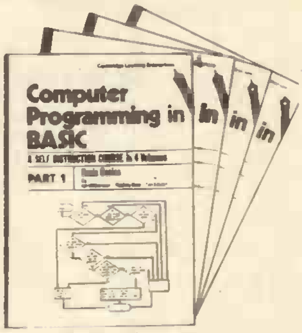

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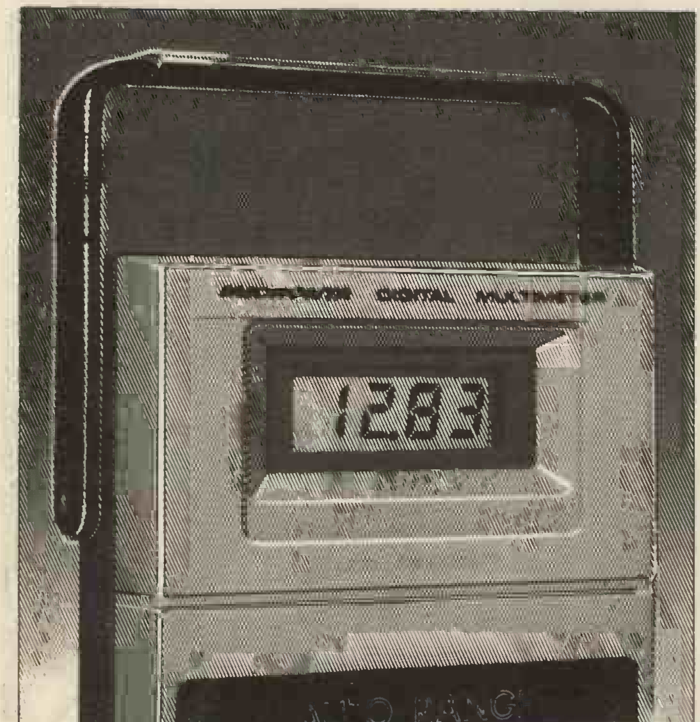

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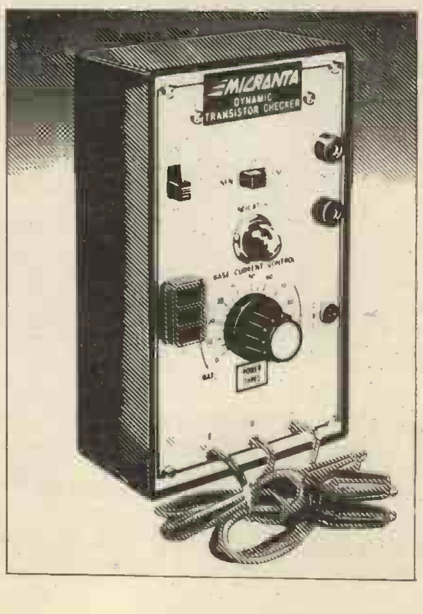

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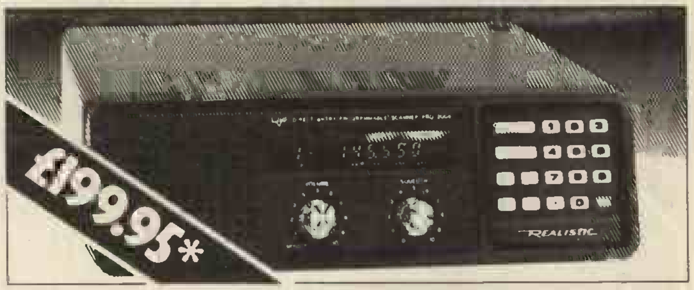

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74LS175	99p
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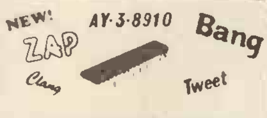

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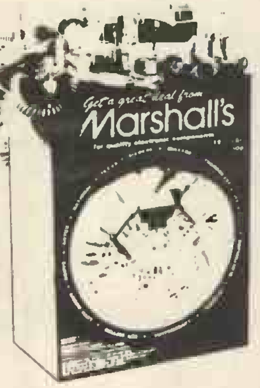

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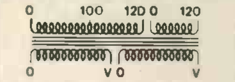

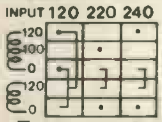

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TTC 461	0·50·2	2·20	60
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TTC 464	1·38·2	3·10	85
TTC 465	2·77·2	4·70	120
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TTC 471	1·04·2	3·10	85
TTC 472	2·08·2	4·70	120
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TTC 477	0·40·2	2·45	70
TTC 478	0·83·2	3·10	85
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1000UF 16V	5	105	15
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DAS02	As above but includes nickel-cadmium batteries.	£53.95
CS02	Siren Kit. (Can also be used with SCA01): Siren, 10 Mtrs wire, wire staples, and mounting hardware.	£8.75
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VOLUME 16 No. 12 DECEMBER 1980

BREADBOARD

PROVIDING there are no last minute production or distribution hiccups with this issue (after our industrial problems earlier in the year we only managed to get back on schedule last month) you could be reading this in time to make plans to visit Breadboard '80. Odd though the name is we are sure nearly every enthusiast will by now be aware that the Breadboard exhibition caters for all those interested in electronics as a hobby.

Once again *PE* will be exhibiting, in our own rather unpretentious manner. We will be very pleased to meet any readers that care to come along, and of course, we will have a number of projects on show—many of them operational. We will also be selling past (back to August '80) and present copies and our own book *PE Popular Projects.*

Some of the items we expect to have working are: *PE Teletext, PE Master Rhythm, PE Starspinner* (see page 31), a speech synthesiser (see page 44), *PE Congress* Hi-Fi Amp, *Compukit Sound Generator,* etc. We will also be showing many items of test gear including the *PE Microtune* (see page 26) and the range of in-car entertainment equipment from our special offer on page 24 (this equipment **will not** be available to purchase from the stand). So if you want to see any of these items or if you just want to chat, come and find us on stands E3 and E4.

If last year is anything to go by, a weekday is best and make sure you bring earplugs and a loud voice! Might we suggest that you also bring plenty of money as there have been many exhibition offers on retailers stands in past years and you could find some bargains.

AVAILABILITY

Many readers have informed us that they have problems buying recent issues—some have been told that we have not published certain issues, one man even rang recently to ask if PE had ceased publication! Let us make it quite clear that we have published every issue this year—although some were more than a month late.

One of the problems is that these days the newsagents are watching their finances and are not prepared to stock more issues than they are sure they can sell. This means that they often sell out early and few spare copies of any issue are available. In order to make sure of your issue, may we suggest you place an order with your newsagent and ask for your copy if it fails to arrive.

SPECIAL ISSUES

The availability problem becomes more acute when we have a special issue, gift or extra supplement etc., This issue carries the Electrovalue catalogue free with all UK copies and next month the issue will carry a free 132 page Tandy catalogue, banded to it. These free catalogues do increase demand for issues so please don't miss out! You have been warned! We are also planning special issues for March, April, May and June and we expect our February issue to be in demand because we hope to cover the electronics incorporated in an entirely new and quite revolutionary luxury British car, which should be launched after Christmas.

For some time PE contributors have been involved in the development of instruments and a locking system for this £65,000 plus vehicle. We will be describing the development of these instruments and showing how to make similar items to fit rather more mundane vehicles. We can't reveal what the car is or what it looks like yet, but "stay tuned" for full details.

Mike Kenward

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We regret that lengthy technical enquiries cannot be answered over the telephone (see below).

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Technical Queries

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

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

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

Back Numbers

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

Binders

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

Subscriptions

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

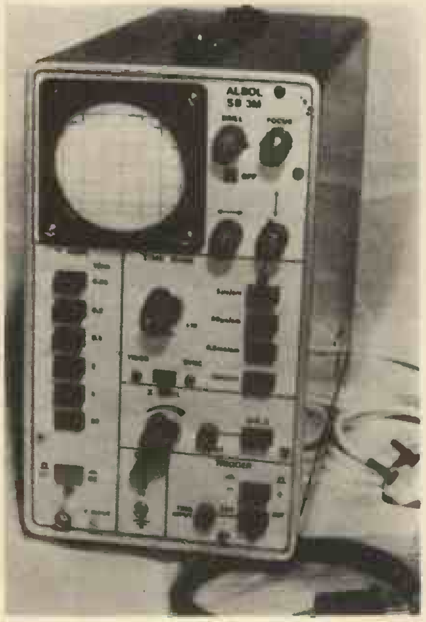
Market Place

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

by David Shortland and Jasper Scott

ECONOMIC SCOPE

The new Model SB 3M oscilloscope from Albol Electronic will serve most purposes required by industrial, service and hobby engineers, and yet manages to keep on the right side of the significant £100 price barrier. With a bandwidth of 0 to 3MHz at −3 dB (extending to 6MHz at −6 dB), the SB 3M breaks new ground, in its class, by offering time-base automatic triggering by i.c. comparator control of the type usually fitted only to luxury 'scopes. A 10 mV signal is all that is needed for a firmly locked and triggered time-base.



The measuring field on the c.r.t. is 50 by 60mm, and the deflection sensitivities are selectable (by push-button) from 0·05 to 20 V/cm. Calibration accuracy is ± 5 per cent. Albol say that the input characteristics are 1 megohm ± 5 per cent, and 30 pF ± 10 per cent. The time-base can be either automatically triggered or synchronised, and it has four switch-selectable calibration speeds, from 1 µs/cm to 5 ms/cm. A six-stage attenuator, from × 1 to × 10, can be applied to each.

Triggering, which can be either internal or external, can be polarised positive or negative, in the range 10Hz to 500kHz. If internal synchronisation is used the range extends from 10Hz to 3MHz. The internal trigger threshhold is 5 mV, and the external 100 mV.

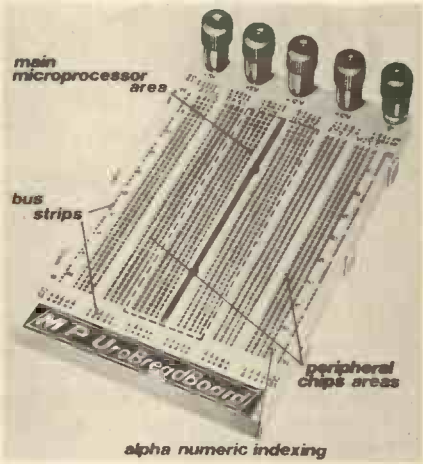
The SB 3M takes about 20 watts from the 240V mains, weighs 4·5kg, and measures 150mm wide by 340mm deep by 280mm high. The price is £99·00, plus VAT; delivery is ex-stock.

Albol Electronic & Mechanical Products Ltd., 3 Crown Buildings, Crown St., London SE5 0JR (01-703 2311).

MICRO BREADBOARD

The first Eurocard size breadboarding system designed specifically for microprocessor based circuit designs will be launched at this years Breadboard Exhibition by Boss Industrial Mouldings Ltd.

Comprising a central MPU Section capable of accommodating a mixture of 24, 28, 40 and 64 pin microprocessors, and flanked on both sides by Auxiliary breadboarding sections for RAM's, ROM's and peripheral chips, this 'world first' system enables complex designs to be rapidly built whilst keeping interconnection link lengths to an absolute minimum. Dual and single bus strips on all sides, plus 5 incoming power line turret terminals all contribute to make this remarkably versatile and rugged breadboarding system. Easily replaceable, double sided, nickel silver contacts, rated at 1A and typically 10m ohms resistance will accept a wide range of lead sizes enabling d.i.l. i.c's transistors, resistors, capacitors and diodes etc to be readily plugged in. The rigid High Impact Polystyrene body is rated up to 75°C and has non-slip rubber backing for working stability.



Capable of accepting ·3", ·4", ·5" and ·6" pitch d.i.l. packages without needlessly wasting auxiliary pin positions and breadboarding areas, every contact is alphanumerically indexed, this being imperative for education and training applications where step-by-step build-up instructions are used.

Boss Industrial Mouldings Ltd, 2 Herne Hill Road, London SE24 0AU (01-731 2383).

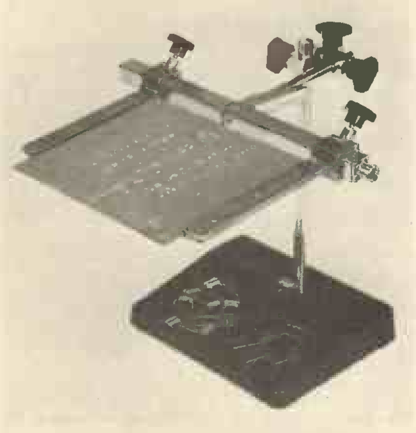
SUPER STRIPPER

Tele-Production Ltd. have recently come up with a simple but effective wire stripper, the Telpro Automatic Wire Stripper.

A single squeeze operation strips the insulation from single and stranded wires without damage. Its wide jaws permit fast and accurate stripping without any nicking or scraping of the wire and a gauge is supplied to ensure consistent lengths of stripping during fast production work. Five diameters of wire can be used on this tool, which has the following size cutter: 1·0, 1·6, 2·0, 2·6 and 3·2mm. Of an all metal construction, it is available ex stock priced £10·50.

Also available from Tele-Productions is a new p.c.b. holder with a quick release trigger which allows a p.c.b. to be removed and replaced in seconds. There is also a special attachment which when fitted to the holding arms of the unit can be repositioned to hold small components such as switches etc., during soldering.

The unit can hold boards up to 12in long and can revolve through 360 degrees. The quick release trigger works by spring tension which can be adjusted. The diecast base of the holder incorporates two trays for holding components.



The MPC 2 Holder is priced at £30·00 excluding VAT and p&p.

Tele-Production Tools, Stiron House, Electric Avenue, Westcliff-on-Sea, Essex SS0 9NW. (0702 352719).

$4\frac{3}{4}$ Digit DMM

The new $4\frac{3}{4}$ digit multimeter from Thurlby Electronics has a scale length of 32,768 counts (±15 bits). This extra resolution enables it to monitor a 1mV change in a 30 volt power rail, for instance, when a $4\frac{1}{2}$ digit meter would be limited to 10mV, and a $3\frac{1}{2}$ digit meter to 100mV. In addition, the high resolution virtually eliminates inaccuracy caused by digitising error since this is reduced by 0·003 per cent of full scale, compared to the basic accuracy figures of 0·05 per cent of reading.

Thirty measuring ranges are provided covering the five basic functions of d.c. and a.c. voltage, d.c. and a.c. current, and resistance. In addition, diode test and frequency measurement functions are included. Frequency measurement is achieved via a crystal controlled timebase, and is particularly useful for monitoring oscillators or checking microprocessor clock frequencies, etc. Maximum reading is 3999·9kHz with overflow to 7MHz.

The 1503 is housed in a high impact ABS case with a six-position tilt stand which doubles as a carrying handle. Although primarily intended as a laboratory instrument, very low power circuitry gives it 200 hours of operation from batteries, enabling it to be used as a fully portable field service multimeter. This low power consumption circuitry also eliminates drifts caused by internal heat generation and improves long term stability.

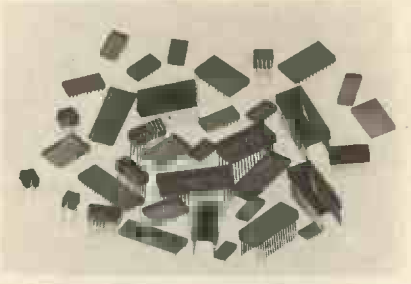
The price of the 1503 is £139 ex VAT and p&p.

Thurlby Electronics Ltd. Coach Mews, St. Ives, Huntingdon, Cambs. PE17 4BN.

LUCKY DIPS

The latest range of dual-in-line sockets from OK Machine & Tool for pluggable packaging of integrated circuits includes 8, 14, 16, 18, 20, 24, 28, 36 and 40 pin configurations with standard 0·1in (2·54mm) in-line spacing.

Virtually all SS1, MS1 and LS1 devices can be accommodated and in the case of the wire wrap versions the pins are suitable for three-level wire wrapping. The insulations are made of glass filled thermoplastic polyester and contacts are phosphor bronze. Pins are gold plated over nickel.



These sockets are complemented by a range of cable assemblies of varying lengths, to provide a high number of contacts in the minimum of space, together with high density 28-pin input/output sockets and plugs conforming to the basic 0·01in × 0·01in grid layout.

For further information, contact: **OK Machine & Tool (UK) Ltd., Dutton Lane, Eastleigh, Hants SO5 4AA. (0703 610944)**

VERO CASE

A pocket, hand-held box, ideal for housing remote control handsets, instruments etc., is the latest addition to the Vero range of cases.

It incorporates a 20×50mm cut-out slot which may be used for fitting panels or switches and a 12×35mm recessed panel for labelling. A circuit board 71×107mm can be accommodated in the top section of the two

part body by the use of four self-tapping screws, whilst the bottom section will house a board of 56×105mm. The two sections snap together and are secured by four screws through the base. There is an integral battery compartment which will accept a PP3 or a nickel cadmium stack of 25×45mm, it has a slide-off cover which allows easy access.

The price of the case is £12·47 excluding VAT and p&p.

Vero Electronics Limited, Industrial Estate, Chandler's Ford, Eastleigh, Hants SO5 3ZR.

AMBIT

Four new compact modules from Ambit can provide the ideal solution to many MPU data output decoding and display requirements.

Two versions (DM180/1) provide simultaneous decoding and display from multiplexed b.c.d. inputs. Additional options allow for either Hex or Code B displays. The DM180/1 will operate over a voltage range of 3·5V to 6V at 20µA in either the 3·5 or 4 digit display format.

The DM182/3 provides decoding and display using serial data inputs compatible with many types of MPU. At operating voltages of 3V to 15V current consumption is typically 60µA.

The modules which are priced at £10·99 excluding VAT and p&p measure 60×30×7mm and 12·5mm l.e.d.s with integral backlighting can also be supplied.

Ambit International, 200 North Service Road, Brentwood, Essex. (0277 230909).

A TO D INTERFACE

The ADC 1660 is a high speed 16 channel analogue to digital interface board which will connect directly into a standard Acorn 64 DIN bus. The unit provides A to D conversion of 16 inputs at a rate of 16K conversions per second to 8-bit resolution.

To the processor the card appears as a block of 16 memory locations which by using 12 d.i.l. switches can be placed in any of 4000 positions in a 64K map. No special software is required to control the interface, a write pulse from the processor to any of the 16 memory locations loads the analogue multiplexer with the four low order address bits and initiates the conversion sequence. Sample and hold timing is carried out on board and 60 microseconds later the conversion is complete. The processor can time out or an interrupt from the card can inform it that data is available to be read from the same memory location that was written to.

At present the ADC 1660 is available in eurocard form with a 64 way indirect connector for the Acorn bus, but can be link programmed to suit any other 64 way bus.

The ADC 1660 costs £82·00 in kit form, or ready assembled and tested with front panel and 34 way connector for £110·00.

Stoneage Electronics, The Cottage, 70 Albion Drive, London, E8 4LX. (254 4727).

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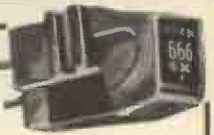

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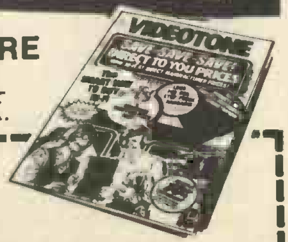

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PE/12/80

INDUSTRY NOTEBOOK

By Nexus

New Year

The political New Year which opened traditionally with the Political Party and Trade Union conferences has every promise of turbulence. Criticism of Government policy reached a new crescendo, as might be expected, but with a remarkable reversal of roles.

It takes a bit of getting used to when we see the more radical forces of the left becoming the new conservatives, with the reactionaries of the right making the pace in forcing radical change.

We all realise that politicians and trade union leaders need to make their views known in reasonable force but their choice of words and phrases is hardly consistent with fact. Thus, while everyone admits the need for change in industrial performance, we have seen the verbal description of such change progress from the neutral and moderate term rationalisation to restructuring, and now to the destruction of industry. Similarly, the population over the same period has moved from a comparatively mild state of misery, via suffering and sacrificing, to the ultimate crucifixion. The medical metaphor is also much in vogue, particularly on the delicate question of whether the cure will kill the patient.

Listening to the Jeremiahs you might imagine that the whole nation is in extremity whereas the truth is that the areas and industries most affected by the need for change have been problem areas and problem industries for decades and no government yet has found a satisfactory solution for them or is likely ever to do so.

On the broad economic front industry shows no sign of 'destruction' although, naturally, it is feeling the effect of economic squeeze at home and world recession abroad. Exports have been comfortably ahead of imports during past months and the aerospace and electronics industries are not only buoyant but have record order books. Overall, manufacturing industry output has declined seven percent over a period of a year which embraced crippling strikes in engineering and steel. In the circumstances a creditable performance.

On crucifixion, incomes have kept ahead of inflation and personal savings are near, if not at, an all-time high. And those wanting a late continental holiday were disappointed to find planes fully booked. Of course there is inconvenience, even hardship, deserving of every sympathy and assistance in individual cases, but even these hardly merit the 'crucifixion' label.

Employment

Employment is the most emotive issue, especially when presented in lurid terms as unemployment in numbers of people rather than percentage of the total workforce. The electronics industry finds itself in a unique position in this delicate area by simultaneously creating new jobs in a new industry while destroying existing ones in long-established industries.

Every new advance in industrial automation developed by electronic engineers and fabricated in an electronics plant has had a single purpose, that of increasing productivity per unit cost elsewhere. Thus, to give but one example, a battery of programmable numerically-controlled machine tools could, in theory, be supervised by a single operator rather than having a skilled manual operator for each machine. One of the tragedies of British industry over the immediate past years is that the attitude to such changes in manufacturing practice has been little different from that of the Luddites of 169 years ago. Hence, the tardy progress in modernisation and excesses in over-manning which are now being rectified at considerable social cost to the individual and to the nation as a whole.

At the same time the electronics industry itself has had to readjust to new work patterns resulting in changes of technology as well as to variations in markets. On the latter, one notes that the small-boat radar business of Decca is being discontinued by Racal, new owners. This is no surprise and is a result of being unable to compete commercially with Asian manufacture. Some 350 jobs are said to be at stake but transfers to more profitable areas within the Racal group and imminent retirement of other Decca people will ease the blow and enable most to be absorbed.

Improved technology rather than lack of market is said to be the reason for Thorn cut-backs at their consumer electronics plant at Colwick. The TX9 and TX10 television chassis were designed for easier assembly. Not only are there far fewer components (through LSI) but automated insertion means that assembly is far less labour-intensive.

In fact the number of people in electronics goods manufacture is increasing but only at a fraction of the rate of growth of cash turnover. There is still an increasing demand for engineers and technicians but the armies of girl assemblers once needed for wiring up and soldering are no longer required. The circuits are now supplied already wired in the shape of ICs and LSI from the semiconductor manufacturers, interconnected in PCBs, and are machine soldered in final assembly.

One can't help reflecting on the good fortune that the British electronics industry has remained comparatively free from Luddite attitudes, otherwise it would not and could not exist today.

Forecast

At the risk of treading hazardous ground I still forecast continuing prosperity for the electronics and aerospace industries. I include aerospace because of its huge electronic content. The two are interdependent, especially in the higher and more sophisticated branches of technology.

There will still be ups and downs, mainly in consumer electronics (a perennial problem) but taken as a whole, growth curve has got to be upwards.

I base this assessment on past and present performance of the larger well established companies on which, like the motor industry, many smaller companies feed, and on continuing investment such as the £8·5 million recently announced for expansion of GIM's plant at Glenrothes. There is also heartening news from Inmos with a promising development in a 16k static ram although we must wait to see how technical design is converted to production and sales.

Another favourable indicator is the exhibition scene. The Farnborough Air Show was the best for many years. The production equipment Internepcon show in its new home at the Brighton Conference Centre has 400 exhibitors, the greatest number yet. Also new to Brighton this year (from London) was the International Broadcasting Convention packed with professional studio and transmitting equipment from a whole gamut of companies from Acron Video to Zoom Television. Across the channel in Paris the British-run Automatic Testing 80 was also a success with a complete sell-out of space and record attendance.

There is every reason for cheer in high technology industries. They are actively doing, not just talking. They are also crying out for young numerate, literate and scientifically-minded recruits. And yet the National Union of Teachers and the Schools Council are reported as criticising the proposed core curriculum which calls for a minimum number of hours per week to be devoted to study—of what? You guessed right first time, the study of mathematics, English and science.

It is now abundantly clear that technology is the road forward. And this is the area where we can and do sell profitably to all countries including our own. Not only electronics but in other high technology areas, too..

I remain optimistic, at least for the technology-based industries. But even taken overall, for all industries, our export performance has consistently improved in cash terms over the years, more than doubling in the 'difficult' years of 1975-79. As I have often said in this column, the real high-fliers do well in good times and bad and there is plenty of life in the old dog yet.

Semiconductor UPDATE...

FEATURING IMS 1400 EF9365

R. W. Coles

THANKS FOR THE MEMORY

At last our very own "Silicon Valley" Company, Inmos, has lifted a corner of the veil to reveal a glimpse of the goodies to come.

In fact, the "Silicon Valley" tag with its California connections is not strictly accurate since the action is actually spread between plants in Colorado Springs, Colorado, U.S.A. and Bristol, Avon, U.K., with future production facilities scheduled for a site in South Wales. But apart from its geographical position(s) the Inmos outfit is every inch a progeny of "Silicon Valley", deeply engaged in the business of producing innovative yet practical microcircuits aimed at capturing a big slice of the billion dollar market of the 1980s. It would be terrifying really, if it were not for the fact that they are doing it all for us, the poor old British taxpayers! Everyone who knew anything about the deal must have been worrying a lot about the investment of all that hard earned money in a field where corporate fortunes are not only made, but lost. There was a lot of criticism when the deal was first announced, a lot of delay in making the second instalment of money available, and a long, long, wait before any hint of a return on the investment could be perceived—but now at last it begins to look like money well spent (Thank Goodness!)

The first device out of the Inmos stable, a 16K static RAM coded IMS 1400, looks like a real winner because it employs ingeniously different techniques to give a memory which has a larger capacity than any of its rivals, is faster, and is also potentially cheaper to produce. Innovation is the name of the game in the cut-throat memory market-place, as has been demonstrated by such giants as Intel and Mostek, but innovation alone is not enough, the clever new products have to be producable too, and producable in large enough volumes to swamp the competition. With the IMS 1400, Inmos appear to have made an excellent start. Until the IMS 1400, most memory improvements have been made by simply shrinking device geometries so that more and more cells could be squeezed onto a given area of silicon. While this has been an important process of improvement, it does mean that memories have been getting more and more difficult to produce. The Inmos approach does not depend on scaling but on changes to the circuit design used for each memory cell which together produce a more efficient element which is, in manufacturing terms, actually *simpler* than rival chips of lower capacity. The performance of the IMS 1400 is adequate for all present and projected microprocessor and minicomputer applications, and it exceeds by a comfortable margin the performance of today's fastest (but smaller) 4K 2147 device.

The IMS 1400 is housed in a 20 pin 0·3 inch wide package which has an extended version of the 2147 4K pin-out. The chip runs from a single five volt line and has a very low power consumption of 375 milliwatts (active) and 35 milliwatts (standby). Perhaps the most significant performance feature is the access time of just 30 nanoseconds, *too* fast for most of today's microprocessors, but useful for other memory applications currently filled by exotic and expensive bipolar devices of much lower capacity. As if all this alone wasn't enough to make Inmos a blue chip investment, the designers in Colorado Springs have hedged their bets by building in *spare* columns of memory cells which can be selected after chip fabrication by means of fusible links which map one or more of the spares into the active area to replace defective columns discovered during wafer test.

If future Inmos devices are as ingenious, I think I for one will retire on the proceeds!

ELECTRIC DRAWING BOARD

You can draw pictures on a CRT in one of two basic ways, direct vector or raster scan. In the direct vector scheme, lines are drawn by tracing them onto the tube face with a moving beam of electrons, in a scheme somewhat similar to that employed by an oscilloscope. To draw a line from A to B the beam is turned on in position A and the correct waveforms are applied to the X and Y deflection plates or coils to move the beam so that its intersection with the display surface describes a straight line on the screen. In raster scan on the other hand, a beam of electrons is constantly scanning the screen in TV raster format and the drawing of a straight line involves no out-of-sequence movement of the electron beam at all. With raster graphics, the screen is arbitrarily divided up into picture elements as "pixels" each of which has a unique bit reserved for it in the screen memory array. To draw a straight line, the start and end points are used to calculate which of the bit cells in the screen memory need to be "on". As the raster is built up, every memory location will be scanned in sequence, but only those bit cells which are "on" will cause the beam to excite the screen phosphors. The result is a line as before, although in this case the line may appear jagged if the screen memory resolution is limited.

The advantage of raster graphics lies in the fact that multicolour displays using readily available television monitors can be easily constructed, whereas direct vector systems need special long persistence tubes and cannot easily produce multicolour pictures.

Complete raster graphics systems are available from several manufacturers, and are widely used for engineering design and other similar applications where the cost is acceptable. Resolution is typically 512 × 512 pixels for a 625-line monitor, giving a memory requirement of at least 16K bytes per colour, a factor which has ruled out such desirable high definition graphics for home computer applications until now.

Thanks to cheap dynamic memory and a new chip from Thompson CSF, the EF 9365, all that is about to change and we can expect to see much wider application of the "Electric drawing board" in low cost systems. The new chip performs many of the functions currently performed by the proprietary raster display systems costing hundreds of pounds, yet it comes in a 40 pin package and will eventually cost less than £20! Teamed with a microprocessor and a group of dynamic RAM chips the EF 9365 will turn complex input specifications such as vectors, symbols, shapes and points of origin into the appropriate bit patterns in the screen refresh memory. To cater for the necessary but more mundane alphanumeric display requirement (to label graphics pictures for example) the Thomson device also has an on chip character generator for a full 96 character ASCII set. When drawing vectors on the screen, a mean writing rate of 1·36 milliseconds per pixel is possible, and when this device becomes freely available in 1981 we can expect to see a colourful revolution in microprocessor display peripherals.

SPECIAL OFFER!
IN CAR ENTERTAINMENT

PE has taken a pride in bringing readers some excellent offers over the months. Offers arranged to enable the purchase of technical products at exceptional prices. Back in April we arranged a special offer on Videotone speakers. That offer was so successful that Videotone have again come up with exceptional prices, this time on in-car-entertainment products, just for PE readers.

We believe these products represent incredible value for money, and that this is one of the best offers we have ever been able to arrange. The equipment and speakers on offer, shown and described here, are all covered by a full one year guarantee and money back facility if you are not satisfied.

£42

AM/FM STEREO RADIO AND AUTOREVERSING CASSETTE PLAYER

AS6123 20W HiFi GRADE SPEAKERS WITH 3 DRIVE UNITS ON SWIVEL MOUNT

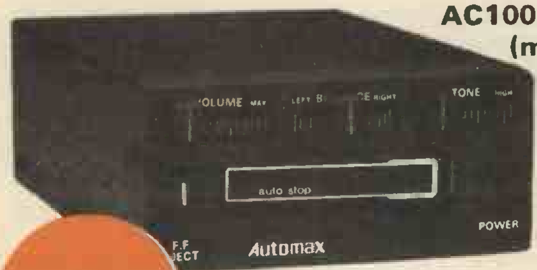
£17·50 PER PAIR

£17

AC200 STEREO 10W per channel (max.) CASSETTE PLAYER

AS4107 10W HIGH QUALITY WATERPROOFED DOOR MOUNTING SPEAKERS

£10·50 PER PAIR



AC100 STEREO 7W per channel (max.) CASSETTE PLAYER

£14·50

AS6111 15W WEDGE TYPE SPEAKERS WITH METAL GRILLE

£8·50 PER PAIR

ALL PRICES INCLUDE POSTAGE PACKING & V.A.T.

BASIC SPEC. FOR THE RADIO/CASSETTE PLAYER
AM 540 – 1605kHz, 20μV sensitivity (at 20dB S/N), 455kHz i.f.
FM 88 – 108MHz, 5μV sensitivity (at 30db S/N), 10·7MHz i.f., antenna impedance 75Ω unbalanced, l.e.d. stereo beacon, AM/FM/FM multiplex switch.
TAPE PLAYER Autoreversing, 4 track 2 channel stereo, wow and flutter <0·3% (WRMS), signal to noise >–40dB, crosstalk >–40dB, l.e.d. indication of tape direction, manual tape reverse button, fast forward and rewind.
GENERAL Output 7W per channel, frequency response 80Hz – 10kHz, output impedance 4 – 8Ω, supply voltage 12V (11 – 16V d.c.) **negative earth only,** tone, balance, volume and tuning controls, range switch, scale illumination, size 180 x 44 x 148mm deep, weight 1·9kg, supplied with fixings for in-dash mounting, in line fuse holder and fuse and instructions for mounting, wiring and operating the unit.

BASIC SPEC. FOR THE CASSETTE PLAYERS
Autostop, 4 track 2 channel stereo, wow and flutter <0·25% (AC200), <0·3% (AC100) WRMS, frequency response 50Hz – 12kHz, signal to noise <–45dB, fast forward time <180 sec. for C60 cassette, output impedance 4 – 8Ω, supply voltage 12V (11 – 16V d.c.) **negative earth only,** size 110 x 50 x 170mm deep (AC100), 110 x 55 x 170mm deep (AC200), loudness +7dB (AC200 only), supplied with fixing brackets, connecting plug, wire, in line fuse holder and fuse and instructions for mounting, wiring and operating, including circuit diagram.

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Countdown

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

Semiconductor International 80 Nov. 25–27. Metropole Convention Centre. **T1**
BEX 80 Nov. 26–27. Exhibition Centre, Bristol. **K**
Breadboard Nov. 26–30. Royal Horticultural Halls, Westminster. **T**
BEX 81 Feb. 4–5. Pavilion, Bournemouth. **K**
Microsystems 81 (exhibition and conference) March 11–13. Wembley Conf. Centre, London. **Z1**
INSPEX 1981 March 16–20. NEC, Birmingham. **Z1**
Seminex 81 (seminars only) March 23–27. Imperial College, London. **H1**
BEX 81 March 25–26. Metropole, Brighton. **K**
The Northern Electronic Test & Measurement Exhibition 81 March 31–April 2. Wythenshawe Forum, Manchester. **T**
Laboratory 81 April 1–2. Glasgow. **I**
BEX 81 April 8–9. Centre Hotel, Liverpool. **K**
Laboratory 81 April 8–9. Manchester. **I**
All Electronics Show 81 April 22–24. Grosvenor Ho., Park Lane, London. **F1**
Computer Graphics 1981 April 28–30. The Barbican Centre, London. **O**
BEX 81 April 29–30. Dragonara Hotel, Leeds. **K**
Entertainment 81 May 9–17 (weekday mornings trade only). NEC, Birmingham. **B2**
The European Consumer Electronics Show 81 May 10–13. Nuremberg, West Germany. **I**
The European Consumer Electronics Show 81 May 10–13, Nuremburg Fair Centre. W. Germany. (Trade) **I**
BEX Train May 11–22. Calling at: Cambridge, Norwich, Leicester, Sheffield, Newcastle, Middlesbrough, Hull, Nottingham, Reading and Portsmouth. **K**
Defence Components Expo 81 May 12–14. Brighton Metropole. **I**
Scotelex 81 June 2–4. Royal Highland Exhibition Hall, Ingliston, Edinburgh. **A1**
Semlab 81 June 2–5. Grand Hall, Olympia, London. The international scientific, educational; medical and industrial laboratory equipment exhibition. (Trade) **I**
Transducer Tempcon 81 June 9–11. Wembley Conf. Centre, London. **T**
Components 81 (Electronics Components Industry Fair) June 9–12. Earls Court, London. **I**
International Word Processing Exhibiton & Conf. 81 June 23–26. Wembley Conf. Centre, London. **Z**
Solar Energy Exhibition Aug.23–28, 1981. Brighton. **M**
Laboratory 81 Sept. 8–10. Grosvenor Ho., Park Lane, London. **I**
International Business Show 81 Oct. 20–29. NEC, Birmingham. **A2**
Electronics 82 (Sub-titles International Electronics Control and Instruments Exhibition) May 24–28, 1982. NEC. **I**

I Industrial Trade Fairs. ✆ 021-705 6707
K Douglas Temple Studios. 1046 Old Christchurch Road, Bournemouth
M Montbuild. ✆ 01-486 1951
O Online Conferences. ✆ 0895 39262
T Trident International Exhibitions. ✆ 0822 4671
A1 Institute of Electronics. ✆ 0706 43661
H1 Seminex Ltd. ✆ 0892
T1 Kiver Communications UK, Millbank House, 171–185 Ewell Road, Surbiton, Surrey KT6 6AX.
Z1 IPC Exhibitions Ltd., 40 Bowling Green Lane, London EC1R 0NE. ✆ 01-837 3636
A2 Hart Browne & Curtis Ltd., 29 Sackville Street, Piccadilly, London W1X 1DR. ✆ 01-439 8556
B2 Brintex Exhibitions Ltd., 178–202 Great Portland Street, London W1N 6NH. ✆ 01-637 2400

PE MICROTUNE

MARTIN KENT

THE PE MICROTUNE is a general-purpose automotive tester which, as well as featuring *volts, amps* and *resistance* measurement, can also check *r.p.m.* and ignition *dwell angle*. The voltage and current ranges also have an a.c. function, making the meter extremely useful on car radios, cassettes etc., as well as being suitable for general electrical or electronic diagnostic use. The digital read-out gives a far higher accuracy than is attainable from analogue "pointer" type meters. Use of an l.c.d. display gives large, easily read digits, visible even in bright sunlight, and giving very long battery life.

A total of seven functions (DC Volts, AC Volts, DC Current, AC Current, Resistance, RPM, Dwell) and twenty ranges, makes this the most versatile car tester yet. It is suitable for use on positive or negative earth vehicles, fitted with normal or electronic ignition, and *four, six* or *eight* cylinder engines are catered for.

MICROTUNE BASICS

As with the PE DMM (July 1980), the Microtune uses the Intersil 7106 as the heart of the instrument, the single range voltmeter. This is a 3½ digit analogue to digital convertor, which drives an l.c.d. display directly. The July article outlined the operation of a dual-slope A/D Convertor, so the explanation will not be repeated.

The heart of the instrument is the single range 200mV voltmeter formed by IC1, the 7106. The input impedance is greater than 100MΩ, to ensure that negligible current is drawn from the circuit under test. An input filter to limit noise voltage is formed by C6 and R6; the latter also increases the overload protection by restricting the input currents. An on-chip reference voltage is provided at pin 32 of IC1, which is maintained at approximately 2·8V *below* the positive supply rail. The voltage reference is the critical part of any A/D convertor as all inputs are compared against it. To optimise reference stability, a bandgap voltage reference IC3 is used, which operates from the on-chip 2·8V reference. The reference voltage output of bandgap devices depends inherently on the properties of transistor junction potentials. The V_{be} of a junction depends upon bulk properties and doping levels of the semiconductor material; its long term stability being essentially unaffected by surface phenomena. A potential divider is formed by resistors R3, R4, R5, and VR1 to adjust the 1·2V output of IC3 and produce an extremely stable 100mV reference, while C7 eliminates any noise voltages.

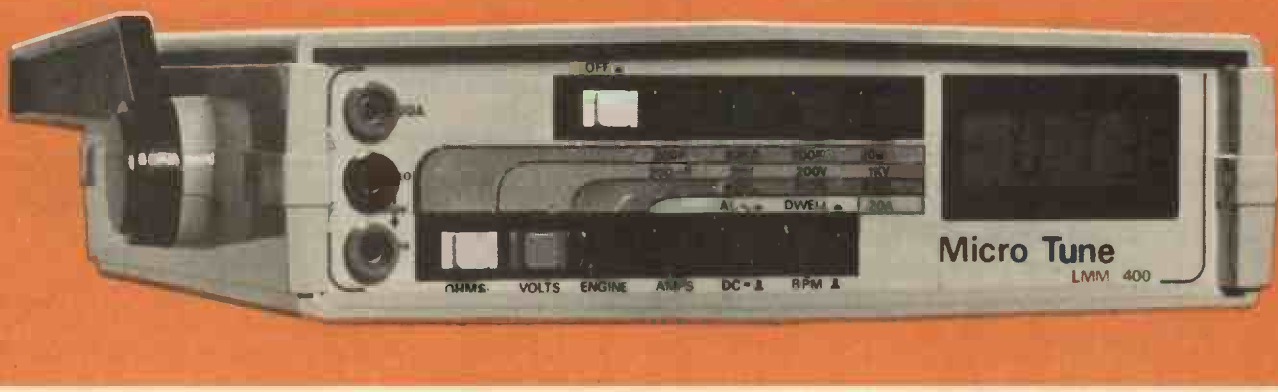
The frequency of the interval clock oscillator is controlled by C5 and R2, the values chosen providing a frequency of approximately 48KHz, to produce a conversion rate of three readings per second with good rejection from 50Hz pick-up.

The A/D convertor is inherently auto-zero in its' operation, such that when the inputs are shorted together the digital outputs are guaranteed to be zero, to eliminate the need for offset adjustments. The auto-zero capacitor C2 prevents noise voltages affecting the above function. The integrator time constant is set by C1 and R1.

DISPLAY REQUIREMENTS

The 7106 drives liquid crystal displays direct and the square wave backplane signal is provided at pin 21. L.c.d.s require a.c. drive signals since steady d.c. potentials can burn-in the segments. For a particular segment to be turned on, it must be driven by a signal of equal amplitude but opposite phase to the backplane signal.

Voltage comparator integrated circuits are designed to produce a logic "1" output when the difference between the inputs is positive and a logic "0" when the difference is negative. This is the basis of the auto-polarity circuitry within IC1 which drives the negative polarity bar directly from pin 20. Decimal points are selected by sections of the range switches S2-S5 and the correct l.c.d. drive is provided by dual-input EXCLUSIVE-OR gates within IC4. Examination of the truth table of an EXCLUSIVE-OR gate will show that the output is high if one or other of the inputs is high, but the output is low if both inputs are high. If one of the inputs is used as a control input, when it is low it will allow through the gate a high or low level, as applied to the second input. When the control input is high it will invert the level applied to the second input. Resistors R7, R8 and R9 hold the control inputs, pins 8, 13 and 6 of IC4, at a normally low level by using the test output, pin 37, of IC1. The backplane signal is applied to IC4 pins 9, 12, and 5. When a control input is



...ENGINE TUNE-UP UNIT
Part One

taken to a high level by the range switch, the respective gate acts as an invertor to provide an output in antiphase to the backplane input and so provide the required l.c.d. drive signal.

When using battery-operated instruments, it is important to know when the battery voltage is dropping to a level where performance of the instrument may be impaired. The liquid crystal displays supplied by Lascar have "LO-BAT" wording which can be turned on when the battery voltage has dropped such that 20 per cent of useful life remains. The operator therefore receives advance warning of battery failure while being able to maintain accurate readings until the battery can be changed.

A potential divider is formed across the supply rails by R10 and R11. When the supply voltage drops to approximately 7 Volts TR1 collector is taken high and IC4d becomes an invertor for the backplane signal, and turns on the low battery warning display segments.

INPUT CONDITIONING

All of the signal inputs to the Microtune must be converted to 0-200mV d.c. levels to ensure compatibility with the A/D convertor.

(a) D.C. VOLTAGE AND CURRENT MEASUREMENT

Four d.c. voltage ranges are provided with f.s.d. of 200mV, 20V, 200V and 1KV. The four range switches S2-S5 are interlocked with the Off Switch S1 such that any range selection switches the instrument on. Sections of the function switches then select appropriate areas of circuitry to minimise current drain in unwanted circuitry. Switch S1b also isolates the main signal input when the power is off to prevent damage to the A/D convertor. When the Voltage function is selected by S7, the input is applied to the 10MΩ attenuator formed by resistors R13-R18 which are extremely stable 0·25 per cent metal film types. On the 200mV range the input is routed directly to the A/D convertor, whereas the higher range switches select the appropriate attenuation point.

Voltage dependent resistors R21-R23 are connected across the input terminals to clamp any transient high voltage spikes which may otherwise cause damage to the instrument. A VDR normally exhibits extremely high resistance such that it does not affect measurement accuracy but when the threshold voltage is exceeded the device alters rapidly to a low resistance to shunt out transients.

A single current range of up to 20A is provided via a separate input terminal to avoid high currents flowing through the switches. To convert the input current to the required voltage requires a shunt resistor of value 10mΩ and whilst this value is available such resistors are very expensive. The cost of such resistors may be eliminated by using the p.c.b. track and recalling that the resistance of an element is given by its' resistivity (p), length and cross-sectional area.

$$\text{Resistance, } R = \frac{pl}{A} \text{ ohms}$$

The industrial standard copper laminate fibre-glass board used for p.c.b. manufacture uses 1oz. (0·035mm thick) copper coating. The track width was chosen first to restrict the temperature rise to 20 deg. C with 20A flowing, and then the cross sectional area was calculated. From the resistivity of annealed copper, the length of the required track for a resistance of 10mΩ was then calculated.

No protection is provided on the current range and care must be exercised when connecting this range in circuit.

The d.c. voltage developed across the shunt resistor R24 is switched by S9a, and the decimal point on the display is set for 19·99A by S9b.

(b) A.C. VOLTAGE & CURRENT MEASUREMENT

When a.c. functions are selected by S10, capacitor C8 is connected in series with the input to remove any d.c. component. Voltage inputs are fed through the 10MΩ attenuator as before and current input is applied to the shunt resistor.

Integrated circuit IC5 is a TL061 operational amplifier, connected as a precision rectifier. Alternating inputs are rectified by diodes D4 and D5 with the positive component

SPECIFICATION

FUNCTION	FSD	RESOLUTION	ACCURACY
VOLTS (DC)	200mV	0·1mV	0·5% ± 1 Digit
	20V	10mV	
	200V	100mV	
	1kV	1V	
CURRENT (DC)	20A	10mA	5% ± 2 Digits
VOLTS (AC)	200mV	0·1mV	0·75% ± 5 Digits
	20V	10mV	
	200V	100mV	
	1kV	1V	
CURRENT (AC)	20A	10mA	6% ± 5 Digits
RESISTANCE	200Ω	100mΩ	0·5% ± 1 Digit
	20kΩ	10Ω	
	200kΩ	100Ω	
	20MΩ	10kΩ	
RPM	20,000RPM (4, 6 or 8 cylinders)	10RPM	1% nominal ± 3 Digits
DWELL	200° (4, 6 or 8 cylinders)	0·1°	2% nominal ± 3 Digits

COMPONENTS . . .

Resistors

R1, R36	47k	Carbon film 5% (2 off)
R2, R20, R30	100k	Carbon film 5% (3 off)
R3, R5	1k	Carbon film 5% (2 off)
R4, R27, R28	18k	Carbon film 5% (3 off)
R6, R26	10M	Carbon film 5% (2 off)
R7–R10, R12, R25	1M	Carbon film 5% (6 off)
R11, R19	220k	Carbon film 5% (2 off)
R13	9M	Metal film 0·25%
R14	900k	Metal film 0·25%
R15	90k	Metal film 0·25%
R16	9k	Metal film 0·25%
R17	900R	Metal film 0·25%
R18	100R	Metal film 0·1%
R21	VDR	400V
R22	VDR	400V
R23	VDR	400V
R24	10mΩ	P.c.b. integral
R29	6k8	Carbon film 5%
R31	Thermistor	PTC, 1k, 260V a.c.
R32	100k	Carbon film 5%
R33	470R	Carbon film 5%
R34, R45	3k3	Carbon film 5% (2 off)
R35, R39, R41, R44, R46, R47	10k	Carbon film 5% (6 off)
R37, R38	27k	Carbon film 5% (2 off)
R40, R50	1k	Carbon film 5% (2 off)
R42	2k2	Carbon film 5%
R43	4k7	Carbon film 5%
R48	6k8	Carbon film 5%
R49	910k	Carbon film 5%

Variable Resistors

VR1	2k	Multiturn cermet
VR2-VR4	5k	Multiturn cermet (3 off)

Capacitors

C1, C14	220n	Polyester (2 off)
C2	470n	Polyester
C3, C10–C12, C15	100n	Polyester (5 off)
C4, C6	10n	Polyester (2 off)
C5	100p	Polystyrene
C7, C9, C13	10µ	Tantalum bead 16V (3 off)
C8	20n	Ceramic disc 2,000V
C16, C17	22µ	Tantalum bead 16V (2 off)

Semiconductors

D1	IN4004	
D2-D5, D8, D10, D11	IN4148	(7 off)
D6, D7	BZY88	5V6 (2 off)
D9	BZY88	2V7
TR1	BC237	
TR2	MPSA42	
IC1	ICL7106	
IC2	LCD106	
IC3	Teledyne	9491 or Ferranti ZN423
IC4	4070	
IC5	TL061	
IC6	LM2907-8	
IC7	LM324N	

Switches

S1-S5	4PDT	All interlocked, Bank 1	
S6	8PDT	All interlocked	Bank 2
S7, S8	4PDT	All interlocked	Bank 2
S9	DPDT	All interlocked	Bank 2
S10	6PDT		Bank 2
S11	DPDT		Bank 2

Miscellaneous

Strips of 20-way soldercom pins (2 off)
Nylon soldercon nests (2 off)
20mm p.c.b. fuse clips + 2A fuse
PP7 batteries and connectors (2 off)
Printed circuit boards (3 off)
15-way p.c.b. mounting socket
10-way p.c.b. mounting plugs (2 with long pins) (4 off)
Ribbon cable, 10-way with end sockets
Through-board pins (22 off)
4mm input terminals (2 red, 1 black) (3 off)
Springs (2 off), nuts and screws etc.
Case kit, comprising top, bottom, front panel, rear panel, sides/carrying handle, four feet with screws.

Constructors' Note

A complete kit of all parts for the PE Microtune, including batteries and test leads is available from Lascar Electronics Ltd., Unit 1, Thomasin Road, Burnt Mills, Basildon, Essex SS13 1LH, price £69·80 which includes p&p and VAT. A calibration and fault finding service will also be offered.

sampled by R26 then filtered by R30 and C12. The op-amp has a j.f.e.t. input resulting in high input impedance, and the supply current is typically 250µA, which makes it ideal for battery operation.

The circuit is mean-sensing and calibrated to indicate the r.m.s. value of sine wave inputs by adjustment of VR2.

(c) RESISTANCE MEASUREMENT

One method of measuring an unknown resistor is to apply a constant current and measure the voltage developed across the resistor. The PE DMM used such a method but the Microtune with its increased space to provide more intricate switching, uses a more streamlined method of resistance measurement. The Intersil 7106 analogue inputs are fully differential as are the reference voltage inputs. In the normal mode of operation a fixed reference voltage is applied to the 7106 and the signal input voltage is measured as a ratio of the reference voltage and the digital reading is $1000\frac{Vin}{Vref}$. So that with a 100mV reference, an input of 100mV would be read as 100·0. For resistance measurement the arrangement shown in Fig. 2 may be used.

The bandgap reference IC3 forms a stable voltage source which is applied across the reference resistor Rr and the unknown resistor Rx.

The voltage developed across each resistor is dependent upon the ratio of the two resistors and the ratiometric method of operation of the 7106 permits the value of the unknown resistor to be read directly.

$$\text{Reading} = 1000\ \frac{Rx}{Rr}$$

The reference resistor is selected from the input voltage attenuator resistors, to avoid expensive duplication, by S2-S5 and is in reverse order to the voltage settings. The value of Rx is 100Ω for the 200Ω range, 10kΩ for the 20kΩ range etc.

A simplified form of the instrument circuit with the 200Ω range selected for resistance measurement is shown in Fig. 3 to clarify the switching.

Resistance measurements should not be made on live circuits, however protection is included to prevent damage to

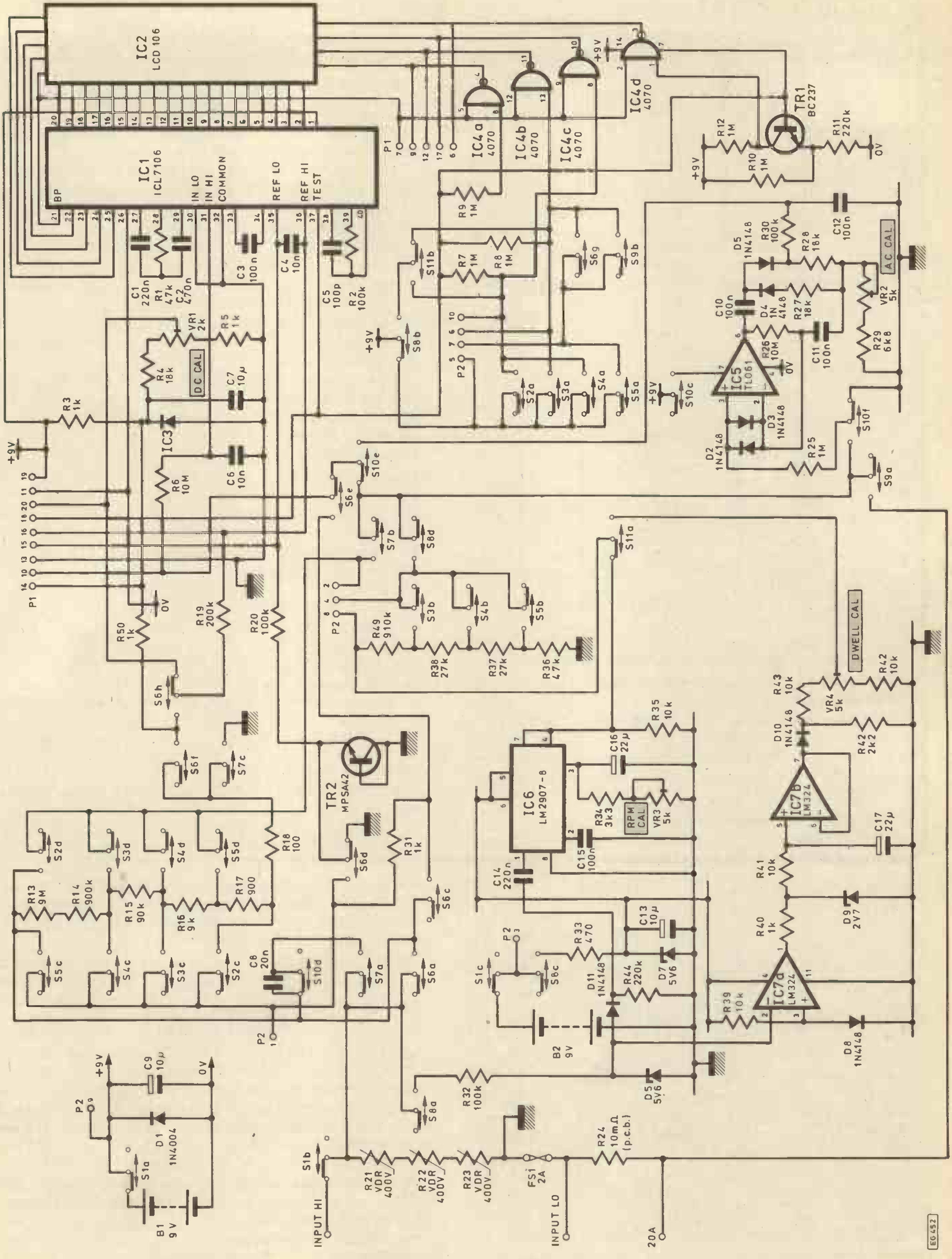
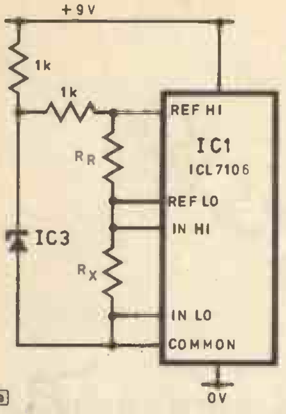


Fig. 1. Full circuit diagram.



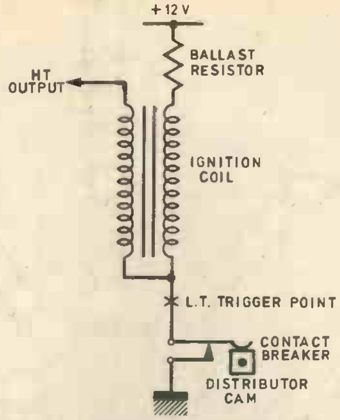


Fig. 2. Ratiometric resistance measurement

Fig. 4. Ignition system triggering

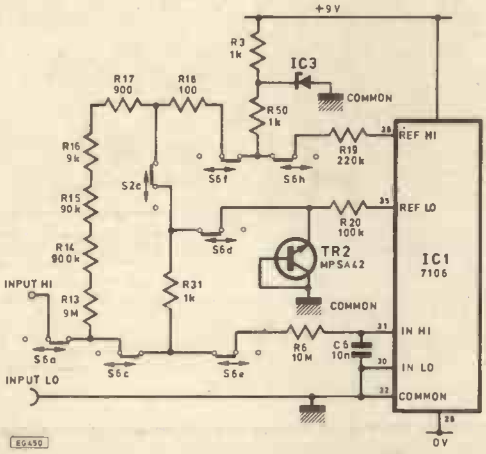


Fig. 3. Switch configuration for resistance 200Ω range

the instrument against applied high voltages. Transistor TR2 will turn on at approximately 10V and shunt the applied voltage. Thermistor R31 has a nominal value of 1kΩ at room temperature, but when TR2 draws current through R31 the thermistor temperature rises and due to the positive temperature coefficient the resistance increases so limiting the input current.

(d) R.P.M. MEASUREMENT

The measurement of engine r.p.m. can be very useful when servicing cars and we shall see later that specific tests carried out whilst monitoring the speed of an engine enable its efficiency to be optimised.

Although the internal combustion engine has changed very little over the years, there have been distinct changes in the area of the ignition system. A large number of new vehicles still employ the conventional contact breaker, driven from the distributor, to trigger the ignition coil and hence produce h.t. voltage to the sparking plugs. However, an increasing number of engines are being fitted with electronic ignition units usually triggered by the contact breaker, and capable of producing higher voltage at the sparking plugs from lower supply voltages. Some electronic ignition systems dispense with the mechanical contact breaker and are triggered by a Hall effect switch which detects the passing of a magnetic vane to control the timing. Amidst the variety of ignition systems, one component usually remains unchanged and that is the ignition coil. By monitoring the triggering of the ignition coil, measurement of engine r.p.m. may be made without the need for expensive transducers.

Fig. 4 shows the simplified ignition arrangement of a negative earth vehicle.

For a four-stroke engine, the distributor shaft rotates at half the speed of the crankshaft and the number of trigger pulses applied to the ignition coil is given by:

$$\text{Pulses/Min} = \frac{\text{r.p.m.} \times \text{number of cylinders}}{2}$$

alternatively,

$$\text{r.p.m.} = \frac{\text{Pulses/Min} \times 2}{\text{Number of cylinders}}$$

Therefore, for a given engine, the r.p.m. varies linearly with the pulses/min applied to the ignition coil.

Measurement of the pulse rate is most easily carried out by conversion to an analogue voltage with a frequency-to-voltage convertor and then measuring the d.c. voltage on the 7106-based voltmeter.

The basic diode pump circuit is dependent upon pulse width and amplitude but may be improved by feeding it from monostable which delivers a pulse of fixed amplitude and duration each time the ignition coil is triggered.

Integrated circuit IC6 is a monolithic frequency-to-voltage convertor based upon a charge pump whose output voltage is buffered by an op-amp.

Due to the ignition coil inductance, high transient voltages can be found superimposed upon the normal 12V trigger pulse on the coil primary and the input voltage to the f/v convertor is clipped by R32 and D6. The input signal is fed through C14 as the comparator input is required to pass through zero to ensure correct triggering. The output voltage of the LM2907 is referenced to its power supply zero volt line but the 7106 input is not able to operate down to its zero volt line, therefore a separate supply is used for the tachometer section. Output voltage is proportional to timing capacitor C15 and load resistor R34 + VR3, whereas filter capacitor C16 suppresses ripple but will also lengthen the convertor response time. Resistors R49 and R36-R38 form an attenuator to reduce the output voltage when switching between 4, 6 and 8 cylinders, since r.p.m. is inversely proportional to the number of cylinders as shown earlier. Full scale output of IC6 is set at 2V.

The normal range-switch selection of decimal points is overriden on engine functions by S8b, and S11b sets the d.p. for 19·99 (x1000) r.p.m. for 4, 6 or 8 cylinders.

(e) DWELL MEASUREMENT

Each vehicle has a specific dwell angle quoted for the distributor and is the angle through which the contact breaker cam rotates whilst the points are closed. Adjustment of the dwell angle is very important to ensure correct combustion and the angle may be measured by comparing the points open time to points closed time, or duty cycle. The cam has a number of lobes equal to the number of cylinders such that a four cylinder engine will have four lobes spaced 90° apart and the dwell angle is usually slightly less than two-thirds of the cam lobe angle.

$$\text{Dwell angle} = \text{cam lobe angle} \times \frac{100\%\text{—Duty Cycle}}{100\%}$$

The instrument is connected to the same coil primary connection as used when measuring r.p.m. and the input voltage is fed to IC7 which is an LM 324 quad op-amp. The first stage acts as a comparator whose threshold voltage is set at approximately 1V by R39 and D8. The rectangular output of IC7a is an inversion of the input such that the points-closed time is active "high" and clipped to constant amplitude by R40 and D9.

The clipped signal is integrated by R41 and C17 to obtain the average value which is then buffered by IC7b and the 600mV offset is removed by D10. The output voltage is adjusted by R42, R43 and VR4 to produce a 2V f.s.d. proportional to dwell angle.

NEXT MONTH: Construction and Use.

NEXT MONTH

PE STARSPINNER

Most people have seen the fascinating rotating and radiating displays available from modern "zoning" or "matrixing" lighting systems. The *PE Starspinner* can produce 62 dynamic effects of this type plus two static effects and a sound to light advance facility—full circuit and construction details start next month.

SOLAR POWER SATELLITES

Will solar power solve our energy problems? Can we build the satellites? How will they work? When will they be available? How much will it all cost?

For answers to these and other questions the SPS raise, see our article next month.

INTERFACING COMPUKIT

Computers make smashing toys but sooner or later they must pay for their keep by doing some real work. Next month we start a series on interfacing the UK101 with the outside world, using such things as joysticks, l.d.r.s, power controllers, D/A and A/D converters, etc.

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PRACTICAL

ELECTRONICS

OUR JANUARY ISSUE WILL BE ON SALE ON FRIDAY, DECEMBER 12, 1980

PE *Master Rhythm*

Part 1 *A.J. Boothman* B.Sc.

IT is some twenty years since the first commercial attempts were made to simulate the role of a drummer using electronic principles, and despite continuous criticism of monotony and lack of instrument quality the utilisation of this type of musical aid has grown enormously to the present time where, in addition to almost universal incorporation into commercial electronic organs, it is used by Spanish guitarists in Tenerife, Greek singers in London restaurants, Scottish dancers and by practice musicians anywhere.

DEVELOPMENT

Basic design philosophy has changed little over the twenty years but the method of realisation has altered continuously along with the advances made in semiconductor technology. Ignoring tape playback systems early rhythm generators contained a limited number of simple patterns programmed during construction by a diode matrix. This type of system has had a long life and to many musicians its pattern simplicity is still preferable to many of the later "advancements". The advent of high capacity semiconductor memories seemed to provide the perfect answer to rhythm pattern generation—four, eight, twelve, sixteen rhythms on a single chip—then twenty four or more plus extra instruments and measures per bar using multiple chips.

All this looked marvellous, however the technique depended on the fixing of the patterns and instrument channels during the latter stages of manufacture of the integrated circuits and what i.c. manufacturer or commercial electronic musical instrument design house could resist putting in the most complex patterns possible to give his equipment the gimmick appeal required by the general public. Hence the next generation of design realisation known as "Cancel Buttons". This allows a degree of low pass gimmick filtering and there present systems have rested.

The ability to leave the programming function to the musician has been restricted by the relatively slower development of read/write memories, commonly known as RAMs, as opposed to read only memories, or ROMs. This situation has only fairly recently changed in two important respects, the size of RAM available at an economic price and the standby power required to retain the patterns in an easily reprogrammable memory between periods of active use. The CMOS technique of semiconductor manufacture now gives reasonably low cost i.c.s which may be easily configured to give a 4096 bit capacity, similar to the common preprogrammed rhythm generator ROMs, with instant user programming and reprogramming capabilities and a standby data storage current of a few microamps.

The *PE* Master Rhythm makes use of this type of integrated circuit to give a small easily constructed rhythm generator on two p.c.b.s which is completely under the programme control of the musician. At the end of the series a full set of patterns will be given which may be used by the constructor to gain familiarity with the operation of the instrument. These are open to experiment and can be used as a base for further rhythms.

SPECIFICATION

Control Facilities

RHYTHM PATTERN SELECTION—Twelve Dual Section Positions.

Switch Positions	Measures Per Section (A and B)
One to four	Twelve or sixteen
Five to eight	Sixteen
Nine and ten	Thirty two
Eleven and twelve	Twenty four or thirty two

Section and Sequence Operation (Two switches)

Section Switch Position	Sequence Switch Position	Section in Operation
One	Any	A only
Two	Any	B only
Three	One	A then B
Three	Two	3A then B
Three	Three	7A then B

Cymbal Control (Three positions)

Switched—(1) Play programme, (2) Off, (3) Continuous.

Program Control (Ten positions)

Program (write) Tracks—Eight

Play (read) Mode—Two positions

Instrumentation (Three position control)

TRACK	STICK	BRUSH	L–A
Eight	Accent	Accent	Accent
Seven	Short Cymbal	Short Cymbal	Short Cymbal
Six	Long Cymbal	Long Cymbal	Long Cymbal
Five	Rim-Shot	Short Brush	Claves
Four	Snare Drum	Long Brush	High Bongo
Three	High Tom-Tom	High Tom-Tom	Low Bongo
Two	Low Tom-Tom	Low Tom-Tom	Conga Drum
One	Bass Drum	Bass Drum	Bass Drum

Memory Capacity—4,096 bits configured as 512×8

Power Source—4 x HP7 or similar

Operating Current—Typically less than 10mA

Standby Current—Typically less than 10µA

Nominal Output—100mV into 50kilohm

Approx. Dimensions—$8\frac{1}{2}$in x 5in x $2\frac{1}{2}$in

SCOPE OF THE INSTRUMENT

This instrument is capable of storing between twelve and twenty four selectable rhythmic patterns, invented, modified, and entered by the operator onto eight instrument tracks. A three position "Instrumentation" control expands the number of instruments available to twelve, grouped into sounds typical of playing with drumsticks, brushes, or on Latin American bongos and claves. The incorporation of pattern sections containing twelve, sixteen, twenty four, and thirty two measures per section, coupled with dual section selection on the main "Rhythm Select" control which allows a continuous pattern of up to sixty four measures, a wide range of complex patterns may be reproduced.

RHYTHM CAPACITY

Each position of the "Rhythm Select" control selects a portion of the memory, split into two sections A and B. The "Section Selector" switch can isolate each section which may therefore contain totally different repeating patterns for a maximum capacity of twenty four discrete rhythms. However the two sections may be programmed with related rhythms, the B section for example containing a drum roll pattern or turn-round riff which will only be played if the "Section Selector" is set to the "B" or "Sequence" position. In the latter case the sequencer switch will determine how often the B pattern appears which on the first eight rhythms can be switched to alternate bars, four bar repetition, or eight bar repetition. Rhythm positions nine to twelve contain double length patterns—i.e. twenty four or thirty two measures per section, and whilst the longer sections may be used to give more measures per bar, they may also be programmed as two bars each which extends the maximum sequence to sixteen bars.

PLAY MODE

When the instrument is set in the play mode depression of the "Play" switch starts the rhythm sequence which continues until "Rest" is depressed. The start of the pattern is indicated by a pulse on the l.e.d. Restart will always be at the commencement of the pattern and sequence, and the "Section Selector" and "Sequence" switches may be altered at any time during the play condition without disturbance to the synchronisation of the rhythm. The "Instrumentation" and "Cymbal" switch positions may also be altered during performance to introduce further variety as required.

INSTRUMENTATION

The memory system can be considered as an eight track digital recorder in which recording is executed one track at a time and playback occurs on eight simultaneously. Using the "Instrumentation" control the eight tracks may be fed to one of three groups of instruments as shown in the specification. The instruments will be familiar to the reader except possibly for "Accent" which allows a degree of dynamics to be introduced into rhythm patterns giving a more realistic result.

The "Cymbal" control normally selects the pattern contained on the relevant programmed track, but it also has positions to either cancel sound from the "Short Cymbal" or cause it to operate continuously—e.g. in a 16s mode.

PROGRAM MODE

The program mode is automatically attained by moving the "Program Control" to any of the eight instrument track positions. Prior to carrying out this operation the Master Rhythm should be run in the play mode and the "Rest" button depressed to ensure that the rhythm pattern is at its starting point. This will be indicated by illumination of the l.e.d. as the program mode is selected. During programming the "Sequence" control should be in the "A+B" position and the operator can choose to programme "A" and "B" either separately or together by the position of the "Section Select" control.

The "Instrumentation" and "Cymbal" switches can be set to any position during programming. Corresponding instrument sounds will be heard as the rhythm pattern is developed, but the sounds on playback will be determined by the switch settings at that time.

When an instrument track is selected on the "Program Control", depression of the "Play" button dictates that the relevant instrument will play during that measure of the pattern. Depression of the "Rest" button keeps the instrument silent for the corresponding measure. Thus for four beats on sixteen measures per bar the pattern of one "Play" plus three "Rest" is pressed four times. In formulating a complete rhythm this action is repeated on each of the eight instrument tracks, an operation which soon becomes very quick. An individual track may be chosen for modification at any time without disturbing the other tracks. All instruments previously programmed plus the instrument under current modification, play during programming which allows a continuous audible check on the growing rhythm pattern.

PATTERN STORAGE

The play mode is automatically regained by turning the "Program Control" to either of its extreme switch positions, and the programmed information will be retained in the memory until modified, provided that the battery continues to give the required standing storage current of typically 5μA and does not fall below 2V, which represents virtually a shelf life condition for the battery. When a battery change becomes necessary, indicated by a loss of instrument quality, the battery may be removed for up to five minutes without the loss of the rhythm patterns.

MEMORY OPERATION

The heart of the unit is the block of four CMOS memories type 5101. These are 22 pin packaged devices each containing 1024 memory cells arranged as 256 rows four columns wide. By interconnecting the four integrated circuits in a series parallel configuration the final memory has 512 rows, eight columns wide.

Fig. 1 shows the operation of a single 5101 in simplified form, indicating that the chip consists of a set of memory cells plus control circuits. Each row in the memory has a unique address which can be selected by the voltages present on eight address lines due to the normal binary relationship of $2^8 = 256$. Thus for one combination of address input voltages only one row will be selected. In the unit some of the address lines are connected to the "Rhythm Select" switch which defines the row at which the pattern will start, whilst the others are connected, via the "Section" and "Sequence" switch logic, to a counter which automatically increments the row selection process up to the point at which the pattern is intended to be repeated.

When a row is selected the four corresponding memory cells are potentially available at both inputs and outputs. A read/write control line ensures that information can be put into the memory only when the control line voltage is low, and this is inserted on the rows (measures) as required using a positive voltage equal to the supply to indicate that an instrument requires to be played. On playback, with the read/write control line high, pulses will appear at the outputs to drive the instrument circuits when required.

Two chip selection control lines are also provided in the 5101, one of which, $\overline{CE1}$, causes the chip to be active when its input is low and the other, CE2, when high. Unless both inputs are in the corresponding active states the chip presents an open circuit at its outputs preventing any influence on other chips which may be connected into the system. Thus $\overline{CE1}$ is used in a similar manner to the address lines allowing selection of only the first pair of i.c.s with 256 rows and eight columns, or only the second pair of i.c.s with a further 256 rows giving 512 total. CE2 is used by the system clock which beats at one pulse per musical measure, to pulse the chosen address to give the output drive pulses to the instruments.

The remaining connections to the memory are its single supply and ground plus the grounding of pin 18, OD, which is not used in this application. The relative timing and periods of various activities in this integrated circuit are important and are covered by the detailed circuitry.

SYSTEM OPERATION

A schematic of the system is given in Fig. 2, ignoring the detailed operation of the memory. The mode detector senses whether the "Program Control" switch is in either of the two play positions and signals the mode switching circuitry accordingly. This holds the read/write control voltage up to ensure that when the "Play" key is pressed, and its output latched, the clock will start and be fed through the counter, "Sequence" and "Section Select" switches, to the memory address inputs, coupled with the fixed starting address determined by the position of the "Rhythm Select" switch. A pulse is also transmitted to the chip select inputs CE2 for each measure within the rhythm pattern, and the down beat indicator is pulsed for each twelve or sixteen measure period. The memory output pulses are fed to the instruments via the "Instrumentation" and "Cymbal" selectors where applicable.

When the "Program Control" is in an instrument track position the mode detector gives a high output which sets the mode switching circuitry such that the counter is disconnected from the clock but increments on each depression of the "Play" or "Rest" key. High and low level signals corresponding to play and rest respectively pass through the "Program Control" switch to the instrument track selected and replace the level previously stored in that memory cell as a falling pulse is applied to the read/write control input from the mode switching network. The instrument tracks not selected at this time retain the previously recorded information due to the prior state feedback network.

CONTROL CIRCUITS

The complete control circuit detail is shown in Fig. 3. NAND gates IC1c and IC1d form the latch, one output of which is fed to the "Program Control" switch. Resistor network R17 and R18 produces a voltage of approximately 3V at the inputs to the two comparators which make up the mode detector, leading to a detector output of approximately 6V. However when the "Program Control" switch is in either of the "Play" positions the resistor network is overcome and the detector input becomes 0V or 6V dependent on the state of the latch connected to "Play" and "Rest" keys. In either case the detector output becomes zero which prevents any signals passing through IC2b to the write enable portion of the circuit. Under these circumstances the clock, which comprises IC1a and IC1b, is connected via IC2c and IC2d to

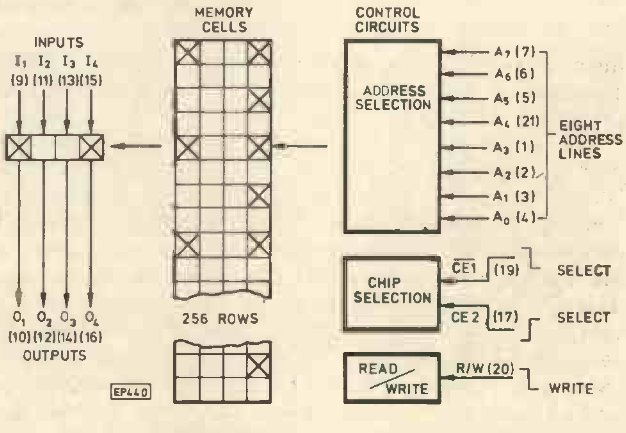


Fig. 1. Showing simplified operation of a 5101

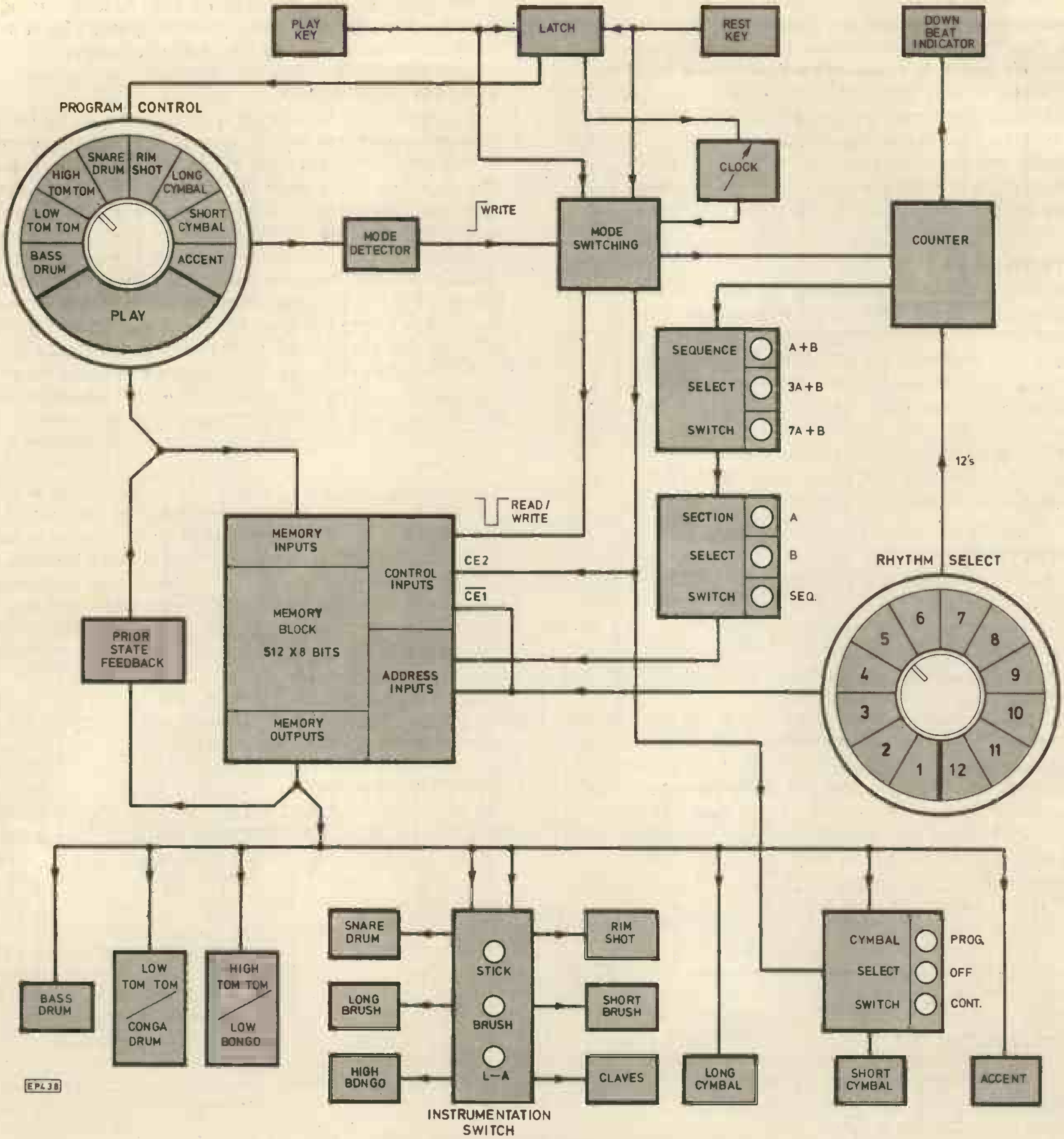
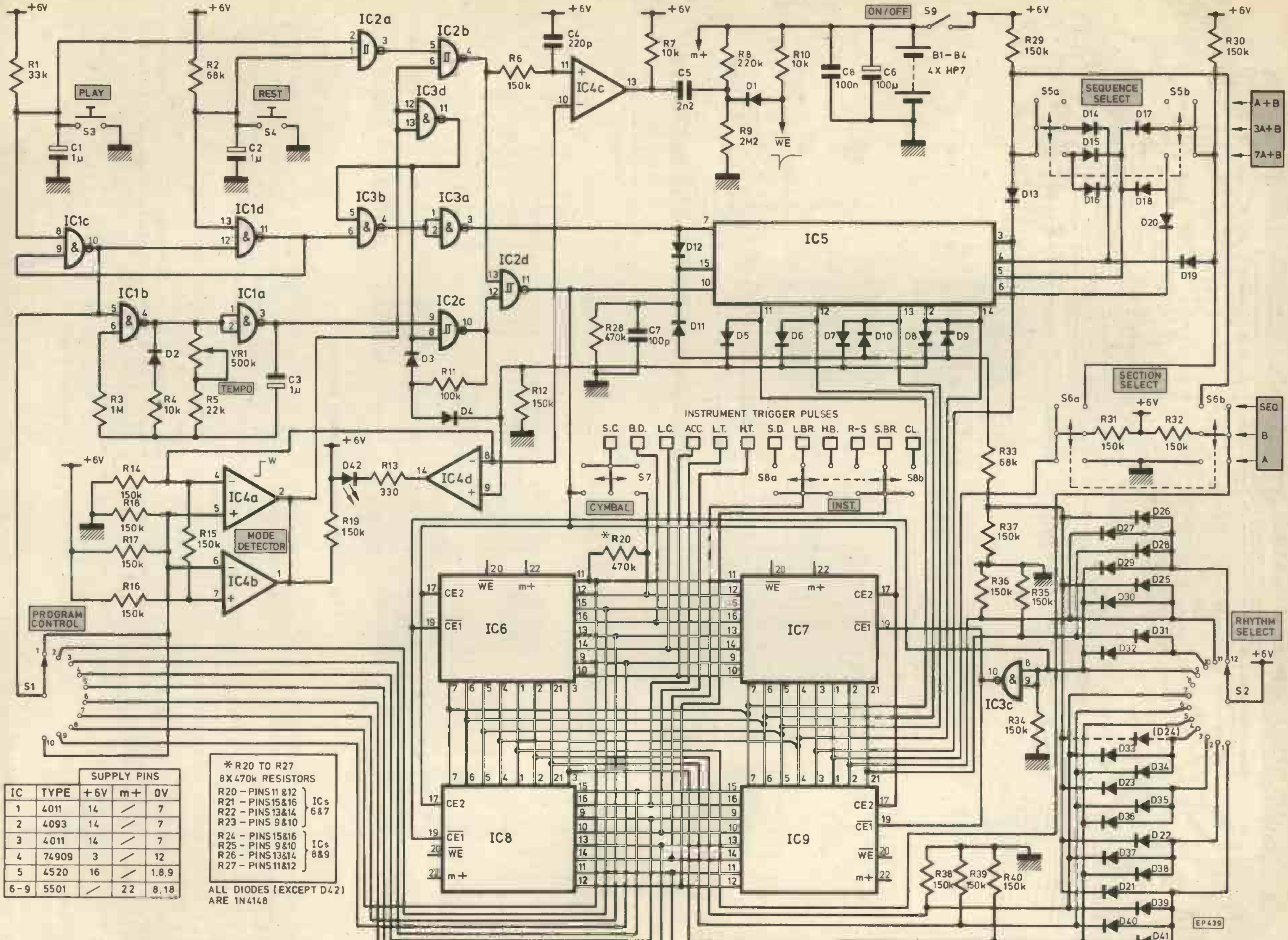


Fig. 2. Schematic of Master Rhythm

the counter input. Depression of the "Rest" key will reset the complete counter through IC3b, IC3a and D12, whilst the "Play" key will start the clock.

The counter consists of eight synchronously switched divider stages, the first four of which are decoded by diodes D5 to D8 to produce down beat indicator pulses in conjunction with D4. Outputs from the third and fourth dividers are decoded by diodes D10 and D9 to produce reset signals on the first four counters via D11 after every twelfth measure when R33 is raised by selection of a twelve measure category rhythm. The last four stages of the counter are decoded by diodes D13 to D20 which link with the "Sequence" select switch S5 to pass sequence address information via the "Section Select" switch S6. Counter outputs provide the incrementing address information required by the memory, whilst the fixed starting addresses are provided through diodes D27 to D41 from the "Rhythm Select" switch. As described earlier the memories work in pairs, IC6 plus IC8 and IC7 plus IC9. The changeover chip enable signals $\overline{CE1}$ are provided in opposite sense through the inverter IC3c.

When the "Program Control" is in an instrument track position the high output from the mode detector prevents the passage of the clock through IC2c and enables IC2b to pass the pulses, which occur at the output of IC2a each time either the "Play" or "Rest" key is depressed, forward to IC2d and IC4c. The former provides the stepped clock required during the programming operation whilst the latter provides a negative sense write enable pulse timed by R6/C4 and R10/C5. The prior state feedback network consists of resistors R20 to R27 which protect the information on the non-operative tracks during programming.



IC	TYPE	SUPPLY PINS +6V	m+	0V
1	4011	14	/	7
2	4093	14	/	7
3	4011	14	/	7
4	74909	3	/	12
5	4520	16	/	1.8.9
6-9	5501	/	22	8.18

*R20 TO R27
8X470k RESISTORS
R20 - PINS 11 & 12
R21 - PINS 15 & 16
R22 - PINS 13 & 14
R23 - PINS 9 & 10
} ICs 6&7
R24 - PINS 15 & 16
R25 - PINS 9 & 10
R26 - PINS 13 & 14
R27 - PINS 11 & 12
} ICs 8&9

ALL DIODES (EXCEPT D42) ARE 1N4148

Fig. 3. Control circuit

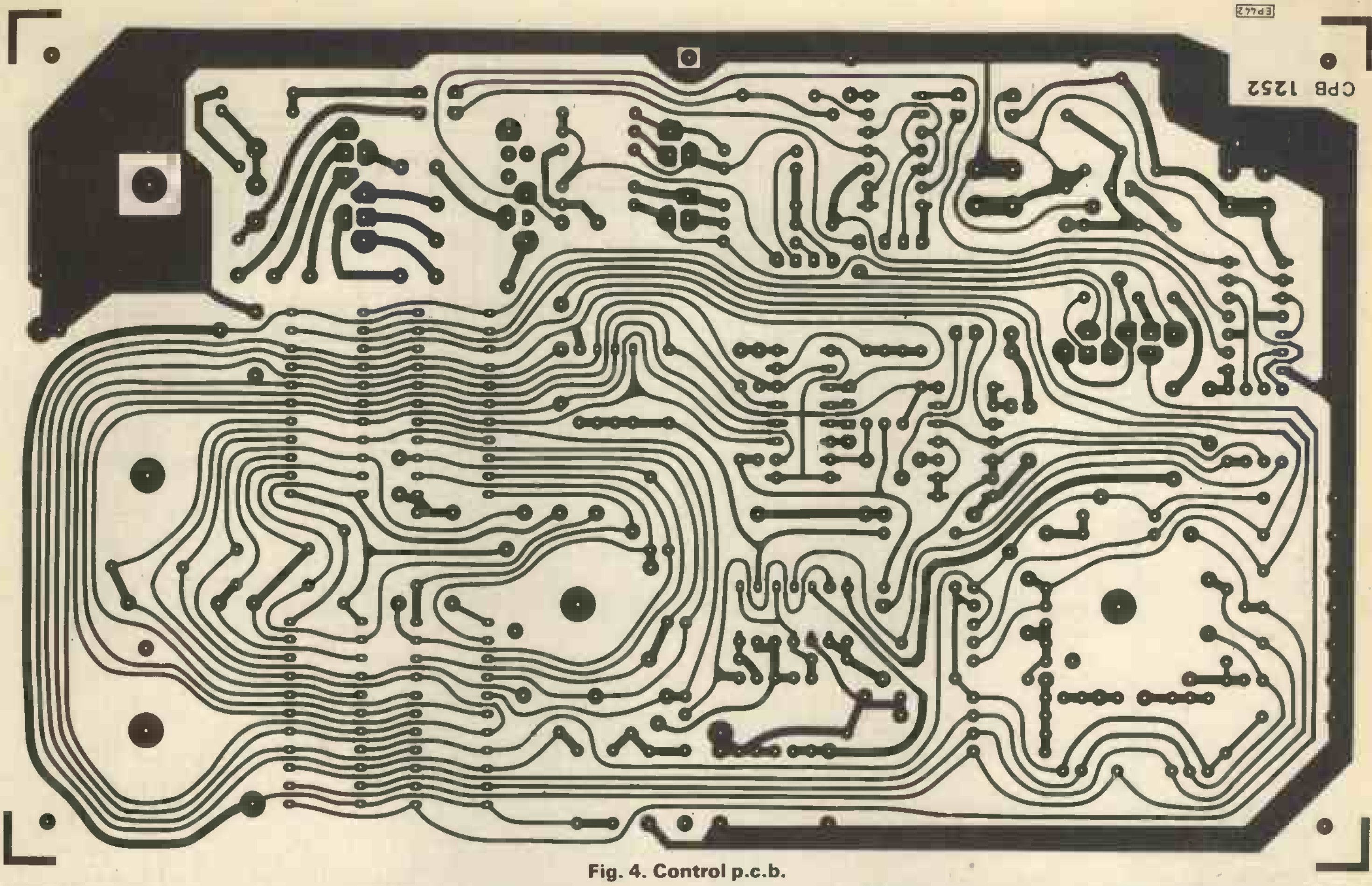


Fig. 4. Control p.c.b.

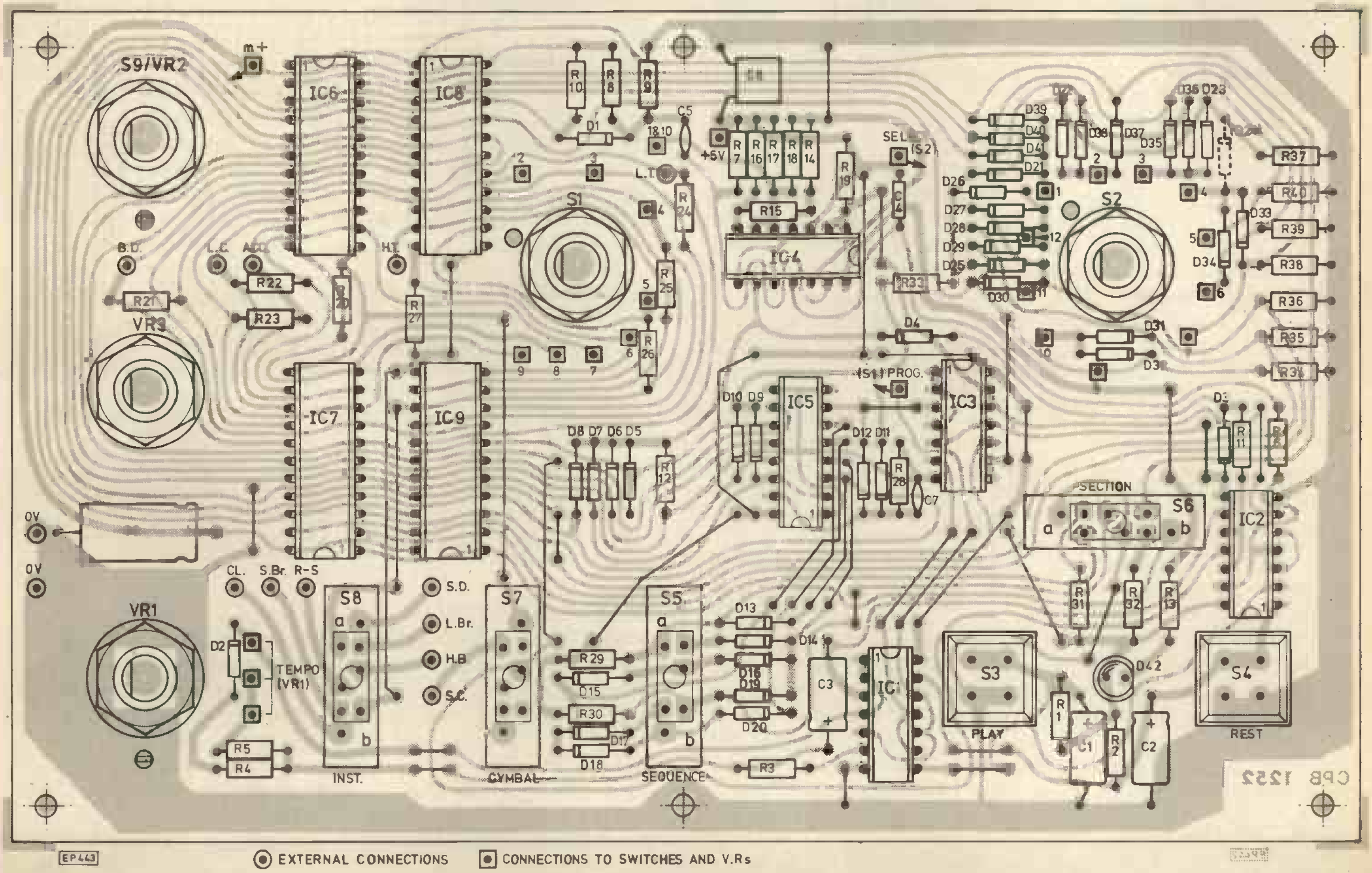


Fig. 5. Control board overlay

COMPONENTS — CONTROL BOARD

Resistors

R1	33k
R2	68k
R3	1M
R4	10k
R5	22k
R6	150k
R7	10k
R8	220k
R9	2M2
R10	10k
R11	100k
R12	150k
R13	330R
R14–19	150k (6 off)
R20–28	470k (9 off)
R29–32	150k (4 off)
R33	68k
R34–40	150k (7 off)

All resistors 0·25W, 5% carbon film

Switches

S1	Single pole 10 way rotary
S2	Single pole 12 way rotary
S3–4	Single pole push-to-make (2 off)
S5–8	2 pole 3 way sliders (4 off)
S9	Single pole (see potentiometer VR2)

Capacitors

C1–C3	1µ/16V axial electrolytic
C4	220p ceramic plate
C5	2n2 ceramic plate
C6	100µ/16V axial electrolytic
C7	100p ceramic plate

Diodes

D1–41	1N4148 (41 off)
D42	l.e.d.

Integrated Circuits

IC1	CD4011
IC2	CD4093
IC3	CD4011
IC4	MM 74C909
IC5	CD4520
IC6–9	TC5501P (4 off)

Potentiometers

VR1	500k lin
VR2	25k log with switch
VR3	25k log

Miscellaneous

0·040in terminal pins 12 off
22 pin i.c. sockets 4 off
16 pin i.c. sockets 1 off
14 pin i.c. sockets 4 off
control knobs 1in dia 2 off
control knobs ¾in dia 3 off
printed circuit board 1 off

A complete kit can be obtained from **Clef Products, 16 Mayfield Rd., Bramhall, Cheshire SK7 1JU**

CONTROL P.C.B.

From the photograph it can be seen that in addition to containing the control circuitry the Control p.c.b. acts as a mechanical support for all switches and the "Level," "Tone," and "Tempo" potentiometers. Diode D24 is shown in brackets and is the twelve measure connection for position 4 on the "Rhythm Select" switch. Since the sample pattern given later for rhythm 4 is based on sixteen measures this diode is omitted. The corresponding twelve measure diodes for positions 1, 2, 3, 11 and 12 are D21, D22, D23, D25 and D26 respectively and may be omitted as required. Rhythms 5 to 10 inclusive are permanently arranged on a sixteen measure basis.

ASSEMBLING THE P.C.B.

The Control p.c.b. has a considerable number of interconnection tracks and it is advisable to inspect closely the p.c.b. before proceeding, particularly ensuring that bridges are not present between the memory tracks or the large switch pads. Figs. 4 and 5 show the track layout and component overlay for the p.c.b.

The twelve terminal pins should first be inserted in the board, note that many of the interconnections are made from the rear of the p.c.b. where pins are not required. All resistors and diodes can be inserted and soldered next. It is advisable to use a small soldering iron with a maximum bit size of 3/32in, and in particular it will be found to help if 22 s.w.g. solder is used rather than thicker varieties which aggravate the possibility of solder bridges. Wire links can be inserted after soldering the i.c. sockets, advisable throughout, followed by the capacitors.

The three position switches are pushed into the holes in the p.c.b. and are a tight fit. The "Sequence" switch requires two tags to be cut off before insertion and care should be taken not to damage the switches. However it is important for front panel alignment that the switches should seat on the p.c.b. and it may be necessary to slightly increase the size of the switch tag mounting holes due to the mechanical spread on the switches. To assist in later alignment of the front panel it is also suggested that at this stage the l.e.d. is soldered temporarily some 0·5in off the p.c.b. The "Play" and "Rest" keys should be easy to locate with the four pin fixing provided.

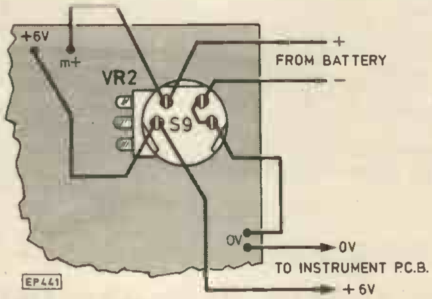


Fig. 6. Wiring connections to S9

ROTARY SWITCHES

The rotary switches are single pole, twelve position, and when supplied they have a small metal ring, concentric with the shaft, which can be repositioned to alter the switching compass. In the case of the "Rhythm Select" switch the ring should be removed completely to allow the full twelve positions to be used. The "Program Control" should be set to give ten positions by adjustment of the ring position to its second slot.

Wiring of the rotary switches to the p.c.b. is carried out from the track side using single core tinned wire of 22 s.w.g. The numbers enclosed by squares on the component ident side of the p.c.b. correspond with the switch tag numbers. Note that pins 1 and 10 on the "Program Control" switch are shorted together and that the connection points for the centre keys are some distance away requiring insulation. These are marked $\boxed{\text{SEL}}$ for the Selector Switch and $\boxed{\text{PROG}}$ for the "Program Control" switch. It is also worth noting that tag 8 on the "Rhythm Select" switch and tags 11 and 12 on the "Program Control" do not have connections to the p.c.b.

POTENTIOMETERS

The "Tempo" control is soldered to the three pads on the p.c.b. again using wire links, whereas the potentiometer sections of the "Level" and "Tone" controls are later connected to the instrument p.c.b. only. Fig. 6 shows all the connections, from the switch S9 integral with the "Level" control VR2, to the control p.c.b. supply points. These are important since they control the standby system in addition to switching on the main operating power.

Next Month: Instrumentation and setting up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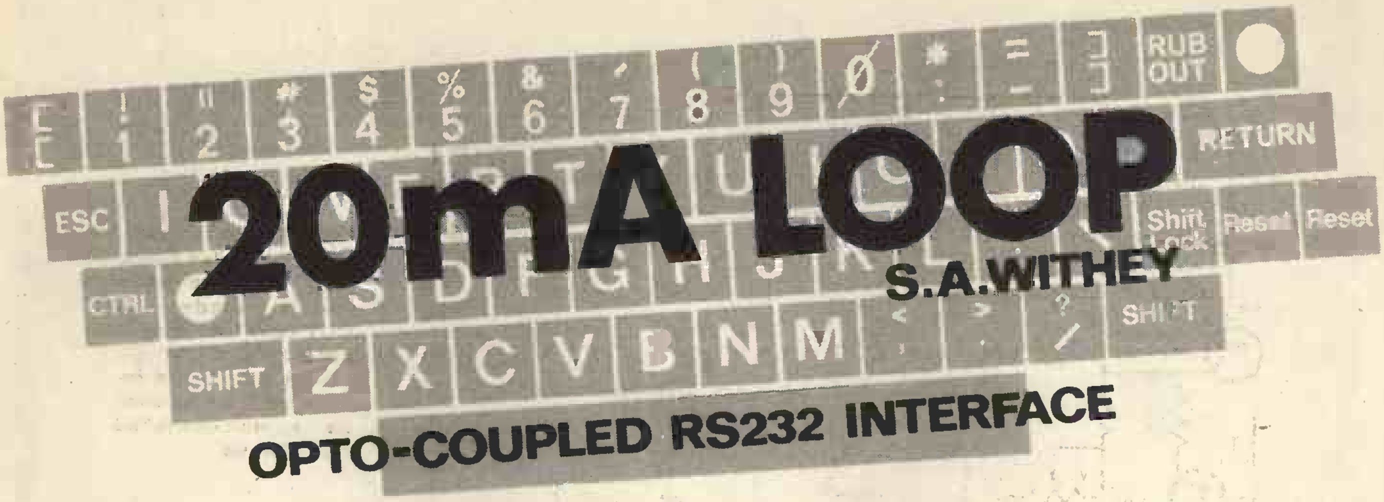


20mA LOOP

S.A.WITHEY

OPTO-COUPLED RS232 INTERFACE

Similar to those installed in converted teletypes, enhancing the price by anything up to £80, yet can be built for only a few pounds

ALTHOUGH designed to interface a Nascom 1 microcomputer with a KSR33 Teletypewriter, this current loop needs very little or no modification to suit other printers and microcomputers with 20mA serial output. The circuit is in three sections; power supply, opto-isolator, and 20mA (or 60mA) current loop mounted on a single, easily drawn p.c.b.

POWER SUPPLY

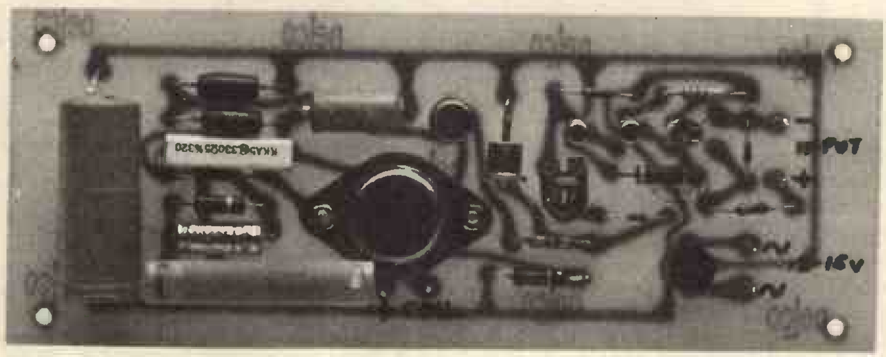
On test it was found that 400mA at 9V was more than sufficient to activate the selector magnet of the teletype, normal being 500mA at 20V. A 14·5V 500mA transformer was chosen to power the circuit, as these are easily obtainable for a very modest outlay, as are the 1A bridge rectifier, 1000µF 40V electrolytic capacitor and 13·5V Zener diode, all of which provide a stabilised power supply. With the exception of the transformer, the components are mounted on the p.c.b.

OPTO-ISOLATOR

R1 is chosen to protect the l.e.d. and any resistance value between 470 and 1k should be sufficient. The reverse-parallel diode D5 bypasses negative peaks across the l.e.d. The light emitted by the l.e.d. causes current to flow through the photo-transistor, which is amplified by TR1 and TR2. The high gain causes a square wave to appear at the collector of TR2. VR1 is used to adjust the current to 20mA or 60mA as required. It also serves as a final adjustment to achieve 500mA at the output to the printer selector magnet.

CURRENT LOOP

TR3 and TR4 can be any power transistors of the 3053 and 3055 n.p.n. types respectively. D7 can be any 1 or 2A diode. Because of the heat generated around the junction of R9 and R10, R7, R8 and R9 should be 2 to 4 Watt wirewound resistors and R10 a 10 Watt wirewound. These resistors run much cooler when the selector magnet is connected than they do whilst under test before installation. R6 might require changing to adjust the current gain to produce 500mA at the output.



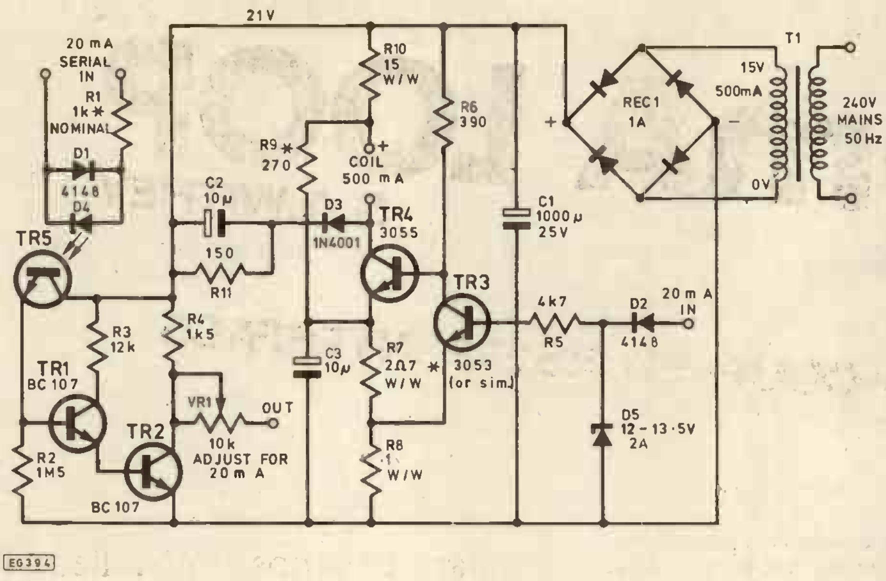


Fig. 1. Circuit diagram of opto-coupled 20mA loop. When in opto-isolated mode, the OUT from VR1 is connected to IN at D2 (as on p.c.b.) The input at D2 can be used as a non-isolated RS232 input

For a mark input a positive current is applied to the anode of D2. This provides a positive bias to the base of TR3 which overcomes the normal negative bias supplied through R5 and stabilised by D5. TR3 will turn off as the increasing positive current reaches one half of its final value. The collector of TR3 then goes negative and this negative potential is applied to the base of TR4 which turns TR4 on. R8 provides emitter bias to TR3 and supplies a regenerative action to the transistor.

The selector magnet of the teletype is connected between the collector of TR4 and the junction of R9, R10. On marks the current rises to 500mA and energises the magnet. On spaces the positive input bias decreases and TR3 is turned on at the half line current point by negative bias through R5. The collector of TR3 rises towards a zero potential, applying reverse bias to TR4, de-energising the magnet. The selector magnet opposes the change in current and applies a transient potential to the collector of TR4. D3 now conducts and passes the transient potential to C2 and R11 which limits the potential to a value well under the breakdown voltage of TR4, while selector magnet energy is being dissipated.

CONSTRUCTION

R10 gets very warm in operation and should be mounted away from the p.c.b. to aid heat dissipation.

D4 should be mounted on long leads and bent over the photo-transistor. They are joined with a short length of coaxial sleeving. The ends should be left open while tests are carried out so that room light shines through the end and activates the photo-transistor, thus preventing the printer from chattering. When the unit is connected to a 20mA current a plastic pen-cap makes a neat cover.

Should a photo-transistor not be available, the top can be carefully cut from a BC107 and the base exposed.★

COMPONENTS . . .

Resistors

R1	1k nom. see text
R2	1M5
R3	12k
R4	1k5
R5	4k7
R6	390 see text
R7	2R7 w.w. 2W
R8	1 w.w.
R9	270 w.w.
R10	15 10W
R11	150

All resistors ½W 5% unless otherwise stated

Capacitors

C1	100μ/40V
C2, C3	10μ/25V (2 off)

Transistors And Diodes

REC1	1A bridge rectifier
D1, D2	4148 or similar (2 off)
D3	4001 or similar
D4	0·2 in. red l.e.d.
D5	12V or 13V Zener 1·5W
TR1, TR2	BC107 (2 off)
TR3	2N3053
TR4	2N3055
TR5	n.p.n. photo-transistor

Transformer

T1	240V 50Hz prim. 14·5 to 20V 500mA sec.

Constructors' Note

A complete kit of components is available from **Watford Electronics**

20mA LOOP

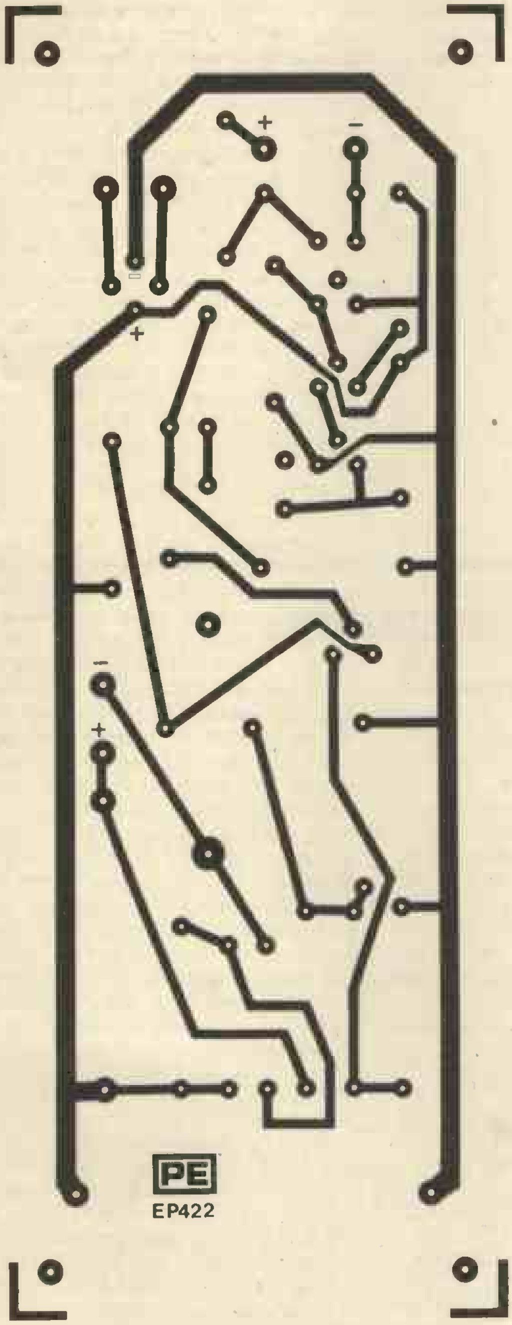


Fig. 2. Printed circuit (actual size)

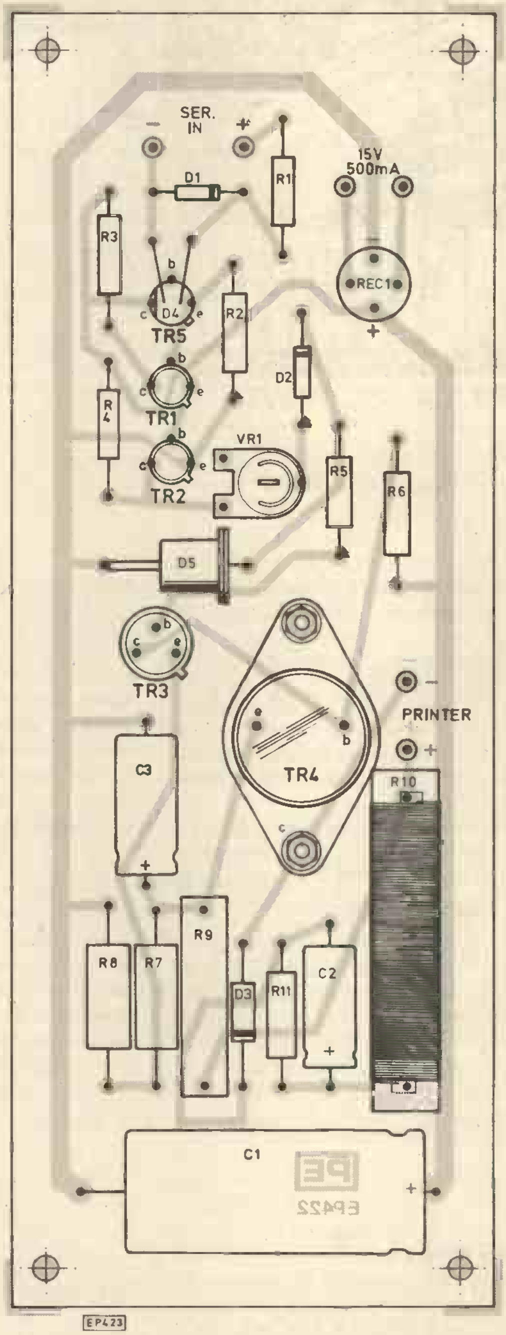


Fig. 3. Component layout

FRANK W. HYDE

THE SHUTTLE TELESCOPE

This infrared instrument is a natural addition to the joint United States, United Kingdom and Netherlands venture, which is expected to be launched in 1982. Its full title is Shuttle Infrared Telescope Facility. It is an observatory 1-metre class instrument. It will be in operation outside the atmospheric difficulties such as the absorption and emission of radiation. This will mean that the degrading of quality, which is suffered by telescopes in lower orbits, can be avoided. In fact the limitations of the SIRTF will be due to the natural background of space.

To the techniques to be used in this mission, which is scheduled for 1987 or thereabouts, will be added the advantages of cryogenic control. Such control can provide considerably greater sensitivity. Part of this will be derived from the fact that the operational area will be outside that which limits sensitivity, namely below the wavelength of 30 micrometres and above 300 micrometres. The normal background in these ranges is spoiled by water vapour and carbon dioxide. It is possible to overcome some of this by the use of aircraft and balloons. However there is still the line of sight difficulty due to random absorption and emission. So important are data that can be retrieved in this part of the spectrum that pressure from astronomy has virtually demanded that the latest techniques are used. At the present time detectors are available which, in ground based telescopes, are limited only by photon background. Much of the noise and the atmospheric limitation is at a level several orders of magnitude above the sources to be studied. The use of cryogenic techniques enables this background to be overcome with the result that a cryogenic system outside the atmosphere will offer up to a 1,000 times increase in sensitivity above current equipment. For the first time it will be possible to study high-luminosity extra-galactic sources and stellar formations.

The value of scientific advantages such as the SIRTF lie in the ability to look forward in time as well as backward. The early history of the expansion of the Universe with the formation of galaxies may lie in this cosmological area because of the redshift. Once again the real workload lies with the electronics of control for which the specification is severe. It is required that there shall be a pointing accuracy ±1-arc/second and a guidance system to ensure a stability of 0·25-arc/second. Other requirements are that the primary mirror must be held below 12 Kelvin for the first half of each 7 to 14 day mission and thereafter below 16 Kelvin. The secondary mirror must also have a low temperature control at 10 Kelvin or less for the first part of missions and then 15 Kelvin maximum for the rest of the period.

For a nominal 14 day mission SIRTF would need to carry about 1,300 litres of supercritical gaseous helium. This will be held at a pressure of 6 atmospheres to cool the telescope optics and the body. There will be facilities to carry superfluid helium to cool the instrument chamber to a level of 2-Kelvin. There are current investigations to get the temperature down to a few tenths of a degree kelvin using the isotope helium 3. This is a case of the sword into ploughshares for Helium 3 is a byproduct of weapons technology.

There are difficulties in attaining the ultimate goals but already there are satisfactory signs of progress. For example the optical systems will be diffraction limited at 5 micrometers. This can be achieved using optical grade beryllium. There is a doubt as to whether that beryllium can attain the 2 micrometre diffraction. This figure is of importance for the observation of proto-galaxies, these are galaxies that are forming and would show a high redshift. Other materials are being investigated and these matters will be on-going during this continuing updating. The first flights will be about 14 hours duration rising to 30 hours. The reusable system is expected to reach mission durations of 30 days with a reusable condition free of replacement of any major part for 20 missions.

The aperture of the telescope is ·85 metres in diameter and 9·2 metres in length. The cryogenic tanks, the electronics and the pointing systems are housed outside the main shell. There is a sun shield and a collapsible cover to reduce the off-axis radiation in to the telescope. This allows the main axis of the telescope to come within 45 degrees of the sun or the earth. The optical arrangement is that of a primary and secondary mirror arranged in what is known as the Ritchey-Chretien-Cassegrain configuration. The telescope can be used for over a wide range of studies which include:—

The observation of quasars, star formation, normal galaxies; objects in the solar system such as asteroids, comets and the satellites of the outer planets, also the observation of mass exchange between stars and the interstellar medium. It would also be possible to detect the massive halos of cool stars surrounding galaxies, with the identification of high redshift galaxies in formation.

THE HEART OF A SUPERNOVA

With optical activities growing all the while it is easy to miss the new developments in radioastronomy. However the 5 kilometre radio telescope at the Mullard Radio Astronomy Observatory has been in operation investigating the Tycho Brahe supernova remnent. This was observed to explode in 1572. This is a Type 1 supernova, a most bright and energetic star explosion.

The discovery made at the observatory at Cambridge by Steve Gull and Guy Pooley was a very small but intense source of radiation at the centre of what remains of the supernova. Until now only one other nebula has been shown to have a Pulsar and this was the Crab Nebula which is within our own galaxy. The radiation of the Tycho remnant was detected at a wavelength of 11 cm. With the high resolution of this radio telescope the picture of the collapsed star can be built up in considerable detail. The observer's suggest that the pulsar or neutron star is in fact the collapsed star. It is not yet finally decided what the real answer is because there could be other reasons for the small star like object being present. If it is in fact the final 'bit' of the original star then it must be moving at 2000 k/ms a second. This is about 10 times faster than known pulsars. Other observatories are now checking on this star but it may be some time before it is confirmed.

THE SOLAR WIND

Back now to the Earth itself. There is a new collaboration of scientists from 11 countries which began in November. It is perhaps one of the more ambitious projects to undertake the study of the physics of the upper atmosphere. Some 200 scientists are involved. It is expected that nearly fifty rocket launches will be made and observations from 37 ground stations supplemented by satellites and balloons will provide data about the upper atmosphere. The main object of the exercise is to study the atmosphere from 80 to 200 kilometres above the Earth during a magnetic storm.

Magnetic storms are severe disturbances of the earth's magnetic field by the solar wind. There is a continuous radiation which forms the solar wind but this is enhanced by flares and sunspots. The magnetosphere round the earth becomes distorted and the tadpole like tail which appears on the side of the earth away from the sun is extended. The plasma which is composed of ionised particles mostly of hydrogen carries tremendous energy. The particles are dissipated in the upper atmosphere. The solar wind expelled radially from the sun is composed of protons and electrons. When they near the magnetosphere they are lulled out of their straight paths and focussed towards the poles. As the denser part of the atmosphere at about 150 kilometres is reached larger protons are inhibited but the electrons move on. As a result there is a drift of high energy current in a westward direction. This leaks into the atmosphere away from the poles.

Following the article by Frank Hyde on Velikovsky in the April 1980 Spacewatch, we have received many letters from readers, expressing varying opinions. Frank Hyde's final reply to these letters is printed in Readout on page 50.

speech synthesis

Dr A.A. Berk · part 2

LAST month, an introduction to the theory and history of speech synthesis was given as a precursor to this month's constructional article. An American speech board (manufactured by Telesensory Systems Inc.) is available through Modus Systems Ltd., and its interface to any general computer or logic system is described. The Compukit and Edukit are used to give examples of the interface, and hence provide readers with a practical demonstration of the way in which speech may be added to their own type of system.

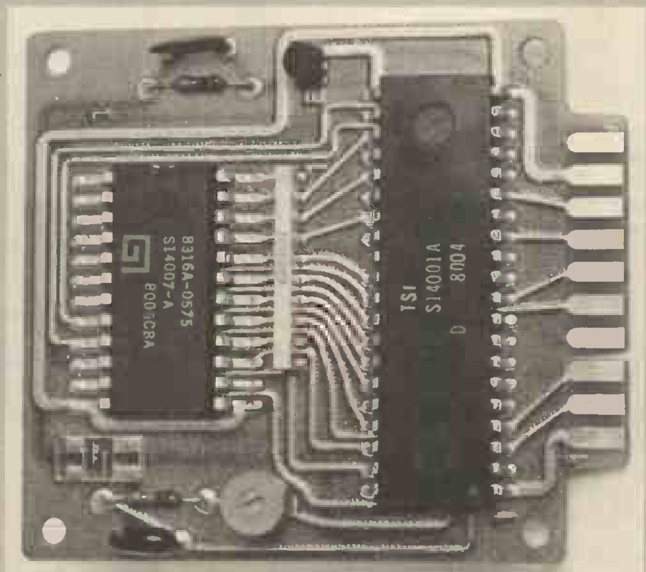
INTRODUCTION

Converting the theory of last month's article into practice at the "one-off" small computer level, was, until recently, rather difficult. Texas Instruments, for instance, have not made their speech products available on this experimentation level, and most other companies are only interested in the large volume "OEM" buyer, who needs expensive customised speech sets. To experiment with the technology, the alternatives include some excellent, but relatively expensive phoneme analysis boards, whereby any word may be synthesised by sending it information of the phonemes which make it up. To "try out" speech synthesis, a far better approach is to use a cheap, mass produced fixed-word synthesiser giving digitally controllable speech on demand from any computer or logic system. If more than one speech set is also available then so much the better. It is with this in mind that Modus have imported a range of fixed-word speech synthesisers, for applications where a customised vocabulary is unnecessary. The words available are basic and revolve around numerical words such as "two", "thirty", "pounds" etc.

One of the advantages of the fixed-word approach is the extreme ease of interface with any logic system. To aid in the evaluation and addition of speech to any computer or logic device, the interface is described below, as a constructional article. The speech board is available separately, however, with a full technical specification for the user to design his own interface in any way he wishes.

TSI SPEECH SYNTHESIS BOARD

Telesensory Systems Inc (TSI) are the manufacturers of several products for the synthesis of human speech. They produce a talking calculator which has found obvious application for the blind. The units of particular interest, produced by TSI, are the fixed 24 and 64 English word units, consisting of a controller chip (called the CRC), and one or two 2K ROMs, respectively. The photograph shows the chips mounted on a p.c.b. with one or two other discrete components, and a gold-flashed edge connector. The size of the board is 66×73×13mm, with 0·156in. pitch edge connector tracks. The 64-word versions have two ROMs on the board and are slightly larger.



TSI speech board

The CRC is a general speech synthesis chip which requires data of pronunciation, pitch, word-length etc. from a ROM to create the necessary sounds. To store the raw data of a word on a read only memory, a complex computer program accepts speech through a microphone and converts it to data suitable to the CRC. TSI have commissioned ROMs, by this method, for several different speech "fonts", and standard vocabularies in a number of different languages (German, French, Arabic etc). The words available here are detailed in Table 1.

S2A	S2B	S2C
(Calculator type 24-words)	(Standard English 64-words)	(ASCII 64-words)
		space, X-point, quote,
oh	Same as S2A plus:	number, dollars,
one	ten, eleven, etc.	percent, and, apostrophe,
two	twenty, thirty, etc.	left parent, right parent,
three	hundred, thousand,	star, plus, comma,
four	zero, and, seconds,	minus, point, slash,
five	degrees, dollars,	zero, one, etc. nine,
six	cents, pounds,	colon, semicolon, less than,
seven	ounces, total,	equals, greater than,
eight	please, feet,	mark, at, A, B, C, (etc.) . . . Z
nine	metres, centimetres	lower case, tone,
times-minus	volts, ohms, amps,	upper case, up arrow,
equals	hertz, d.c., a.c.,	control
percent	down, up, go,	
low	stop, low and high tones	
over		
root		
em(M)		
times		
point		
overflow		
minus		
plus		
clear		
swap		

N.B. The ASCII set is of course arranged in exact ASCII order to convert any standard binary code into a verbalisation of the corresponding ASCII character.

TABLE 1. Vocabulary of the three TSI speech boards available

The speech board acts by accepting a control word of six bits to identify the spoken word to be output, followed by a start pulse to tell it to begin speaking. The board is also equipped with a "busy" line to tell external devices that a word is in the process of being spoken. Fig. 2.1 shows a block diagram with timing signals to illustrate the process. The timing shows that the speech output itself does not occur until the "start" signal has fallen to zero. In a typical interface set-up, a set of six latches would feed the control word to the CRC, the "start" signal would fall after 140 micro seconds or more, and the output would be forthcoming. It must be noted that if the "start" line should rise at any time during the speech output, the output is stopped in mid flow. When the "start" line falls again, the word is started from the beginning. To assist in preventing this occurrence, the "busy" line should be monitored by the external system, and the "start" line only operated when the machine has finished talking.

INTERFACING

As is clear from the above, the logic interface requirements are straightforward, and the only problems arise from the rather strange power supply requirements, which are −5V and −15V. However, by a simple trick, the −5V level can be derived from the normal supply of a microcomputer, while the −15V supply must be derived separately.

The final requirement of the board is for audio circuitry of essentially two types, a filter and an amplifier. The sound is produced by the CRC via a digital to analogue converter

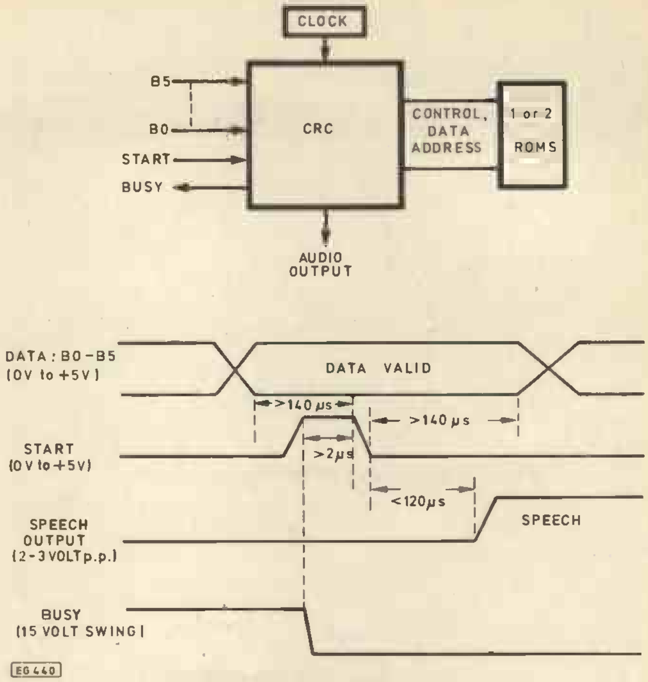


Fig. 2.1. TSI Speech Board

(DAC). This implies that the output waveform is not completely smooth. Its variation from level to level is by a set of steps. A sinewave derived from a DAC will have the form shown in Fig. 2.2. Note that the horizontal width of each step is constant, while the vertical steps vary to approximate the sinewave. This shows that the waveform thus formed may be viewed as a sinewave modulated by a constant frequency squarewave. However, a squarewave contains the elements of many frequencies mixed together (depending on how square it is), and hence the voice output must be passed through a band-pass filter allowing just the band of frequencies needed for voice to pass. To give an idea of the frequencies needed and some typical characteristics, Fig. 2.3 reproduces TSI's suggested op-amp filter response. The three decibel level is often used as a method of comparing such responses, and the frequencies at which this level cuts the graph are called the "corner frequencies". The reason for their importance is that at these frequencies, the incoming waveform's amplitude is exactly halved by passing through the filter.

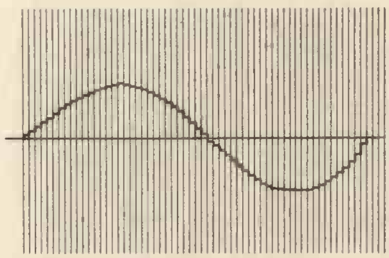


Fig. 2.2. Sine wave output from D to A converter

In considering the TSI output, however, it was found most advantageous to be able to vary the response to different ears, and for different loudspeaker arrangements. After much experimentation, a very simple single op-amp band-pass filter was selected, which, together with an integrated circuit power amplifier gave acceptable results. This circuit is

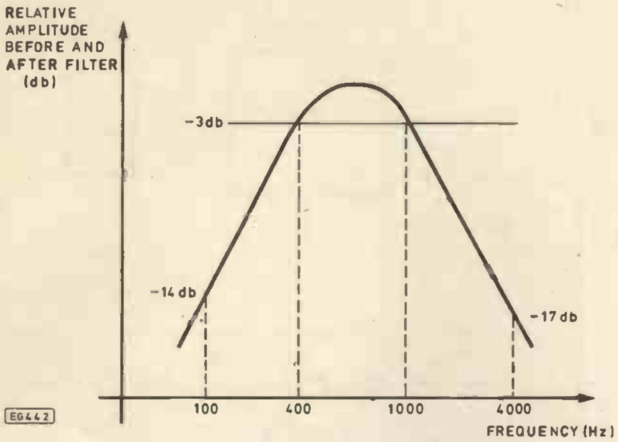


Fig. 2.3. Bandpass filter characteristics

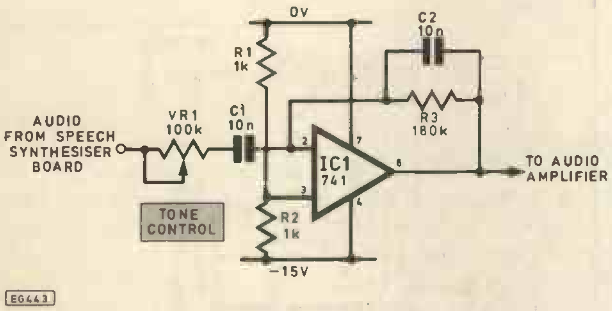


Fig. 2.4. Bandpass filter

shown in Fig. 2.4, and includes a tone control, which varies the filter's pass characteristics.

THE INTERFACE UNIT

As explained above, interfacing is dependent upon three main systems: logic, power and audio sections. All these are included on the interface board described here, along with such important details as the correct edge-connector into which the TSI speech unit plugs.

Fig. 2.5 shows a complete circuit diagram of the interface unit, which is designed to be as complete as possible. A separate 5-volt supply is needed for the logic, as well as a small 10 to 20 volt transformer (at around 250mA) and an 8 ohm speaker.

The word to be spoken is requested by supplying a set of bits (D0 to D5) along with a positive going "latch enable" pulse. The word is latched into IC2 and presented to the speech synthesis board. When the "start" line changes from high to low, and held there, an audio signal is output from the synthesiser. IC1 filters this audio signal in a manner partly determined by the setting of VR1. The filtered signal is a.c. coupled to a volume control and the i.c. power amplifier IC3 which feeds an 8 ohm speaker through C4. The power supply on the board adds 10 volts to the 5 volt supply from the external logic, and just requires an external mains transformer as indicated. The "busy" signal output swings through 15 volts and to convert this to a 5 volt swing, D5 and R5 are included.

CONSTRUCTION

The p.c.b. design and component layout for the unit is shown in Fig. 2.6.

Assembly of the unit is straightforward, and the sockets for the i.c.s should be inserted and soldered first, followed by the edge-connector and ribbon cable connector. Note that the ribbon cable connector has some spare pins for expansion. Discrete components and regulator should be fitted next, observing the correct polarities with great care. It is a very good idea to check that there are 10 volts between −5V and −15V lines from IC4, before proceeding. The 5 volt

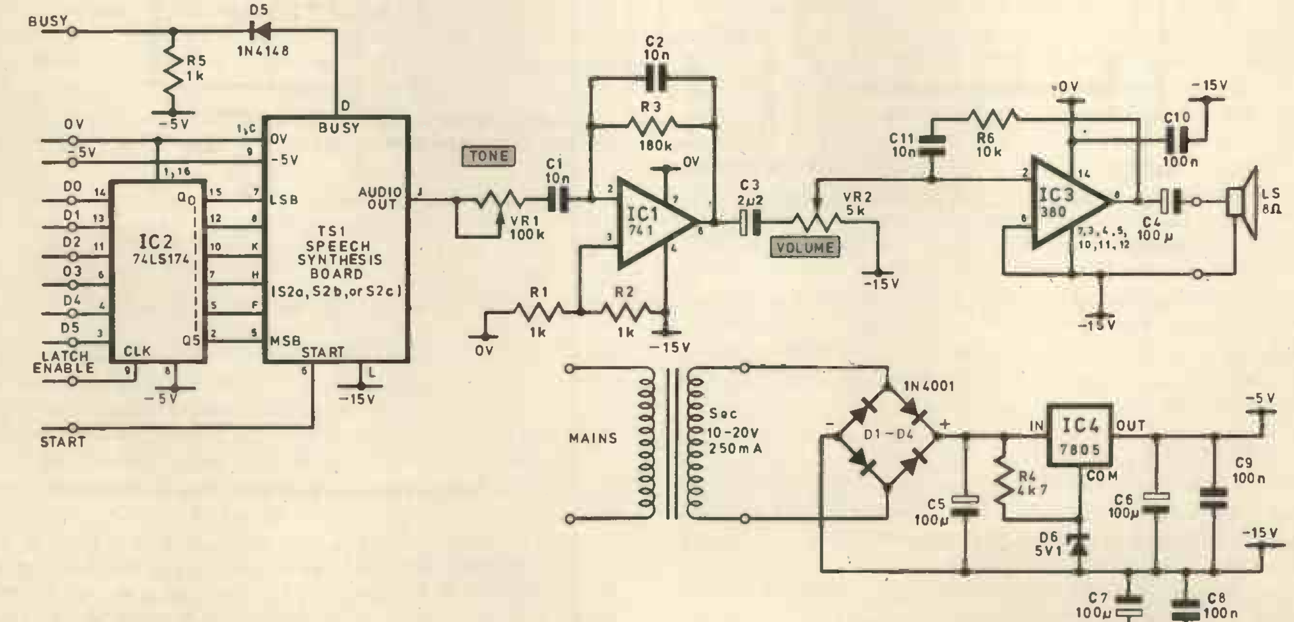


Fig. 2.5. Interface and speech board circuit diagram

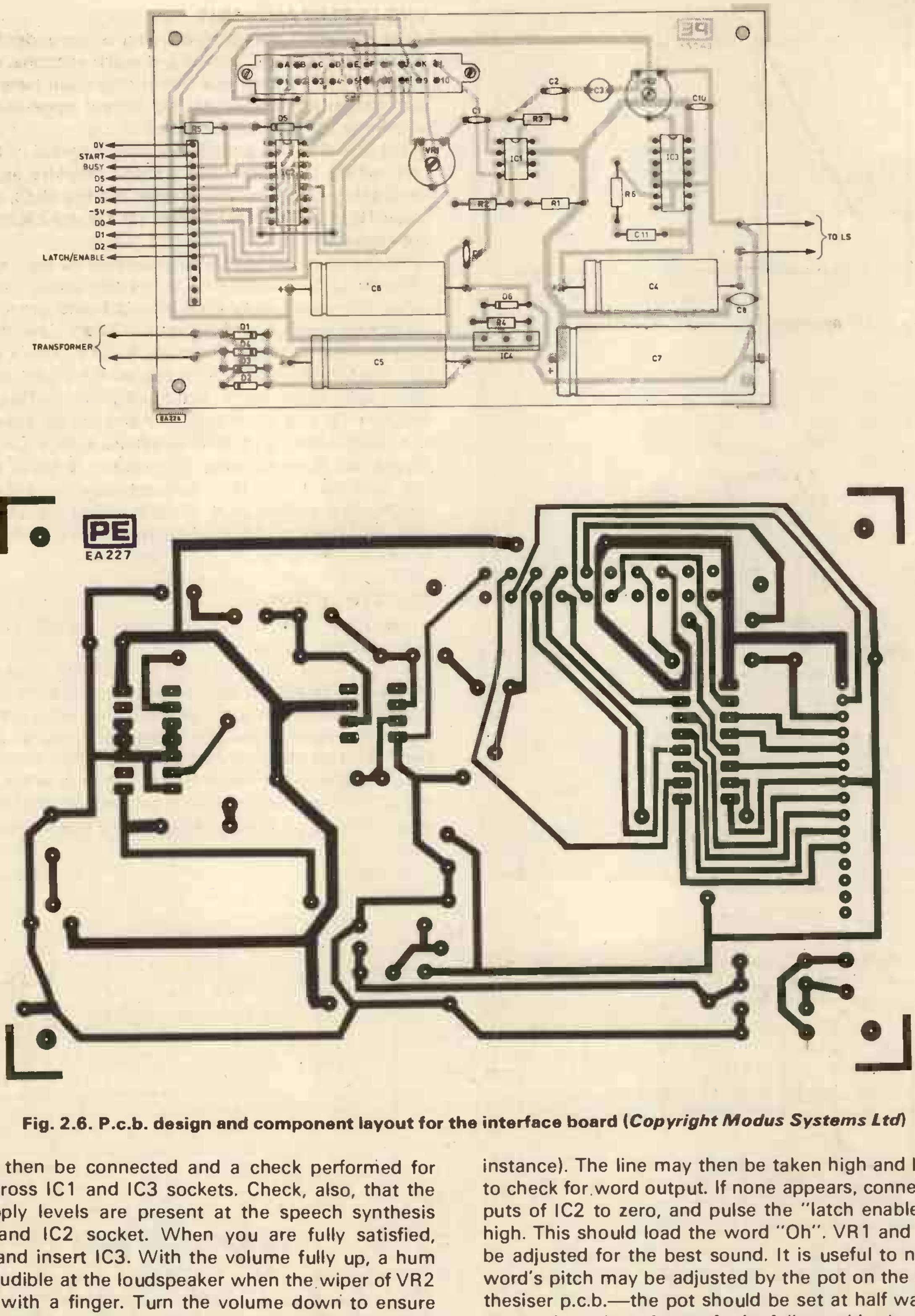


Fig. 2.6. P.c.b. design and component layout for the interface board (*Copyright Modus Systems Ltd*)

supply can then be connected and a check performed for 15 volts across IC1 and IC3 sockets. Check, also, that the correct supply levels are present at the speech synthesis connector and IC2 socket. When you are fully satisfied, switch off and insert IC3. With the volume fully up, a hum should be audible at the loudspeaker when the wiper of VR2 is touched with a finger. Turn the volume down to ensure that this causes the hum to disappear. This will verify IC3's operation.

Next, insert IC1, IC2 (the correct way round) and the speech synthesis board, with the component side inwards as shown. The unit will sound highly unstable unless the "start" line is held at "one" or "zero" (TTL levels). The line should be taken to zero (−5V) through a low resistance (100 ohm for instance). The line may then be taken high and back to zero to check for word output. If none appears, connect all the inputs of IC2 to zero, and pulse the "latch enable" low, then high. This should load the word "Oh". VR1 and VR2 should be adjusted for the best sound. It is useful to note that the word's pitch may be adjusted by the pot on the speech synthesiser p.c.b.—the pot should be set at half way initially—the total number of turns for its full travel is about four and a half, the pot should be turned one way until obviously at its end, and a couple of turns added in the opposite direction. If no sound appears, use a logic probe, meter (or l.e.d. in series with a 1k resistor), to check that the data bits from IC2 to the speech synthesiser board are all zero. If nothing is forthcoming, power should be removed and the whole unit

COMPONENTS . . .

Resistors

R1, R2, R5	1k (3 off)
R3	180k
R4	4k7
All resistors ¼W 5% carbon	

Potentiometers

VR1	100k hor. preset
VR2	5k hor. preset

Capacitors

C1, C2	10n ceramic disc (2 off)
C3	2µ2 15V elect.
C4, C5, C6, C7	100µ 15V elect. (4 off)
C8, C9, C10	100n disc ceramic (3 off)

Semiconductors

D1–D4	1N4001 (4 off)
D5	1N4148
D6	5V1 Zener BZY88
IC1	741
IC2	74LS174
IC3	LM380
IC4	7805

Miscellaneous

P.c.b.
PL1 ribbon cable plug and connector
SK1 edge connector socket (10 double way at 0·156in. pitch with polarising plug)
Mains transformer 10–20V sec 250mA
8Ω loudspeaker
S2A, S2B or S2C speech synthesis board
i.c. sockets

Constructor's Note

All components including the speech boards are available from **Modus Systems Ltd., 29A Eastcheap, Letchworth, Herts, SG6 3DA (04626 74468/76392).**

The interface board (ex. transformer and loudspeaker) is £14.95 ex. VAT and p&p, and the S2A board is £39.95 ex. VAT and p&p.

checked with the greatest care for any incorrect soldering or component location.

When the unit is working, adjust the two pots on the interface, and the pot on the synthesis board for the best sound. Any tendency toward instability will almost certainly be removed by adding to the power supply decoupling capacitors. Experimentation with the loudspeaker mounting is very worthwhile. Try mounting the speaker in a closed cardboard box with just the speaker cone exposed through a hole of the same diameter. The prototype gave excellent results with a speaker in a transistor radio housing. The speaker should be around two inches or more in diameter for the best results, any smaller and the important base responses will be lost.

COMPUTER SPEECH

It is expected that a number of readers will want to attach the unit to a microcomputer and this section deals with its interface to the Compukit, and the Edukit. The interface requirements for the two machines are sufficiently different to provide an excellent illustration of the process.

In order to operate the speech board effectively, the host computer should have two output lines and one input, as well as the six data lines, usually derived from the data bus, to supply details of the exact word to be spoken. One of the output lines is used to clock the six bit word into the data latch, the other output is used as a "start" signal to the speech board, and the input line is connected to the "busy" line and monitored by the computer to ensure that a new word is not requested before the current one is finished. This last line is not necessary if a delay loop is used by the computer to ensure that the next word is never output too soon.

The Edukit has several input and output lines for these purposes, and its interface is very straightforward. Fig. 2.7 shows a tried and tested arrangement. The Edukit is based around the RCA 1802 MPU which has a number of special and useful features for hardware control. One of its lines, called the Q line, is a flip-flop output whose condition may be set by a couple of dedicated machine-code instructions—one to set and one to reset. This output is used here as a "start" signal. The Edukit has a transistor connected to the Q line, and a couple of pins on the board give access to its collector (through a 100 ohm resistor). A load resistor (2k2 at least) should be connected across the pins, and the collector end of the resistor (pin nearest to the keyboard) should be connected, as shown, to the "start" line of the interface. Thus, the Q output from the 1802 is inverted, and starting of the speech output is effected by first setting Q (giving zero at the "start" line), resetting and setting Q again. This provides a short pulsed "one" on the "start" line.

The Edukit also has a number of input lines, called "External Flags" (EF lines). The states of these lines may be examined by a comprehensive set of jump instructions in the 1802. The "busy" line, therefore, may be examined by EF1, for instance, and the next word sent when the "busy" line returns to a "one".

To transfer data from the computer, the lower six data lines are used, and a further output line is necessary to latch these data bits into the interface's latches. Again, the 1802 is well designed to allow the presence of "output" data on the "data bus" to be signalled by a particular set of output lines (N0 and N2). On the Edukit, one of these lines is inverted and used to allow data to be shown on the digital display. The signal appears at pin 3 of the display drivers, (IC11 or IC12), and it is from here that the latch enable of the interface should be drawn.

To ensure that the unit is interfaced correctly, write a program to turn the Q line off, then on, then off again.

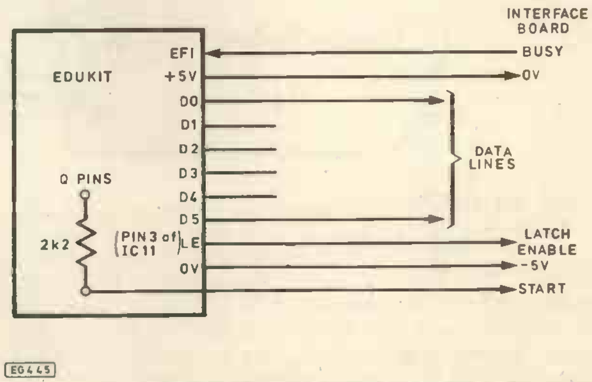


Fig. 2.7. Edukit interface board

Whatever word is held on the latch (IC2) will now be heard when the program is run. If this is working, the hex equivalent of the word spoken will appear on the digital display.

Fig. 2.8 gives a flow chart of a typical piece of software to output all the words offered by the speech board. Either 24 or 64 words are offered on the board, and this will decide when the last word has been spoken. The routine starts by setting the Q line to a "one", and setting the contents of the memory location (called "I" here) to the number 0, which is the first word to be spoken. The OUT instruction is then used exactly as for outputting to the digital display. "I" is then incremented and Q set to 0 for a short time. The word spoken should agree with the digital display reading. A loop is then entered which simply repeats until the "busy" line returns to a 1 level. When this happens, a check is done to determine whether the last word has been spoken; if not the process is repeated, otherwise the end is reached. This routine, does, of course, form the basis for operating any system, though the exact manner in which the checks are made, and the data output, depends upon the hardware set-up involved.

Interfacing to the Compukit is a rather more difficult business as there are no I/O lines on the board. There are two approaches which may be considered. Which is chosen depends upon whether a quick experimental set-up is sufficient, or a fully operational unit capable of controlling the speech fully is required.

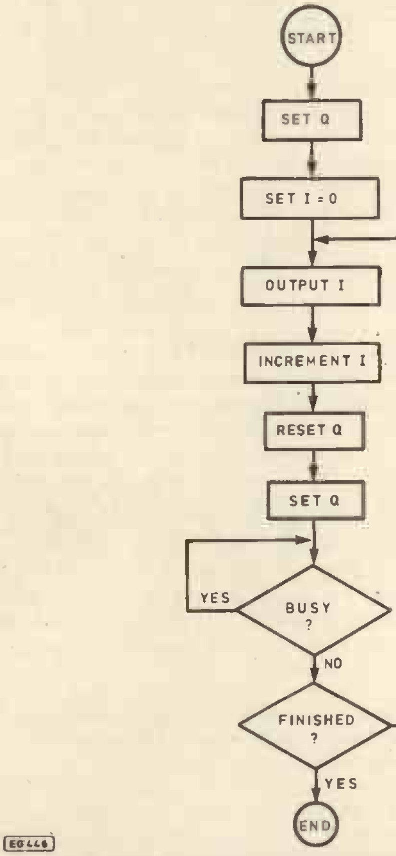


Fig. 2.8. Flow chart to output all the words offered by the speech board

A quick interface to the Compukit, which is by no means a finished set-up, but will give a flavour of the use of speech for a later more sophisticated approach is shown in Fig. 2.9. Here, the top 2K of RAM i.c.s are removed, and their "data" lines, "supply" lines and "chip select" lines are used to drive the speech unit. Notice that the RS lines from the Compukit need inverting before being able to drive the "start" line. The easiest solution is to use any small signal transistor for the job. This interface proved perfectly satisfactory, and should be realised by a couple of d.i.l. headers, rather than by soldering to the p.c.b. When the Compukit is reset and cold started, the Monitor does a memory test, and hence the RS lines are activated. This should cause a word to be output. The theory of operation of this interface is as follows. When a word is to be output, a POKE statement is performed to any memory location in the top 1K of memory. This causes RS7 to go low when the "data bus" contains the desired word. The word is then latched by the speech interface. The next operation is to POKE any location in the next to last 1K of memory—any value will do. This causes RS6 to fall to a zero for a short time, which, via the transistor invertor,

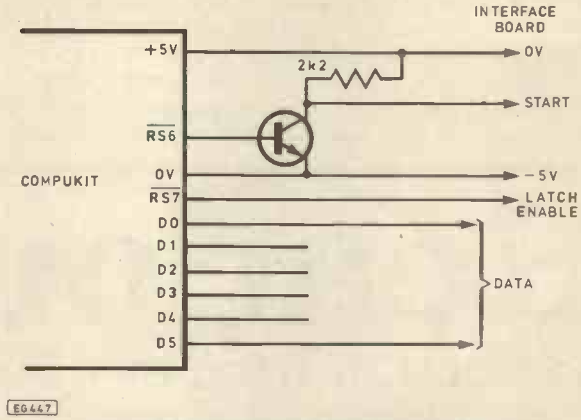


Fig. 2.9. Simple Compukit interface

causes the "start" line to rise for a short time and the speech board outputs the latched word. No provision is made for monitoring the "busy" signal, and if a string of words is to be output, then it is necessary to include a delay loop such as:

FOR I = 1 TO 1500 : NEXT I

between each word output.

The upper 1K of memory starts at decimal 7168, and the next 1K below at 6144. Thus, for instance, the following program will "say" all the words on the 24-word version of the speech board.

```
10 FOR J = 0 TO 23
20 POKE 7168,J
30 POKE 6144,0
40 FOR I = 1 TO 1500
50 NEXT I
60 NEXT J
```

The upper value in line 40 depends upon the frequency of the clock on the speech board, and hence may need to be adjusted to ensure that nothing is lost.

The above interface should not be viewed as a long term method of providing the Compukit with speech. The correct approach is to use a PIA type device such as that detailed in the PE Compukit articles. By this means, the "busy" signal can be used to ensure that nothing is lost, and the top 2K of RAM remains free. An excellent and general interface project for the Compukit is described in a set of articles by D. E. Graham, starting in the next issue of PE. The project is perfectly set up to control the speech board as well as many other things. Another advantage of this interface is that it allows the use of digital to analogue converters. The need for such devices, with reference to speech, is mentioned below.

GENERAL NOTES

Any digital device which displays decimal information, such as a digital clock, digital car instruments, test gear etc. should be able to be interfaced with the speech unit described here. Some demultiplexing may be required, and the on-board latch provides the basis of such circuitry. Though a major application is for computer speech, a computer is by no means necessary to drive the unit.

In using the speech unit, it is worth pointing out that any word spoken to the human ear out of context may be misheard or misunderstood by the listener. It is therefore a good idea to listen through the complete vocabulary, at least once, while following a written copy. This should adequately attune the ear to the sound being produced.

To experiment with voice output fully, the pitch of the utterance must also be controlled in real time. The speech boards allow the clock frequency to be supplied from an external source, and an external D to A converter followed by a voltage controlled oscillator would be a method of allowing computer control of pitch. Volume could also be adjusted at IC3, and, along with pitch, ultimate control of the process would result. The next step would be to produce a piece of software which automatically determines and controls the pitch and volume depending upon context and syntax of the utterance. Although the speech unit presented here is relatively simple, it is more than adequate for these and many other sophisticated experiments in speech synthesis. Indeed, the unit is actually useful, and provides the user with yet another source of output from electronic equipment. This is especially true when the eyes are busy with other tasks, but constant monitoring of numerical data is required.

Finally, the author would like to thank Mr. M. Terkow of Modus Systems for his assistance in prototyping and checking many of the ideas presented in these articles. ★

Readout...
A selection from our Postbag

Velikovsky: Frank Hyde Replies

I offered to answer specific questions from Mr. Austin but so far none have come to hand. However since Messrs Warlow and Williams have added their criticisms on this matter it gives me an opportunity to assume that, certain main themes are themselves statements of belief if not scientific fact, accepted by these gentlemen.

First let me make it clear that I am dealing with the matter from my own original edition of Velikovsky's "Worlds in Collision". Most of the book consists of statements without any support other than quotations from random works of the past. Much of the support for his own ideas are drawn from the biblical text. It is here that quotation is regarded as confirmation of physical facts and as is all too common with this kind of "proof" is not sufficient to substantiate the claims.

Dominant among the statements which serve to antagonise physicists and astronomers are the claims that a comet was ejected from Jupiter. Let us take this as a starting point and I quote page 48 of "Worlds in Collision" *"In the middle of the second millenium before the present era, as I intend to show, the earth underwent one of the greatest catastrophes of its history. A celestial body that only a short while before had become a member of the solar system—a new comet—came very close to earth"*. Then for some 14 pages of quotations of various happenings interspersed with statements such as *"the tails of comets are composed mainly of carbon and hydrogen gases. Lacking oxygen, they do not burn in flight, but the inflammable gases, passing through an atmosphere containing oxygen, will be set on fire"*. Well the earth passed through the tail of Halley's comet in 1910 but no one noticed it nor was the tail visible, let alone on fire. It is perhaps wise to point out here that the "tail" of a comet appears as the comet approaches the body which determines its perihelion passage. If the comet is large the "tail" will be produced in a direction away from the body it approaches and will continue as it passes round the body to point away from it. It may be that more than one "tail" appears. Sometimes the tail is insignificant and sometimes there is no visible "tail". Halley's comet is due in 1986 and between now and then there is to be a mission to observe the comet at first hand. Thus will all doubt as to the composition be settled. Beyond saying that there is an abundance of literature available about comets which when read will give some of the answers, I will leave the actual comet in order to test the *statement* by Velikovsky that Venus was originally a comet ejected from Jupiter. This he says occurred around the year 1500 BC. The Book of Exodus provides the details of what happened when the comet grazed the earth. Many very strange things are told such as, the houses of the Egyptian people were destroyed, the Nile ran red etc. The curious thing about it all was that the houses of the Israelites were not affected. After forty years the comet came back and caused further trouble, to go off and again return, and, after hitting the earth, again bringing it to a standstill before going on to upset Mars into its present orbit and itself settling down as Venus. The earth regained its place and continued on as it was, before all these events took place. All this supported by historical facts quoted from the Bible and other writings from various parts of the world. These are very far reaching statements and thus need careful examination. Many so-called scientific predictions have gone awry even when evidence appears to be adequate to make a forecast. However there are certain everyday facts of natural science which must be satisfied before new and astounding statements can be accepted. Let us then look at what the statements of Velikovsky imply in relation to comets.

The basis of many of the statements attends on "belief". Because many of the cometary orbits lie near Jupiter a number of people including Laplace and Pierre Simon put forward the view that Jupiter might be the source of cometary bodies. However there are no writings in support of the fact nor indeed are there any sightings of it ever happening nor has Jupiter ever been observed to have unusual events occurring in its vicinity. One person, V. S. Vsekhsviatsky does believe that comets are ejected from volcanoes on the satellites.

I will not resort to writing out the mathematics in this reply but will give the consequences as are known and used in astronomical physics. Of course if anyone would like to have the full mathematics I will send them, if a stamped addressed envelope is supplied. The effect of projection of a portion of Jupiter of the density and size to end up as a planetary body like Venus, would be to raise the temperature of Jupiter several thousands of degrees centigrade. This would have melted the body being ejected and therefore it would probably be dispersed as dust or vapour. Thus it is unlikely that even a comet (assuming that a comet is not anything like current thinking) could exist or survive such an experience. There is another problem also. The escape velocity at Jupiter is of the order of 20km/second. Whatever the escape mechanism might be it would not be aware of this fact for if the velocity of escape was 70km/second the comet/planet would fall back into Jupiter, if it were 73km/second it would escape from the solar system. In either case it is more likely that Jupiter would be considerably changed and not its stable self as has been observed over a far longer period of time than as recently as 1500 BC.

There is still a further problem. This is the mass of Venus. It amounts to rather more than 5×10^{27} grammes. The total kinetic energy that would be required to propel Venus to the escape velocity of Jupiter is of the order of 10^{41} ergs. This poses an even greater problem than all the others put together for 10^{41} ergs is equivalent to all the radiation energy of the sun for a year. Or in other terms one hundred million times more powerful than the largest solar flare ever observed.

A final word on this situation, which is occupying more space than is justified. Velikovsky has quoted several rapidly occurring collisions involving planets yet the odds against it happening once in a millenium is 30,000 years. Surely unwritten folk stories and legends must defer to practical and demonstrable facts, for this is why David Birch was dismissive.

Frank W. Hyde, FSE,PEng, FRAS.

This correspondence is now closed—Ed.

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Compiled by DJD.

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

THIS month's Micro-Bus presents six BASIC programs for the Sinclair ZX80 microcomputer.

LARGE CHARACTERS

The ZX80 is unusual among microcomputers in that its character-set is stored in ROM alongside the BASIC interpreter, and characters are written to the display by software. *Bob Sharp*, of Corby, has discovered how to PEEK the ROM and produce displays of large characters. His three programs generate displays of 32, 8 or 2 characters of increasing size. They can give the alphanumeric characters and graphics symbols. together with the symbols "# $: ? .". As well as being extremely revealing about how the ZX80 works, the programs would be useful for creating large displays for teaching or shop-window advertising.

In the ZX80 the character set is stored, starting at address 448*8 in the ROM, as a sequence of 8 bytes per character. Each byte codes the bit pattern for one line of the character matrix. A "1" in that byte is displayed as a black dot, and a zero as a white dot. Thus, for example, the 8 lines for the character with code N can be printed, in decimal, by executing:

```
10 INPUT N
20 FOR R=0 TO 7
30 PRINT PEEK ((448+N)*8+R)
40 NEXT
```

Converting these decimal numbers to binary will then reveal the shape of the character.

HUGE EIGHT

The simplest program of the three to understand is Huge Eight, see Fig. 1, which generates 2 lines of 4 characters; for example, see Fig. 2. The Huge Eight program prints a space character, or an inverted space character, for each bit of the characters, thus giving characters 8 times larger than normal. For each line of 4 characters the character codes (plus 448) are stored in the array I(0) to I(3). Then, for each row in these characters (line 120) the ROM is PEEKed (line 140) and the bits are printed (line 160) starting with the high-order bit. A zero is printed as a space, code 0, and a one as an inverted space, code 128. The expression (X/2** (7-H)) divides X, the row in the character matrix, by successive powers of 2. The low-order bit of the result determines whether, when the result is multiplied by 128, the code produced is 0 or 128.

```
 10 REM HUGE 8
 30 INPUT A$
 60 FOR E=0 TO 1
 70 DIM I(3)
 80 FOR N=0 TO 3
 90 LET I(N)=448+CODE(A$)
100 LET A$=TL$(A$)
110 NEXT N
120 FOR G=0 TO 7
130 FOR U=0 TO 3
140 LET X=PEEK(8*I(U)+G)
150 FOR H=0 TO 7
160 PRINT CHR$(128*(X/2**(7-H))
);
170 NEXT H
180 NEXT U
190 NEXT G
200 NEXT E
```

Fig. 1. Huge Eight program gives a display of eight large characters on a ZX80

Fig. 2. Display generated by the Huge Eight program

GIANT TWO

The Giant Two program, Fig. 3, converts each bit in the character matrix into a square of four spaces, or four inverted spaces, thus giving an enlargement of 16 times and filling the screen with two characters. The program works in a similar way to Huge Eight, except that now I(0) to I(7) hold the bytes of the character matrix for the first character, and I(8) to I(15) hold the matrix for the second character.

BIG THIRTY-TWO

The third of Bob Sharp's programs, shown in Fig. 4, gives four lines of eight characters, and is at first sight the most baffling to understand. It displays each block of four bits in the characters as the relevant graphics symbol, thus giving an enlargement of four times.

```
 10 INPUT A$
 20 DIM I(15)
 30 FOR N=0 TO 15
 40 IF N=8 THEN LET A$=TL$(A$)
 50 LET I(2*N-15*(N/8))=PEEK(N+
8*(448+CODE(A$)-N/8))
 60 NEXT N
 70 FOR T=0 TO 7
 80 FOR N=0 TO 1
 90 PRINT
100 FOR A=0 TO 1
110 FOR I=0 TO 7
120 FOR G=0 TO 1
130 PRINT CHR$(128*(I(2*T+A)/2*
*(7-I)));
140 NEXT G
150 NEXT I
160 NEXT A
170 NEXT N
180 NEXT T
```

Fig. 3. Giant Two program gives a display consisting of two large characters

```
 10 INPUT B$
 20 FOR A=0 TO 3
 30 FOR B=0 TO 3
 35 LET A$=B$
 40 FOR C=0 TO 7
 50 FOR D=0 TO 3
 55 LET Y=0
 60 FOR E=0 TO 1
 65 LET W=CODE(A$)
 70 LET X=PEEK(8*(448+W)+2*B+E)
 90 LET Y=4*Y+X/4**(3-D)-4*(X/4
**(4-D))
100 NEXT E
105 IF Y<8 THEN GO TO 120
110 LET Y=15-Y
115 LET E=0
120 LET Z$="07635B8D"
130 FOR N=0 TO Y
140 LET Z=CODE(Z$)
150 LET Z$=TL$(Z$)
160 NEXT N
170 IF Z>36 THEN LET Z=Z+119
175 IF E=0 THEN LET Z=Z+128
180 PRINT CHR$(Z-28);
190 NEXT D
200 LET A$=TL$(A$);
210 NEXT C
230 NEXT B
240 LET B$=A$
250 NEXT A
```

Fig. 4. Big Thirty-Two program displays four lines of enlarged characters on a ZX80

The program looks up two rows of each character, in lines 60 to 100, and calculates in Y a 4-bit binary number which specifies the

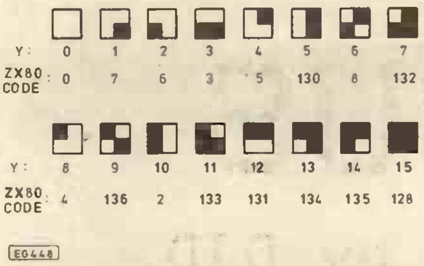


Fig. 5. The graphics symbols used by the Big Thirty-Two program, together with their ZX80 codes

states of the four squares in the graphics symbol. Thus Y=0 is a space, and Y=15 is an inverted space. However, finding the correct graphics symbol for the other values of Y is by no means an easy task, since the codes for the graphics symbols are apparently quite haphazard on the ZX80; the symbols and their ZX80 codes are shown in Fig. 5. Bob Sharp gets around this problem by providing a string, Z$ in line 120, whose characters specify the order of the first 8 graphics symbols. Lines 130 to 160 select the required character in this string, and then lines 170 to 180 convert this to the graphics symbol, and print it. The symbols for Y between 8 and 15 are obtained by inverting one of the first 8 graphics symbols in line 175.

This process is repeated to give the 32 graphics symbols for each line, and for the 16 lines of symbols, and the whole program takes almost two minutes to execute.

These three programs for generating large characters can be modified to give other punctuation and arithmetic signs, in addition to the alphanumeric characters, by replacing the reference to CODE(A$) with: 121-ABS(121-CODE(A$)).

MEMORY-MAPPED DISPLAY

Another unusual feature of the ZX80 is that there is not a precise mapping between the characters in memory and what is displayed on the screen; instead the display is generated from a "display file" which can reside anywhere in memory, and which can contain lines of different lengths so that trailing blanks do not have to be stored.

However, it is sometimes useful to be able to use the display as if it were memory-mapped, so that POKEing to a specific memory location will cause the code for that character to appear at a predetermined position, and PEEKing will read the code of the character at that position. The program of Fig. 6, submitted by *S. J. Duggins* of Birmingham, shows how to achieve this, and demonstrates its use by drawing lines, using inverted spaces, between two pairs of coordinates. The top left-hand corner of the screen has coordinates (1,1), and the bottom right-hand corner has coordinates (32,18). As an example, Fig. 7 shows four lines drawn by the program.

Mr. Duggins describes the operation of the program as follows: "The display file is first created in lines 20–40 by printing spaces. The coordinates are then entered as X1,Y1, and X2,Y2. If 99 is entered as the first coordinate the program will stop. The peculiar LET statements in lines 100 and 110 are used to save having to put four IF statements; their use is explained in the manual. The start address of the display file is then obtained in line 120 from the system variable D-FILE; since the file does not reside in a fixed area of memory the address is obtained before each POKE statement is executed, because even if a variable is assigned the display file will be moved. The reverse space is then POKEd in line 130 to the display position of the coordinates X1,Y1. Then Y1 coordinate (line number) is multiplied by 33 instead of the line width, 32, because a 32-character line does in fact contain 33 characters, the last one being inserted by the monitor as a newline marker. Line 140 checks to see if the second coordinates have been reached, and lines 150 and 160 increment or decrement the plotting coordinates to the next position.

```
 10 LET N=16396
 20 FOR A=1 TO 18*32
 30 PRINT " ";
 40 NEXT A
 50 INPUT X1
 60 IF X1=99 THEN STOP
 70 INPUT Y1
 80 INPUT X2
 90 INPUT Y2
100 LET X=X1<X2 AND 1 OR X1>X2
AND -1
110 LET Y=Y1<Y2 AND 1 OR Y1>Y2
AND -1
120 LET D=PEEK(N)+PEEK(N+1)*256
130 POKE D+(Y1-1)*33+X1,128
140 IF X1=X2 AND Y1=Y2 THEN GO
TO 50
150 LET X1=X1+X
160 LET Y1=Y1+Y
170 GO TO 110
```

Fig. 6. Program draws lines by POKEing to the ZX80 display file

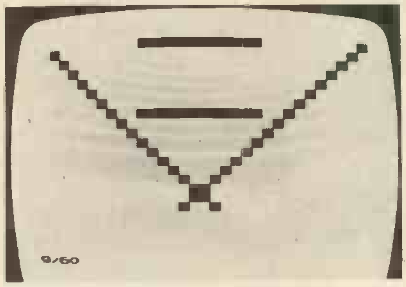


Fig. 7. Graphics drawn by the program of Fig. 6

Note that the program does not check that the coordinates are legal, and drawing to coordinates outside the display area may ruin the program."

STRING ARRAYS ON THE ZX80

Although the ZX80 provides strings and integer arrays, it does not provide string arrays, and this can be very tiresome when strings are being manipulated by a program. *Jeremy Ruston* of Kensington has devised an ingenious way around this restriction. A short routine, Fig. 8(a), sits below the main program and uses the string variables A$, B$, C$ . . . etc. as one string array of up to 25 elements. The number of the required element is passed in Z, and the string is transferred in Z$. The routine then POKEs the reference to C$ in line 2 or line 4 to alter it to the required string variable. On the ZX80 the first line of the program begins at address 16424, and the POKE addresses in lines 6 and 9 of the routine give the addresses of the "C"s in lines 4 and 2 respectively. Obviously the routine should not be altered without changing these POKE addresses.

```
 1 GO TO 12
 2 LET Z$=C$
 3 RETURN
 4 LET C$=Z$
 5 RETURN
 6 POKE 16446,38+Z
 7 GO SUB 4
 8 RETURN
 9 POKE 16436,38+Z
10 GO SUB 2
11 RETURN
12 GO TO 20
```

```
20 FOR Z=1 TO 10
30 INPUT Z$
40 GO SUB 6
50 NEXT Z
60 FOR Z=1 TO 10
70 GOSUB 9
80 PRINT Z$,
90 NEXT Z
```

Fig. 8. (a) Routine to implement a string array on the ZX80, and (b) a program to illustrate its operation

The routine is used as follows. Instead of:

LET A$(X)="HUGO DRAX"

(which is illegal on the ZX80) you write:

LET Z=X
LET Z$="HUGO DRAX"
GO SUB 6

Similarly, to print an element, instead of:

PRINT A$(8)

you would write:

LET Z=8
GO SUB 9
PRINT Z$

The program in Fig. 8(b) gives a simple demonstration of how the routine can be used; it reads in ten strings, and then prints them all out.

MAZE

The final program of Fig. 9 is very simple, but quite fun; it was devised by *D. Stocqueler* of Cardiff, and it draws a random maze on the screen using the ZX80's graphics symbols. His instructions are:

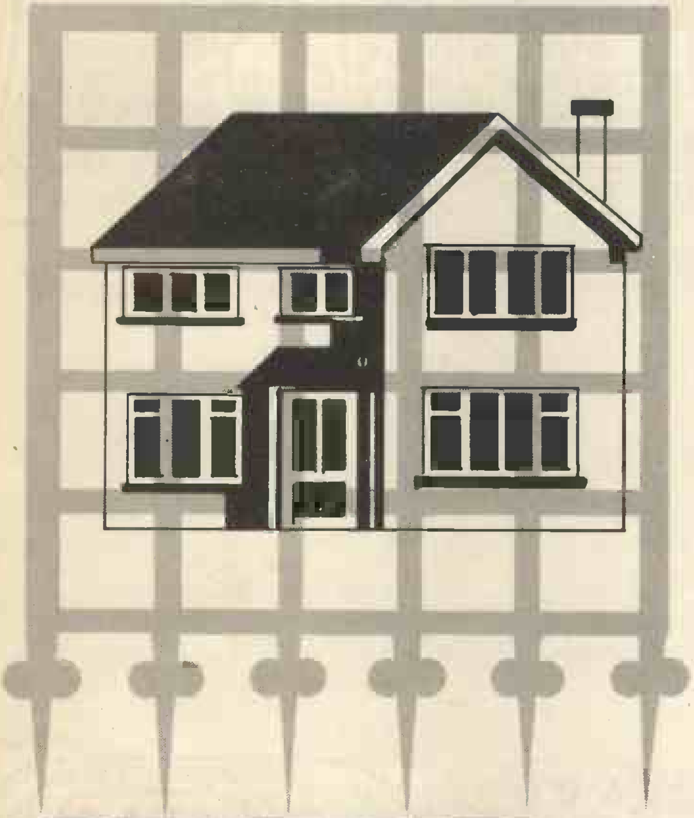
"The object of the game is to try and find a path between the letters A, B, C, D, W, X, Y or Z. Note that the letters may be joined by black or white paths, or they may not be joined at all."

Note that the computer does not ensure that a path exists; this is a much harder task, possibly beyond the capability of an unexpanded ZX80.

```
 10 REM MAZE
 70 CLS
 75 PRINT "A","B","C","D";
 80 FOR A=1 TO 750
 90 PRINT CHR$(RND(3));
100 NEXT A
105 PRINT
110 PRINT "W","X","Y","Z";
```

Fig. 9. Program to draw a random maze

SECURITY



SENTINEL...

Part 2 W.C. Dickinson

THE complete control centre is mounted on two p.c.b.s which are interconnected with ribbon cable. Connections to the sensor and alarm circuits are made via p.c.b. mounted terminal blocks.

CONSTRUCTION

The designs and component layouts for the two p.c.b.s is shown in Fig. 2.1. The Veropins should be soldered first then the rest of the components starting with the smallest. The terminal blocks, potentiometers, transformer and battery holder are all mounted on the track side of the p.c.b.s and should be soldered last. The l.e.d.s should be bent as shown in Fig. 2.2. before they are soldered in position.

When the ribbon cable has been soldered the battery holder can be secured to the p.c.b. via 4BA screws and 6mm spacers. The wires from the battery holder should be passed through the p.c.b. and soldered to the appropriate Veropins.

If nickel-cadmium batteries are used then the three links N1, N2 and N3 should be soldered. If alkaline batteries are to be used then the only link required is A1.

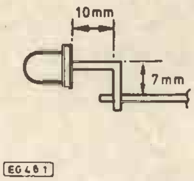


Fig. 2.2. Mounting details for the l.e.d.s. Note the orientation of l.e.d. 90 and 91 is different to the rest

Each channel of the Sentinel can provide either a delayed or immediate alarm signal when an intrusion is detected. The channels which will be used to monitor the normal entrances and exits should have a delayed alarm. Any channel will give an immediate alarm if D11, D21, D31, D41, D51 or D61 are soldered. So this diode should be omitted from any channel where a delayed alarm is required.

SETTING UP

Before carrying out the following adjustments ensure that the batteries are fully charged. Connect a 100kΩ resistor and a 1N4148 diode across each pair of alarm channel inputs with the cathode connected to the 'a' terminal as shown in Fig. 2.3.

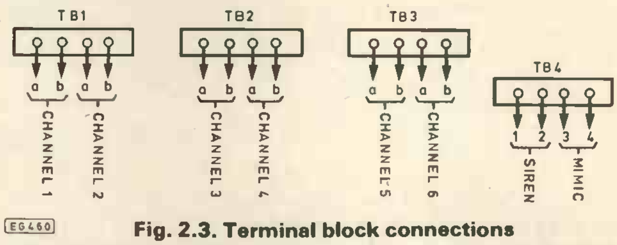


Fig. 2.3. Terminal block connections

Rotate VR10 to VR60 fully anti- clockwise (from the front of the p.c.b.). Insert the batteries depress all alarm channel select switches and release the activate switch. The 'operational' l.e.d. should illuminate in approximately three quarters of a second. None of the channel 'alarm' l.e.d.s should illuminate. Depress the 'system' switch to the 'defeat' position and using an insulated screwdriver adjust VR10 slightly clockwise. Release the 'system' switch to the 'activate' position. When the 'operational' l.e.d. illuminates depress the 'system' switch to the 'defeat' position. Repeat the above procedure until the channel 'alarm' l.e.d. illuminates when the 'system' switch is released to the 'activate' position. Back VR10 off slightly and release the 'system' switch to the 'activate' position. Repeat this procedure until the channel 'alarm' l.e.d. does not illuminate when the 'system' switch is released. Repeat this procedure for the remaining five alarm channels. If any channel displays an erroneous alarm adjust the preset of the offending channel slightly anti-clockwise until normal operation resumes.

REMOTE MIMIC

The remote mimic (Fig. 2.4.) should be installed near the door which is normally used to leave the house. If the pre-siren option is used then the system alarm l.e.d. cannot be used.

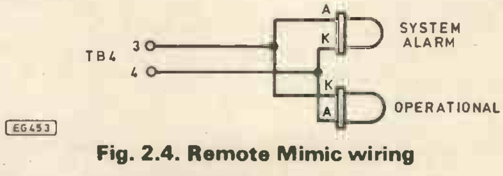


Fig. 2.4. Remote Mimic wiring

PRE-SIREN SIGNAL UNIT

A small piezoelectric sounder can be driven (Fig. 2.5.) instead of the remote system alarm l.e.d. The sounder can be

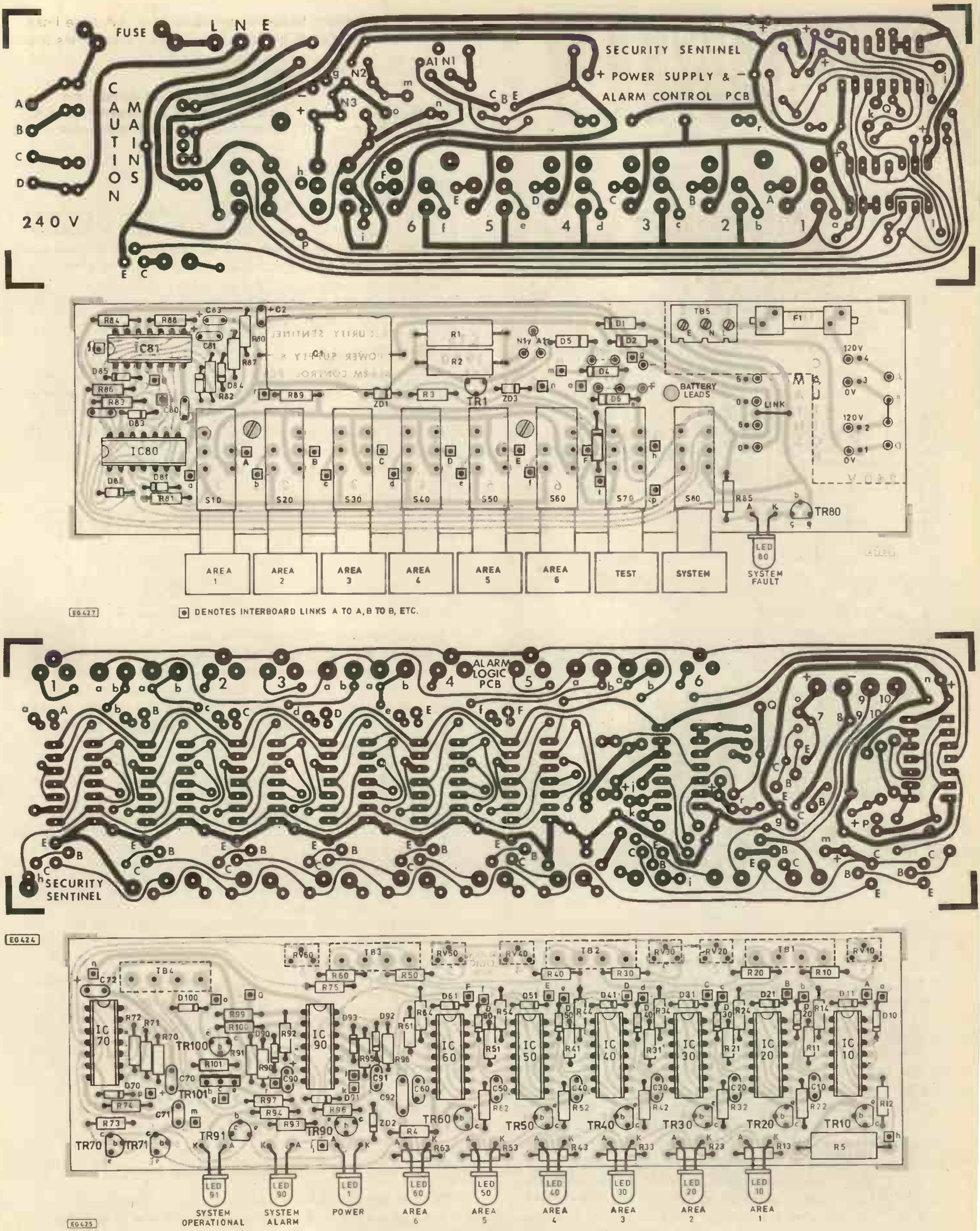


Fig. 2.1. P.c.b. designs and component layouts

used to provide an alarm in advance of the siren being triggered. If this option is used then the value of resistor R89 should be increased to 3M6 to increase the 'immediate alarm' delay time to 30 secs. This enables the system to be defeated before the siren is triggered.

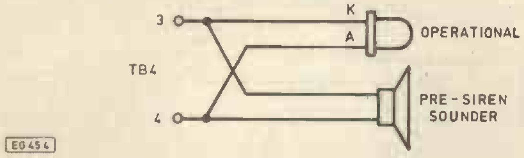


Fig. 2.5. Pre-signal unit wiring

SIREN

Selecting a location for the siren is just as important as selecting the location of the control centre. An ideal arrangement is to have one siren mounted inside the house in a secluded place and a second unit mounted in a high, inaccessible location outside the house. Most systems will only use one unit and this should be mounted near the eaves with the wiring routed through the loft.

ALARM LOOP INSTALLATION

The wiring of the alarm unit will be determined by the layout of the house and the degree of protection required.

SENSORS

Each alarm channel must include one 'tri-mode' sensor and can have up to a maximum of four. An unlimited number of 'bi-mode' sensors, conventional switches, window foils, trip wires and pressure pads may be incorporated in the loop together with fire sensors and 'panic switches'.

TRI-MODE SENSORS

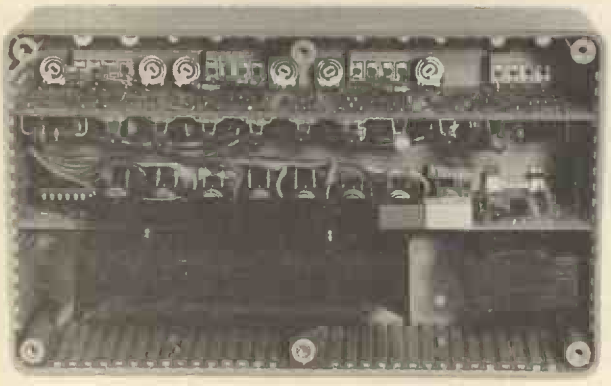
These sensors provide protection against an opened door or window, a magnetically shunted or an electrically shorted sensor. All large windows and external doors should have 'tri-mode' sensors.

BI-MODE SENSORS

These sensors provide protection against an opened door or window and a magnetically shunted sensor. These sensors should be used on external doors and windows when the number of doors and windows in a loop exceed the number that can be protected by 'tri-mode' sensors. The 'tri-mode' sensors should be fitted to the most vulnerable windows and doors with 'bi-modes' fitted to the remainder.

CONVENTIONAL SENSORS

Conventional sensors consist of magnet and reed switch combinations used alone. They can be fitted to windows on first floors to reduce installation costs. They can also be used to provide back-up protection by fitting them to between adjoining rooms. This would however prevent the system being used when the house is occupied.



Internal view of the Sentinel

SHUNT DEVICES

Shunt devices normally take the form of pressure mats fitted under carpets. Magnet and reed switch combinations can also be used in this configuration if they are used to sense a door being closed. Pressure mats are normally fitted near windows, doors and passages between rooms. The use of shunt devices also prevents the system being used when the house is occupied.

WINDOW FOILS

Window foils are inexpensive and easy to install but are very conspicuous and easily shunted. If a 'tri-mode' switch is added to the middle of a foil loop it can be made virtually tamper-proof.

'TRI-MODE SWITCH ASSEMBLY

Before any 'tri-mode' switches are fitted into the system it should be decided how many are to be used in each channel (remember at least one per channel is required to establish the loop impedance). The number of switches will determine the value of resistor Ra (Table 1).

Number of 'tri-mode' switches (per channel)	Value of Ra
1	100kΩ
2	47kΩ
3	33kΩ
4	24kΩ

TABLE 1: All the 'tri-mode' switches in a particular channel should have the same value resistors.

The selected resistor Ra should first be soldered to a germanium diode (OA91) and then fitted into the reed switch assembly as shown in Fig. 2.6.

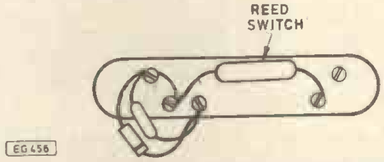


Fig. 2.6. After soldering, the resistor and diode should be fitted inside the switch. Note the reed switch is fitted inside the body of the switch and cannot be seen.

DESIGNING A LOOP

The basic principle of the alarm loop is that it presents a resistance of 100kHz during one phase of the multivibrator. If the resistance of the loop decreases to 80kΩ or less an alarm is sensed. During the other phase of the multivibrator the loop should present a resistance less than 10kΩ. If the resistance of the loop increases to 100kΩ or greater an alarm is sensed. The first phase monitors the loop for short circuits and shunt sensors being activated the second phase monitors the loop of continuity of the series sensors.

When designing a loop there are three basic rules that must be followed:

a) In order to maintain maximum noise immunity twin conductor wire should be used from sensor to sensor. This is important if the sensors are some distance apart or the alarm wiring is in close proximity to the electrical wiring in the house. Wiring in one area, say around a large set of windows, can be separated into single cores whenever it is convenient to do so.

b) The reverse resistance of the loop should be approximately 100kΩ when the loop is safe. This resistance is determined by the sum of the resistors in the 'tri-mode' sensors. (cathode of diode D positive with respect to its anode).

c) The forward resistance of the loop should be less than 10kΩ when the loop is safe. This resistance is determined by the series resistance of the wire and the diodes in the 'tri-mode' sensors. (cathode of diode D negative with respect to its anode).

A basic system would take the form of a 'tri-mode' switch at the external door and at any windows which can be forced open to provide access for the average size person. 'Bi-mode' switches should be fitted to the remaining windows. Doors and windows which are in dark or secluded areas require extra attention as these areas will be the most likely points of attempted access. 'Tamper proof' window foils should be installed on all glass panes in these localities.

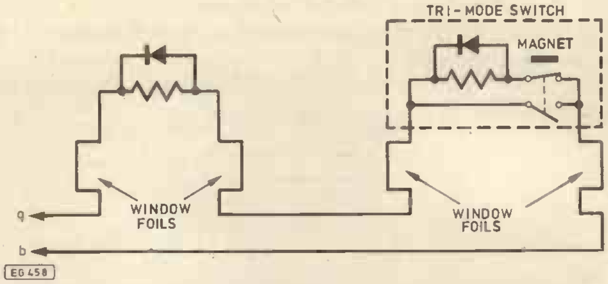


Fig. 2.10. Tamper-proof system for window foils.

TAMPER-PROOF FOILS

Because window foils are conspicuous and are easily shunted the basic type should only be used on fixed opaque glass such as those found in bathrooms. A tamper-proof arrangement for foils can be developed by using a resistor-diode combination from a tri-mode switch in the foil loop of a fixed window. If the window can be opened then it is better to incorporate a tri-mode switch into the loop, this ensures that the alarm will be triggered if either set of foil terminals is shunted.

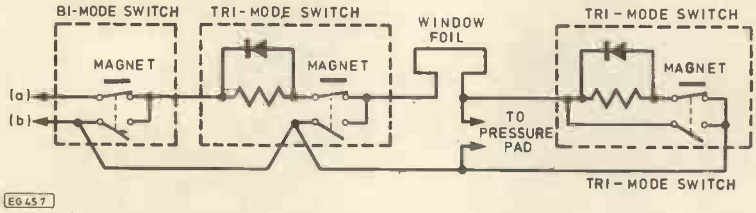


Fig. 2.7. Basic loop system. If a shunt device is used at the end of a loop then an extra wire is required. To overcome this problem each loop should end with a tri-mode switch

One of the major advantages of the 'tri-mode' concept which requires only one twin-conductor wire from the control panel to the area being protected is that only one 'tri-mode' switch need be fitted initially. When time and budget allow, the loop can be expanded without disturbing the existing installation. Wiring is also greatly simplified by this design.

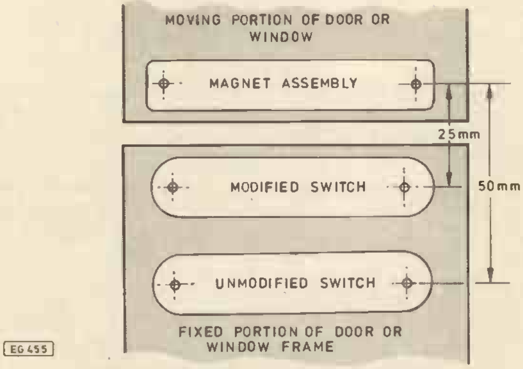


Fig. 2.8. Switch mounting details

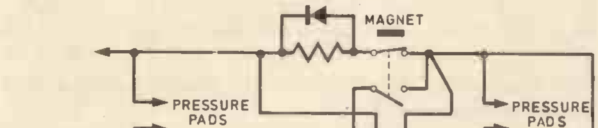
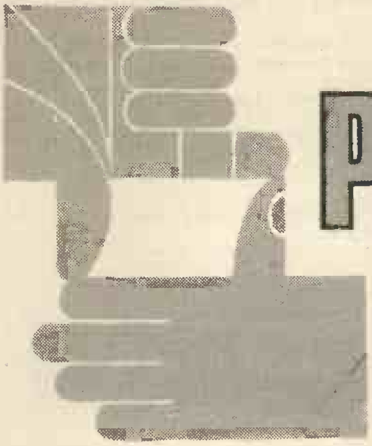


Fig. 2.9. Shunt sensors can be connected across the loop or across a 'tri-mode' sensor

An unlimited number of bi-mode switches can be developed from conventional switches and although bi-mode and tri-mode switches can be used in either leg it is easier to wire all the series devices in 'a' leg and use the 'b' leg as the return.

OPERATION OF THE SYSTEM

Operation of this system is straightforward due to the built-in automatic test facilities. When you are ready to leave the premises close all windows and doors that are monitored and release all of the channel selector switches to the 'activate' position. As you leave release the 'system' switch to the 'activate' position. When the 'operational' l.e.d. illuminates the system is completely clear of alarms and has initiated the exit delay. You now have one and a half minutes to make your exit and close the door behind you. If the system goes to 'fault' when it is activated the channel which is causing the alarm will be identified by the flashing channel 'alarm' l.e.d. If you wish you can depress the channel selector switch to 'defeat', cycle the 'system' switch to 'defeat' and then back to 'activate'. The system will now ignore the alarm sensed on this channel and you can make your exit. The facility to 'defeat' selected channels was provided for use mainly when you use the system to protect the house when it is occupied and you only wish to protect key areas of the premises. When the house is unoccupied the source of the alarm should be identified and corrected before you depart. When you return and re-enter the house you will trigger the system immediately. The entry delay timer allows you one minute to reach the control centre and depress the 'system' switch to 'defeat' before the siren is triggered. The 'operational' status when you depart and the 'system alarm' status when you re-enter are verified by the remote l.e.d. mimic as confirmation that the system is operating correctly. ★



PATENTS REVIEW...

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

BOSE SPEAKERS

European patent application no. 0 007 453 originates from the Bose Corporation of Framingham, Massachusetts. The aim of the invention is to provide the electronic equivalent of mechanical adjustments which are necessary on some of Bose loudspeakers. According to Bose design philosophy a loudspeaker should radiate more sound energy onto a reflecting surface, such as a room wall, than directly into the listening area. This is said to simulate the sound received in a concert hall where the listener receives significantly more reflected energy than direct energy from the sound source on the stage.

This (highly controversial) approach can result in an unnaturally broad sound image which spreads across the entire surface of the wall which is reflecting the indirect sound from the loudspeakers. Some control of the image spread is possible if the user physically adjusts the angle of the loudspeakers with respect to the nearest wall. But as Bose admit in the new patent application, this is "impractical in many situations". The new idea is to provide add-on circuitry which enables the user to vary the image without altering the loudspeaker position.

The Bose 901 loudspeaker is shaped rather like a chunky slice of cake and (see Figure 4) four identical full range loudspeaker drivers 21–24 and 25–28 are mounted on each of the two rearwardly facing and mutually angled panels 120 and 121. A single front facing driver 29 is mounted on the front panel 30 to fire directly into the listening area. The nine drivers are connected in series between loudspeaker terminals 31 and 32 with the junction of front driver 29 and inside rear driver 25 connected to an extra terminal 33. As shown in figure 5, the audio signal input 44 is split between an "inside" channel of amplifier 47, resistor 48 and amplifier 51 and an "outside" channel of amplifier 52, resistor 53 and amplifier 54. The gains of amplifiers 47 and 52 are of equal magnitude but opposite sense to provide phase reversal. Capacitor 55 couples the arm 42 of a potentiometer or "spatial control" 41 to earth. Central terminal 33 of the loudspeaker system is also connected to earth. In this way the spatial control alters the ratio of sound energy generated by the inside and outside panels, but only above a frequency of around 300Hz. Frequencies below 300Hz, which are largely non-directional, are unaffected and radiated at equal level by both the inside and outside panels of the loudspeaker. Moreover the overall radiated power from both rear panels remains constant, irrespective of the changing ratio of radiation between panels. Adjustment of the potentiometer arm 42 should thus vary the perceived image without audible change of volume.

According to Bose the modification is immediately applicable to Model 901 loudspeakers which already have the necessary three terminals, but models 501 and 601 speakers will need some modification. It will be interesting to chart the progress of application no. 0 007 453 through the European Patent Office because the text contains self-congratulatory statements which are arguable and of a type normally inadmissable in a patent document, e.g. according to Bose the 901 system "has met with wide critical and consumer acclaim throughout the world, receiving an unprecedented series of rave reviews"!

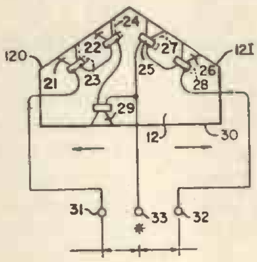


FIG. 4

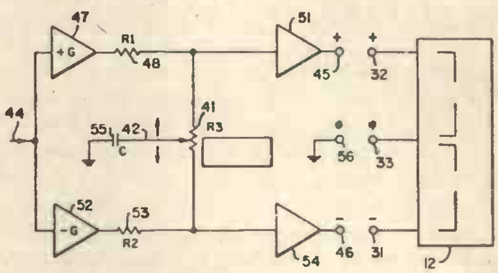


FIG. 5

POINTS ARISING

THE PERSONAL COMPUTER BOOK by Robin Bradbeer *in PE October 1980 (Review)*

NOTE: Input Two-Nine, the publisher of this book has been taken over by Gower. Those who read this review should note that the book is now available from: Gower Publishing Company, 1 Westmead, Farnborough, Hants, GU14 7RU.

News Briefs

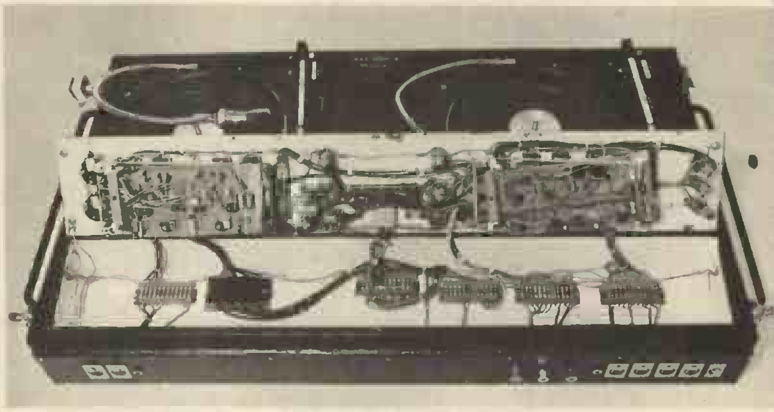
LARGER PREMISES

ACE MAILTRONIX has moved into larger premises at 3A, Commercial Street, Batley, W. Yorks WF17 5HJ. The company specialises in Electronic Components for magazine projects in addition to its electronic component catalogue listing approx 1000 items available from stock by mail order. The catalogue is available now, priced 30p to mail order customers, and refundable with subsequent orders over £5. Callers are welcome during normal working hours Monday to Friday and on Saturday mornings, to whom the catalogue is free. Since its formation in 1977 Ace Mailtronix has helped many magazine project builders to find the more awkward components.

DISCO DESK

Part 4 BEN DUNCAN

IN this part the 12V subsystem, output routing and monitor switching, together with wiring, will be detailed.



PANEL WIRING

The mounting of the components and interwiring is a large task and must be approached systematically. All steps must be carefully checked, because the correction of small errors at a later stage can be very time consuming. A wiring colour code is extremely helpful provided you are not colour blind, in which case the choice of colours would be limited. A table (next month) gives a suitable colour code.

Begin by mounting components on the front panel. Set the rotary switch spigots for the appropriate number of switch positions. When mounting the slide pots and microphone transformer, ensure that the screws do not extend more than 1mm beyond the tapping, othewise damage may result. The sliders are mounted on spacers so that a standard length screw may be used. Use Selotape to hold the spacers in place whilst the slider bezel, screws, panel and slide pot are aligned. Note that although the slider bezels specified are self-adhesive, they are drilled to accept the slide pot's fixing screws. Next, mount all the components on the edge panel. These can be wired directly to their respective barrier strips and the panel can be bolted in place. Then mount barrier strip no. 7 under the turntables. If the relays are mounted on a plate, then it is convenient to wire these up on the bench to their associated components, and then to mount the plate next to barrier strip no. 7 and complete the interwiring. At this stage all the wiring in Fig. 15 can be completed. When the front panel components are all mounted, this panel should be bolted to the console frame by means of hinges along the top edge. The panel should be arranged to sit in the position shown in dashed lines on this figure; this arrangement greatly eases the task of wiring up.

Before beginning the wiring, check the switch positions, ensure that the cards fit their respective edge connectors, especially when the panel is lowered and ensure that the edge connectors are the right way up, so that they connect with the card terminals when the components are facing you. Most important of all, the log sliders must be correctly orientated; pins 11 and 21 are 'earthy' and go to 0V, i.e. these are uppermost when the panel is hinged back.

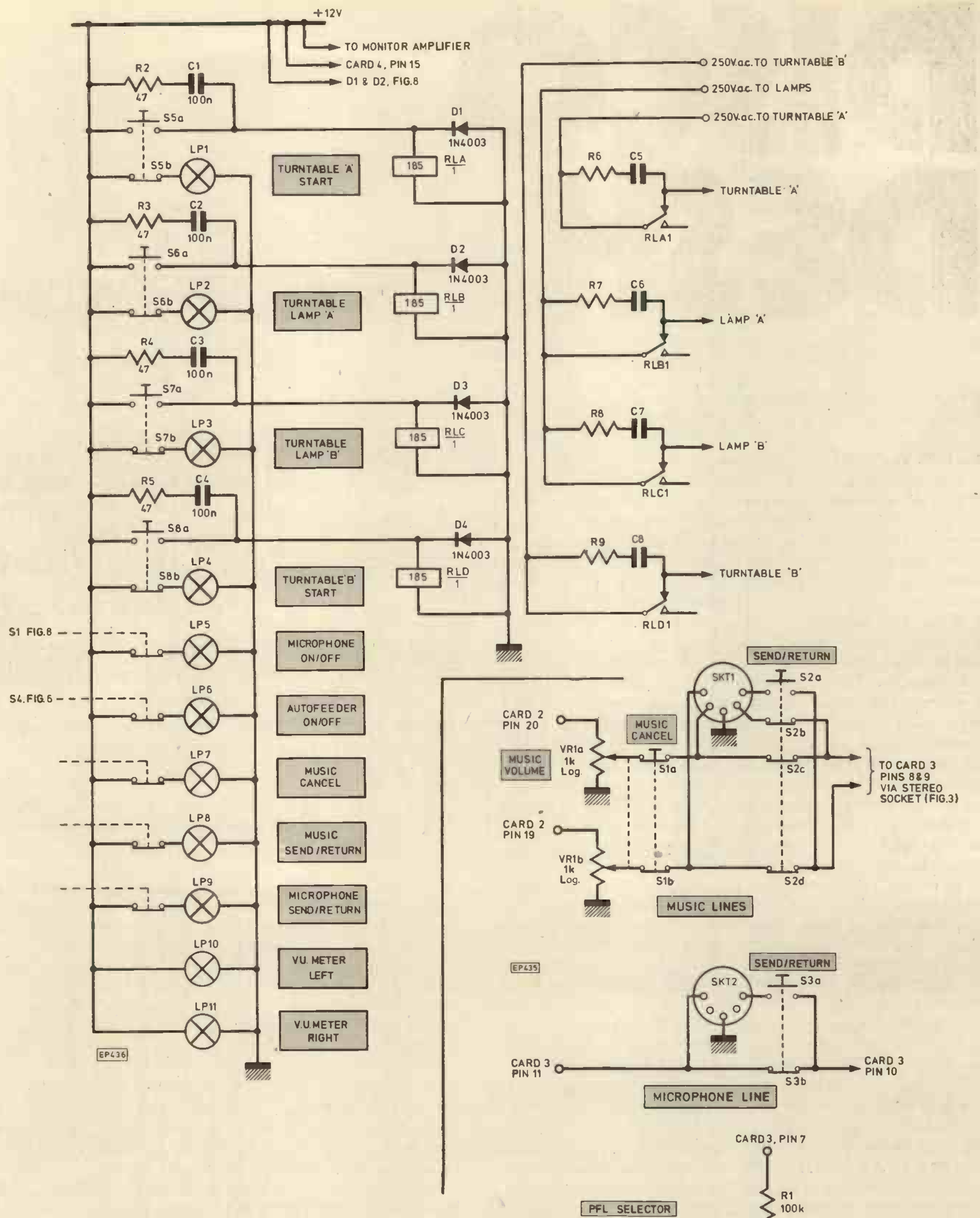
Wiring begins with the 'chassis earths'. Unlike the 0V connections, these go directly to the mains earth from screens and all exposed metalwork, which must be permanently earthed. The 0V connections on the other hand can be 'ground-lifted' to prevent hum loops. It must be emphasised that the chassis and 0V earths should be regarded as being entirely separate. Connect all handles, panels, screens, turntables, gooseneck arms and other exposed metalwork via 16/0·2 wire to the chassis earth commoning point.

12V SUBSYSTEM

The 12 volt subsystem should be wired next and the relays, lamps and monitor amplifier can be tested if a 12V supply is to hand. The lamps are normally wired via the spare contacts on each push-button switch. However, extra switch elements may need to be added to certain switches to ensure a consistent pattern, i.e. 'lamps on' = 'function on'. Also test for isolation between chassis earths and the 12V '0V' connections. Before wiring the left-hand edge connector socket, attach a generous length of wire to the VU meters. These will be wired later, but they are difficult to reach once the adjacent sockets are wired. Likewise, be sure that the 12V subsystem switches adjacent to the right-hand (Cards 3 and 4) edge connectors are correctly wired. Remove edge connector 2 and commence wiring connector 1. Sleeve alternate connections and cut off generous lengths of wire. It will only be possible to connect a few cables as yet, but route the cables as far as possible, using self-adhesive aluminium cable clips to hold them in place temporarily, in conjunction with re-usable cable ties.

When all the connections to the Card 1 edge connector have been made, replace edge connector No. 2 and recommence. As the work progresses, the cable looms will take shape and the loose ends will be tied up. However, where multiple connections are to be made, as on the routing switches and at the power supply bus-bars, the easiest course of action is to attach and solder all the connections simultaneously, and for this reason they are best left until the remainder of the wiring is completed.

Next Month: Completing the wiring



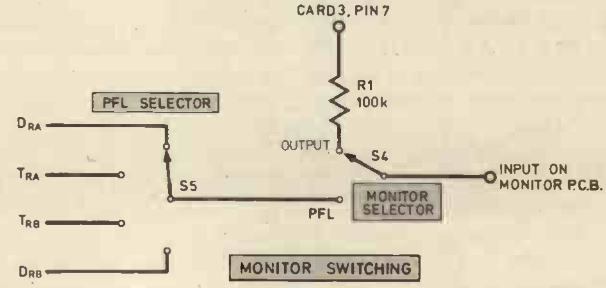


Fig. 14 (Above) 12V subsystem showing turntable and lamp remote switching relays (these are mounted under the turntables)
(Right) Output routing and monitor switching

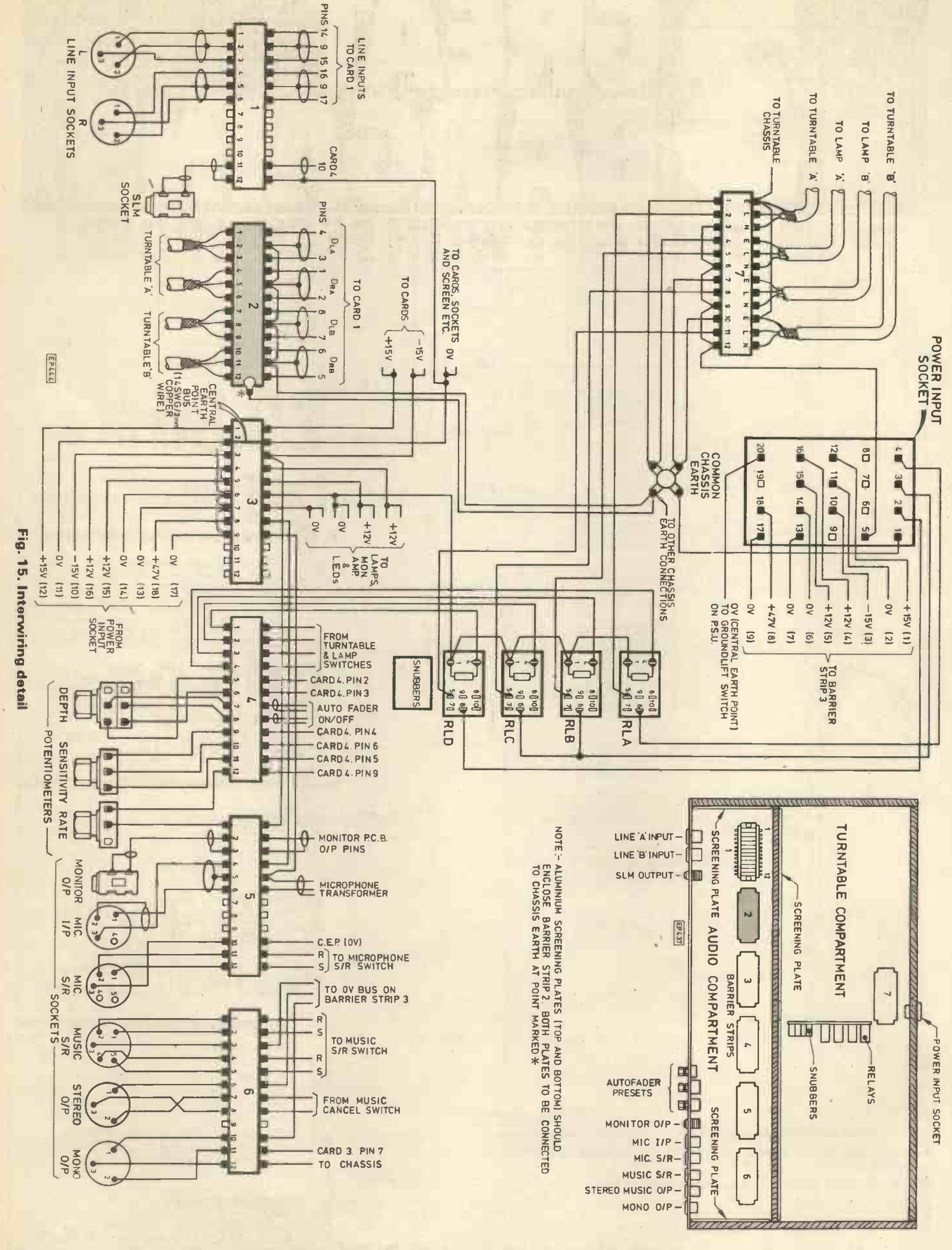


Fig. 15. Interwiring detail

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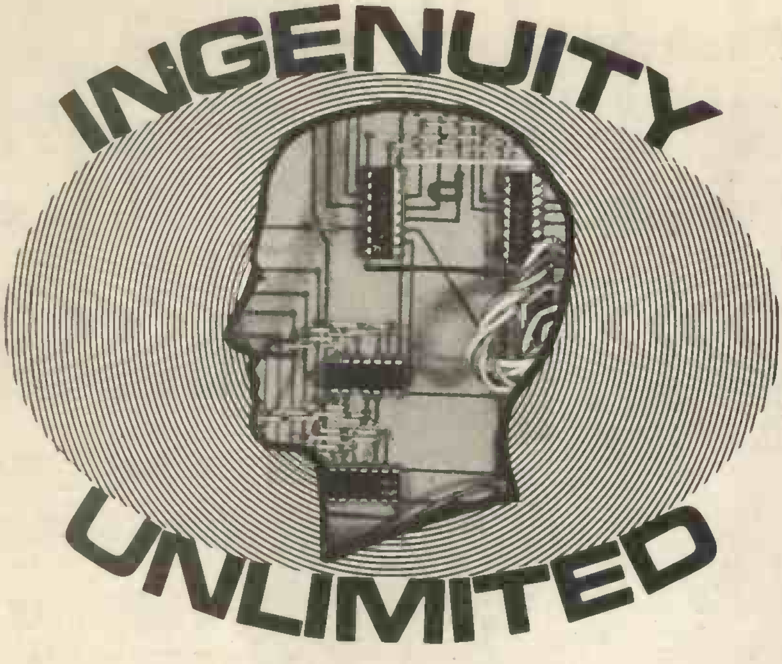


A selection of readers' original circuit ideas. It should be emphasised that these designs have not been proven by us. They will at any rate stimulate further thought.

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

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

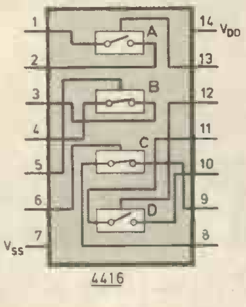
Each idea submitted must be accompanied by a declaration to the effect that it has been tried and tested, is the original work of the undersigned, and that it has not been offered or accepted for publication elsewhere.

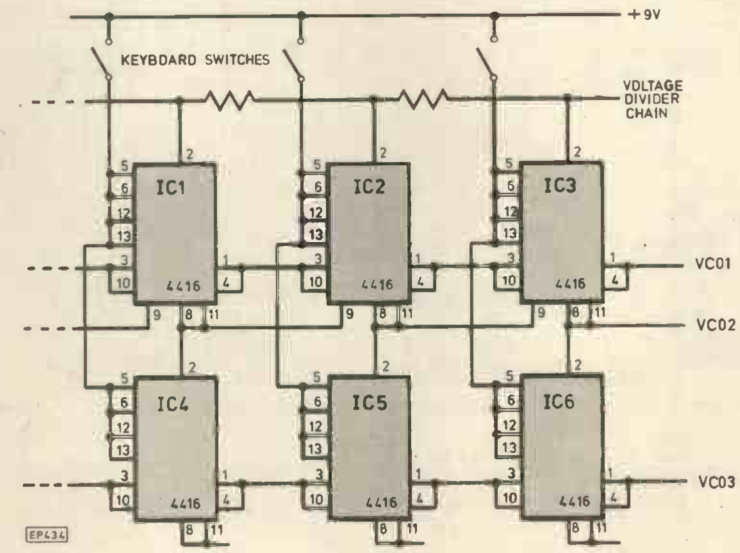
HERE is an electronic substitute for a polyphonic electromechanica. keyswitch assembly. The 4416 is a quad bilateral switch. When a logical '0' is applied to all control inputs, switches A and D are open and switches B and C are closed. When a logical '1' is applied to all control inputs, the reverse happens A and D are closed and B and C are open.

In my design there are two 4416 i.c.s for each keyboard contact. The keyboard can now use simple single pole contacts. When a keyboard contact is pressed, a logical '1' is supplied to the 4416s of that keyboard contact activating the s.p.d.t. switches, and that particular voltage is supplied to VCO1 hold. If any further keys are pressed they will supply simultaneously the relevant voltages to the VCO holds and so on. The voltage divider is now situated between the i.c.s and not on the keyboard contacts. (Power supply connections are omitted from the figure for simplicity — all pin 14s to +9V, pin 7s to 0V.)

The system only uses three of the s.p.d.t. switches, but it can be expanded to provide simultaneous programming for more. 8 or 10 notes played together might be feasible. Alternatively the unused s.p.d.t. switch can be used to provide the −ve voltage for the triggering of the envelope shapers etc. The ohmic resistance of the 4416 switches provides isolation for the VCO hold circuits. All the usual rules should be observed when handling CMOS i.c.s.

R. M. Pimlott,
Bexleyheath,
Kent.





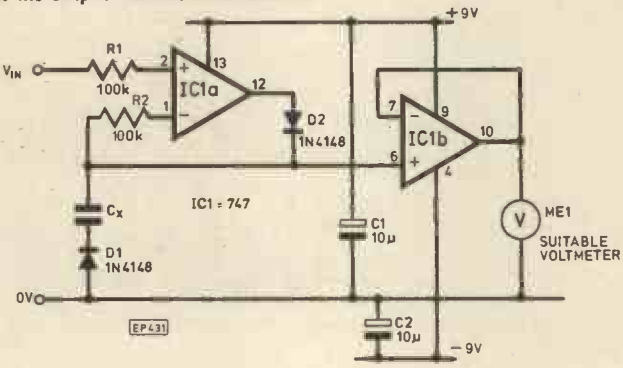
KEYBOARD SWITCHES

A TRUE PEAK-READING D.C. VOLTMETER

THE accompanying circuit shows a simple method of reading the *peak* rather than the average of a d.c. waveform. Of course, this may be applied to an a.c. signal simply by rectification prior to feeding the signal to this circuit. Two 741-type op amps are used, in this case in the form of a dual device. The peak voltage is held in a capacitor C_X, which is charged further whenever the comparator IC1a detects that the input voltage exceeds the value on C_X. D2 prevents reverse leakage into IC1a output, while D1 restores the d.c. offset caused by D2.

IC1b is a simple voltage follower to preserve the leakage resistance from C_X at a high value. In fact, this value will be of the order of 10 megohms. With a 0·22µF capacitor at C_X, the time constant is of the order of 1·5 seconds, giving a good response to a music or audio signal. By using a value as high as 100µF (tantalum) at C_X, a "peak-hold" effect is obtained, with a time constant of some minutes. D.c. offset at the output has not been found to exceed a couple of mV, when using 2 × PP3 for the supplies. Supply-line current drain is about 4mA.

R. J. Crowther,
Stourbidge,
West Midlands.



SIMPLE PULSE GENERATOR

SHOWN is the circuit of a simple pulse generator which is useful for testing the operation of digital circuits. It uses a type 4011 CMOS integrated circuit and functions as follows.

The monostable formed from IC1a and IC1b is triggered by momentarily grounding pin 6 through S1 and then generates a negative going pulse of duration T1, at output A, and a positive pulse, of duration T2, at output B. With the component values shown VR1 will set the duration T1 in the range 50 milliseconds to 1 second. If the triggering pulse or closure of S1 has duration T then for:

$T < T1$ then $T1 = T2$
$T > T1$ then $T2 = T$

Thus output B can also provide a "de bounced" digital signal corresponding to the position of S1.

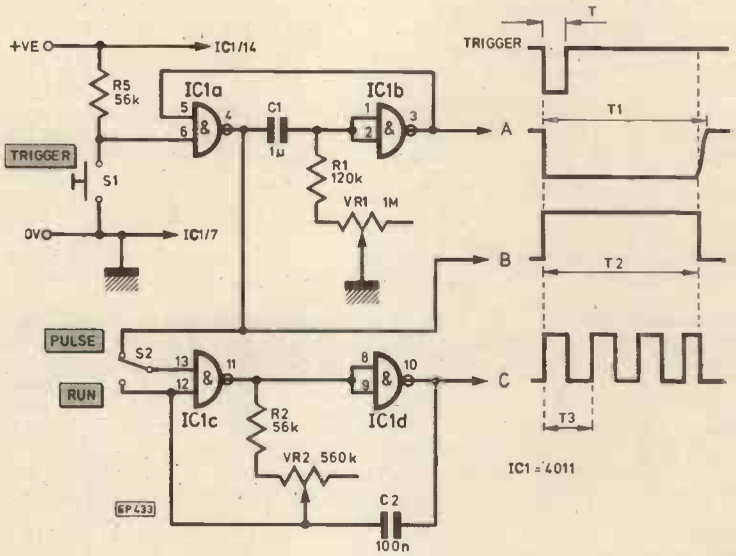
IC1c and d are interconnected to form an astable which can generate pulses of duration T3 varying from about 2 to 100 milliseconds depending on the setting of VR2. With S2 set to "Pulse" the astable is gated by output B and is therefore controlled by S1 to give either a train of N pulses, where N ≈ T2/T3, or a continuous pulse train at output C. If S2 is set to "Run" then output C provides a continuous pulse train independant of S1.

When S2 is set to "Pulse" and VR1 at maximum, VR2 can be set so that N = 1 to 10. Output C can then be used to check a counter/decoder/display circuit, each momentary closure of S1 advancing the counter system by N pulses.

Alternatively, with S1 set to "Run", output C can be used as a source of "clock" pulses, whilst outputs A and B are used for "gate" or "data" pulses.

The supply voltage V+ should be equal to that of the circuit under test and can conveniently be taken from the supply rails of the latter. Each output will drive two TTL or 20 CMOS inputs.

G. B. Wills,
Ealing.



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JANUARY 1980 TO DECEMBER 1980

VOLUME 16

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NEWS AND COMMENT

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BCA14	all purpose solder cream, non-electrical jointing and repairing.	£1.38

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1949	Iron coated bit 3/32" for 1948	£0·53
1950	Iron coated bit 1/8" for 1948	£0·53
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1931	X25 25 watt iron, ceramic shaft and another shaft of stainless steel to ensure strength	£4·88
1935	Replacement element for 1931	£1·84
1932	Iron coated bit 1/8" for 1931	£0·57
1933	Iron coated bit 2/16" for 1931	£0·57
1934	Iron coated bit 3/32" for 1931	£0·57
1953	SK1 soldering Kit – contains 15 watt soldering iron with 3/16" bit plus two spare bits, a reel of solder, heat-sink and a booklet 'How to Solder	£6·38
1939	ST3 iron stand made from high grade bakelite chrom plated steel spring, suit all models – includes accommodation for six bits and two sponges to keep the iron bits clean	£1·86
1724	Model MLX as X25 iron but 12 volts	£5·29

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No.	Length	Width	Height	Price
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171	140mm	75mm	205mm	£4·85
172	140mm	110mm	205mm	£6·30

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No.	Length	Width	Height	Price
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156	11in	6in	3in	£3·10
157	6in	4¾in	1¾in	£1·93
158	9in	5¼in	2½in	£2·59

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159	5¼in	2¼in	1½in	£0·98
160	4in	4in	1½in	£0·98
161	4in	2¼in	1½in	£0·98
162	5¼in	4in	1½in	£1·10
163	4in	2½in	2in	£0·98
164	3in	2in	1in	£0·67
165	7in	5in	2½in	£1·54
166	8in	6in	3in	£1·98
167	6in	4in	2in	£1·32

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

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168	2¾in	7½in	4in	16in	4½in	11in	£8·21

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AMPLIFIERS

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AL20	5 watt Audio Amplifier Module 22-32v supply	£4.73
AL30A	7-10 watt Audio Amplifier Module 22-32v supply	£5.51
AL60	15-25 watt Audio Amplifier Module 30-50v supply	£6.81
AL80	35 watt Audio Amplifier Module 40-60v supply	£10.67
AL120	50 watt Audio Amplifier Module 50-70v supply	£17.38
AL250	125 watt Audio Amplifier Module 50-80v supply	£25.91

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PA100	Supply voltage 24-36v inputs:– Tape, Tuner, Mag P.U., Suit: AL60/AL80	£20.30
PA200	Supply voltage 35-70v inputs:– Tape, Tuner, Mag P.U., Suit: AL80/AL120/AL250	£20.98

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MM100	Supply voltage 40-65v inputs: Mag. P.U., Tape Microphone Max. output 500mv	£14.29
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SPM80	33v Stabilised supply – suit 2 × AL60, PA100 to 15 watts	£5.57
SPM120/45	45v Stabilised supply – suit 2 × AL60, PA100 to 25 watts	£7.34
SPM120/55	55v Stabilised supply – suit 2 × AL80, PA200	£7.34
SPM120/65	65v Stabilised supply – suit 2 × AL120, PA200, 1 × AL250, PA200	£7.34
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2035	2 amp 55v	£7.30	£1.47
2036	750mA 17v suit PS12	£3.68	
2040	1.5 amp 0-45v-55v suit SPM120/45, SPM120/55v	£5.98	£1.21
2041	2 amp 0-55v-65v suit SPM120/55, SPM120/65v	£7.82	£1.47
2050	1 amp 0-20v suit Stereo 30	£3.74	£0.75
1725	150mA 15-0-15v suit SG30	£2.04	

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200	TR12A/200	£0·59	200	TR110A/200	£1·06
400	TR12A/400	£0·82	400	TR110A/400	£1·29

6 amp volts	No.	Price	10 amp volts	No.	Price
			400	TR110A/400P	£1·29
100	TR16A/100	£0·59			
200	TR16A/200	£0·70			
400	TR16A/400	£0·88			

DIACS

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IS922 150V	£0.09	IN5402 200V	£0.18
IS923 200V	£0.10	IN5404 400V	£0.19
IS924 300V	£0.11	IN5406 600V	£0.24
		IN5407 800V	£0.28
		IN5408 1000V	£0.34

1 Amp		10 Amp	
IN4001 50V	£0.05	IS10/50 50V	£0.21
IN4002 100V	£0.06	IS10/100 100V	£0.24
IN4003 200V	£0.07	IS10/200 200V	£0.26
IN4004 400V.	£0.08	IS10/400 400V	£0.40
IN4005 600V	£0.09	IS10/600 600V	£0.48
IN4006 800V	£0.10	IS10/800 800V	£0.58
IN4007 1000V	£0.11	IS10/1000 1000V	£0.69
		IS10/1200 1200V	£0.79

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IS029 1000V	£0.23	IS30/1000 1000V	£2.65
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20 THY600/20	£0.18
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100 THY600/10	£0.29
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50 THY1A/50	£0.30
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200 THY1A/200	£0.37
400 THY1A/400	£0.44
600 THY1A/600	£0.52
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3 amp Volts No.	TO 66 Case Price
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200 THY3A/200	£0.38
400 THY3A/400	£0.48
600 THY3A/600	£0.58
800 THY3A/800	£0.75

5 amp Volts No.	TO 66 Case Price
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100 THY5A/100	£0.52
200 THY5A/200	£0.58
400 THY5A/400	£0.66
600 THY5A/600	£0.79
800 THY5A/800	£0.93

5 amp Volts No.	TO 220 Case Price
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600 THY5A/600P	£0.79
800 THY5A/800P	£0.93

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200 THY7A/200	£0.66
400 THY7A/400	£0.71
600 THY7A/600	£0.90
800 THY7A/800	£1.06

10 amp Volts No.	TO 48 Case Price
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600 THY10A/600	£1.14
800 THY10A/800	£1.40

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400 THY16A/400	£0.89
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800 THY16A/800	£1.60

30 amp Volts No.	TO 94 Case Price
50 THY30A/50	£1.38
100 THY30A/100	£1.64
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200v RMS	BR1/200	£0·29	200v RMS	BR2/200	£0·60
400v RMS	BR1/400	£0·41	400v RMS	BR2/400	£0·67
			1000v RMS	BR2/1000	£0·78

SILICON 10 amp Type	No.	Price	SILICON 25 amp Type	No.	Price
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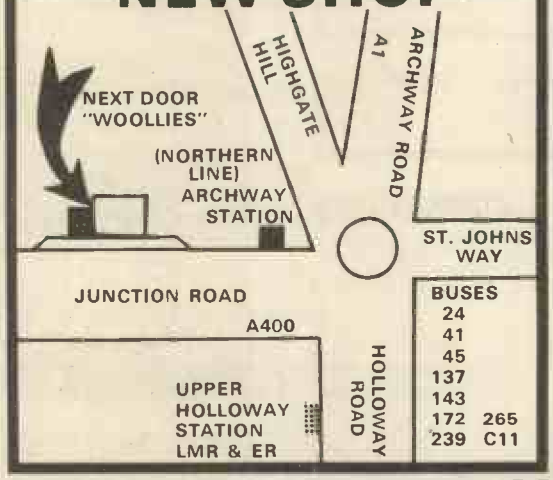

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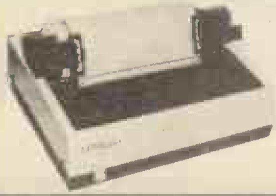

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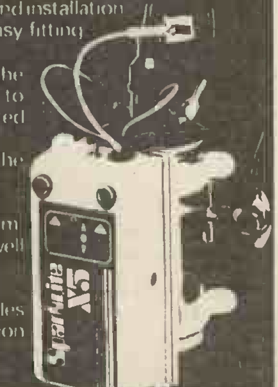

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7417	25p	74LS30	18p
7420	14p	74LS32	24p
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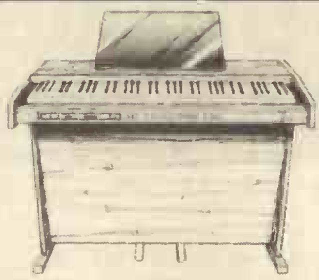

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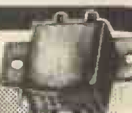

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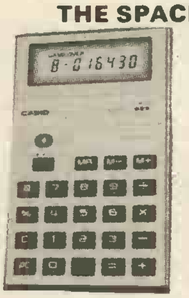

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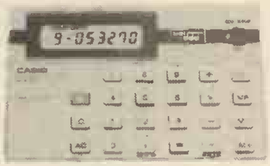

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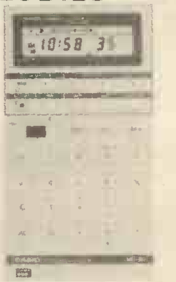

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£49.95

DER 048 Solar powered (right). Weekly programmable alarm, 16 hour interval countdown alarm timer, hourly chimes. 1/100 second stopwatch.
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We employ experts world-wide whose job it is to seek out products of the highest quality at the lowest possible prices. Illustrated here is just a tiny selection of our comprehensive range. Just compare these items with those seen elsewhere – we are confident the prices will amaze you. You can save ££££'s.

GENTS 5 FUNCTION LCD

A

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

£4.95p

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

HERE IS THE AMAZING 12/24 HOUR ALARM/CHRONOGRAPH

D

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

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B

£5.95p

E

LADIES QUARTZ LCD DRESS WATCH

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

£8.95p

C

GENTS LCD ALARM WATCH

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

£8.95p

THE ULTIMATE GENTS LCD CALCULATOR/ALARM WATCH

F

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

£39.95p

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

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WE ARE PROUD TO INTRODUCE THE AMAZING MELODY ALARM CHRONOGRAPH

ACTUALLY PLAYS

THE YELLOW ROSE OF TEXAS

BUT AS YOU CAN SEE FROM THE DETAILS BELOW THIS CHRONOGRAPH IS NO MERE NOVELTY

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

G

£14.95p

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

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

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

MAINS DIGITAL ALARM CLOCK

I

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£8.95p

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

£10.95p

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

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ADDRESS

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The advertisements to watch for quality precision at the right price. All goods dispatched by return.

PE 6

3 CHANNEL SOUND/LIGHT CHASER

LB31000SLC **£29.90**

A high performance sound to light system which automatically switches to a chase when the music ceases. Super sensitive with an anti interference circuit, the unit will operate from practically any amp and control up to 1,000W/channel, 5Hz to 70K. Controls: bass/mid/treble/master sensitivity/chase speed.

3 CHANNEL SOUND/LIGHT

LB31000SL

£21.40

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

2/4/8 CHANNEL CHASER

LB81000LC

£26.50

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

4 CHANNEL SEQUENCER

LB41000LS

£17.50

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

1 AND 3 CHANNEL DIMMERS

LB31000LD

LB31000LD
£14.70

Single channel version
LB11000LD **£6.70**

Power dimmer units for theatre/stage applications up to 1,000W per channel, with on board suppressing. The unit is also available without rotary pots for use with sliders —
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ROPE LIGHTS/DRIVER

LB41000LC-S
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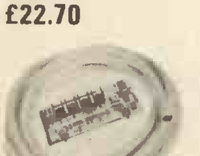

24 feet ropes
Red/Yellow
Blue/Green

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

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LBPA3
M – Magnetic
C – Ceramic

£30.70

Magnetic or ceramic deck versions – please state

NEW ADVANCED MODEL AVAILABLE

All the requirements of a stereo disco preamp on one board, left and right deck mixers/tone controls/mic. mixer/tones/mic. auto fade over decks/and P.F.L. The unit can be used with either LB100/150/250.
LBPA3PS – Regulated supply – £10.50.
Full set of pots — **£8.63** Sliders — **£11.21**

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

LBPA1 **£19.50**
A stereo hi-fi preamp and tone stage for mag. p.u./tape/tuner, etc. Set of pots £3.27, sliders £4.49.

3-WAY ACTIVE CROSSOVER

LBACO1
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LBPSU1
£6.20

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

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

25W R.M.S.	100W R.M.S.	150W R.M.S.	250W R.M.S.
20Hz to 60K	5Hz to 25K	5Hz to 25K	5Hz to 25K
0.07% THD	0.1% THD	0.1% THD	0.1% THD
96DB S/N	110DB S/N	110DB S/N	110DB S/N
LB25	LB100	LB150	LB250
£11.20	**£18.20**	**£26.50**	**£39.50**

Note all models are available with either 500mV or 775mV sensitivity. Please state when ordering.

LBRLD1
£5.70

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

POWER SUPPLIES

LB25PS	LB100PS	LB150PS	LB250PS
£11.20	**£14.70**	**£18.00**	**£24.50**
P/P £1.20	P/P £1.40	P/P £1.40	P/P £1.70

PIEZO HORNS
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P/P 50p

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(8 ohms)

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LBMM4 Mid-boost/cut for either LBMM1/2/3/4/5
LBMM5 Treble boost/cut for either LBMM1/2/3/4/5
LBPSU1 ± 15V supply for up to 8 modules
LBPSU ± 15V regulated for up to 50 modules
MM1 £4.50; MM2 £5.20; MM3 £5.70; MM4 £5.70; MM5 £5.70; PSU1 £6.20; RPSU £14.50.
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L & B
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These consist of spillages, floor sweepings, cosmetic imperfects etc. As we have no time to sort them they are magnificent value for the constructor.

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Membrane actuated, very sensitive, ¼" shaft, 250V, 3.75A Contacts Ideal for greenhouses, centrally heated homes, offices etc. Build your own humidifiers or alarms. Fraction of original cost 90p ea. 3 for £2.

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0·2" LEDS with 2 piece clips.

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Includes 150 sq. ins. copper clad F/G board. 1 lb ferric chloride 1 dalo etch resist pen. Abrasive cleaner. Etch tray plus instructions. Special Price £4.95
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150 sq. in. Single sided board £2.00
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MINIATURE MAINS TRANSFORMERS

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1,000 µf 100V Radial. 1⅜"×2" ONLY 70p. 3 for £1·50.

BD181 78 Watt T.O.3 Power Transistors. 60p ea. 3 for £1.
4AF1 Alternator Diodes. Ideal for making Battery Chargers etc. 4 make 50 amp bridge 50p ea. —Ve or +Ve case 2 of ea. £1.50.

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200 as above and includes AC128, 2N3055, BFY50, BD131, BF200 etc. £9.95
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Knobs for P/B Switches. Fit 3½ mm sq. shaft. 10 for £1. Chrome or Spun Aluminium Finish.

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Pri 220/240 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	.5	1	15V	2.90	0.90
79	1	2	O	3.93	1.10
3	2	4	N	6.35	1.10
20	3	6	L	7.39	1.31
21	4	8	Y	8.79	1.31
51	5	10		10.86	1.52
117	6	12		12.29	1.67
88	8	16		16.45	1.89
89	10	20		18.89	1.89
90	12	24		21.09	2.24
91	15	30		24.18	2.39
92	20	40		32.40	O.A.

50 VOLT RANGE (Split Sec)
Pri 220/240V Voltage available 5, 7, 8, 10, 13, 15, 17, 20, 33, 40 or 240V-0-20V or 25V-0-25V.

Ref.	Amps			Price	P&P
102	.5	1	25V	3.75	0.90
103	1	2	O	4.57	1.10
104	2	4	N	7.88	1.31
105	3	6	L	9.42	1.52
106	4	8	Y	12.82	1.73
107	6	12		16.37	1.89
118	8	16		22.29	2.39
119	10	20		27.48	O.A.
109	12	24		32.88	O.A.

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Pri 0-120; 0-100-120V (120, 220, 240V) Sec 60-55-0-55, 60 twice, to give 55, 60, 110, 115, 120, 125, 175, 180, 220, 225, 230, 235, 240.

Ref	VA	Price	P & P
•07	20	4·84	0·91
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	22·62	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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240V cable in 115V USA flat pin outlet.

VA	Price	P & P	Ref
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75	8·50	1·31	64W
150	11·00	1·31	4W
250	13·39	1·67	69W
500	20·13	1·89	67W
1000	30·67	2·65	84W
2000	64·97	O.A.	95W.

CONTINUOUS RATINGS

All voltages given are at full load

AUTO TRANSFORMERS

Voltages available 105, 115, 190, 200, 210, 220, 230, 240. Voltage for step up or step down.

Ref.	VA	£	P & P
113*	15	2·73	0·81
64	80	4·41	1·10
4	150	5.89	1·10
53	350	10·08	1·31
67	500	12·09	1·91
84	1000	20·64	2·39
93	1500	25·61	O.A.
95	2000	38·31	O.A.
73	3000	65·13	O.A.
80S	4000	84·65	O.A.
57S	5000	98·45	O.A.

*0, 115, 220, 240.

12 OR 24V OR 12-0-12V
Pri 220-240 volts

Ref	Amps 12V	Amps 24V	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	4·46	1·10
85	5	2 5	6·16	1·10
70	6	3	6·99	1·10
108	8	4	8·16	1·31
72	10	5	8·93	1·31
116	12	6	9·89	1 52
17	16	8	11·79	1·80
115	20	10	15·37	2 39
187	30	15	19·72	2 39
226	60	30	40·41	O.A.

Bridge Rectifier

100V	25A	£2.80
200V	4A	.52
200V	4A	.75
400V	4A	.98
400V	6A	£1.44
500V PM7A6	12A	£3.75

P & P 17p VAT 15%

20,000 ohm/V Multimeter mirror. Scale ranges AC/DC to 1000V DC current to 250ma. Resistance to 3 M Ohms 5"×3½×1½ £14·36. P.&P. £1·00. VAT 15%.

60 VOLT RANGE (Split Sec)
Pri 220/240V Voltages available 6, 8, 10, 12, 16, 18, 20, 24, 30, 36, 40, 48, 60 or 24-0-24V or 30V-0-30V.

Ref.	Amps			Price	P&P
124	.5	1	30V	4.27	1.10
126	1	2	O	6.50	1.10
127	2	4	N	8.36	1.31
125	3	6	L	12.10	1.31
123	4	8	Y	13.77	2.12
40	5	10		17.42	1.89
120	6	12		19.87	2.12
121	8	16		27.92	O.A.
122	10	20		32.51	O.A.
189	12	24		37.47	O.A.

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8 MK5	£106.40
71	£43.10
73	£58.60
MM5 minor	£36.90
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EM272 316KΩ per volt	£67.10
DA116 digital	£108.90
BM7 Megger	£58.60

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Antex Soldering Irons 15W, 25W £4.58. **Safety Stand** £1.75 P&P 52p each.

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Thorn, Cannon, Plessey, Bendix, Greenpar now available.

Soldering Iron – 25W to BS spec. £1·75 +30p P&P + VAT.

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0-36-48 twice to give 36-0-36 48-0-48V, 60V, 72V, 84V, 96V.

Amps	Ref	Price	P.&P.
0·5	430	4·88	0·76
1	431	8·12	0·99
2	432	13·35	1·31
3	433	16·17	1·40
4	434	20·65	2·11
5	435	29·30	2·47
6	436	36·69	O.A.
8	437	40·03	O.A.

15V Range
0-C Tap (7·5V-0-7·5V)

171 500mA	2·30	0 52
172 1A	3·26	0 92
173 2A	3·95	0·90
174 3A	4·13	0 99
175 4A	6·30	1 10

U4315 Budget Meter 20Kv/Ω Ranges to 1000V, 2 5A AC/DC 500K Res. In steel case **£15·85 P&P £1·32**

SPECIAL OFFER Multimeter (20KΩB/V with combined audio/I.F. test oscillator at 1KHz. and 465 KHZ. AC/DC to 1000 volts. DC current to 500 MA resistance to 1M size 160×97×40mm **£8·50. P&P £1·00, VAT 15%**

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TRANSFORMERS END OF LINE OFFERS

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M616 – 240V: Screen 1) 13-0-13 1A. 2) 12V 150ma **£1·50** 60p

M489 – 240V: 1400V @ 150ma 6,3V @ 4A **£5·50** £1·04

M708 – 6K to 3Ω matching transformer 5W **90p** 40p

M679 – 120V x 2; 36V 1·6A **£3·00** 78p

M865 – 100V Line to 4Ω 10 watts **£1·90** 60p

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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 ×	25·09	1 10
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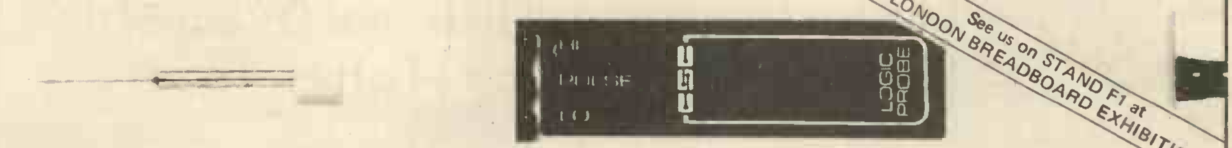

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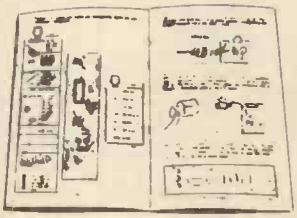

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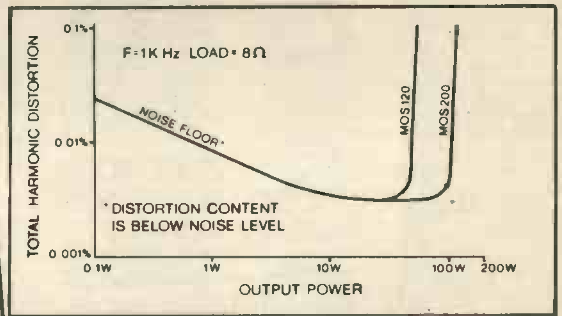

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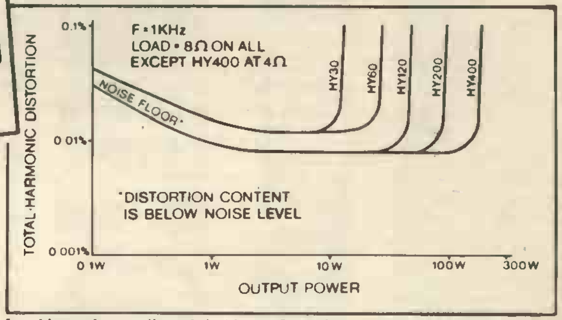

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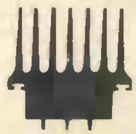

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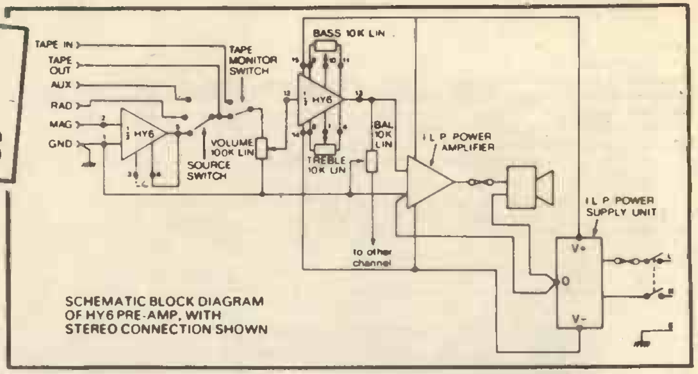

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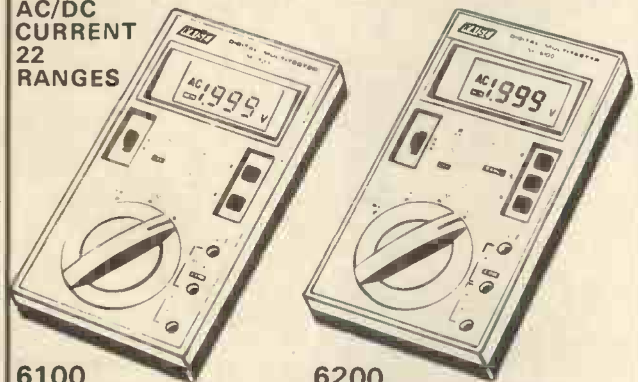

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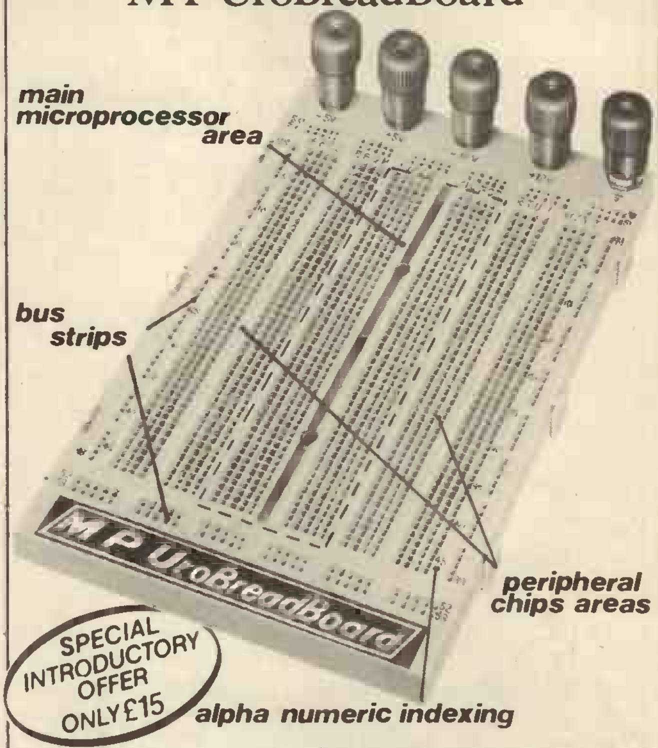

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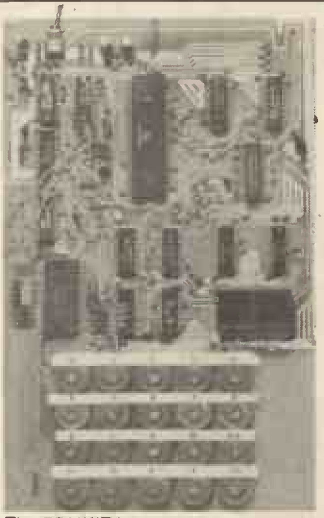

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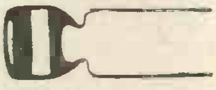

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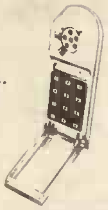

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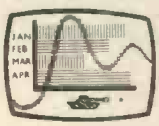

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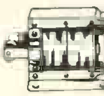

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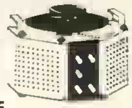

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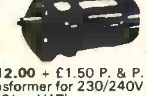

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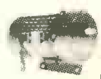

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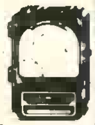

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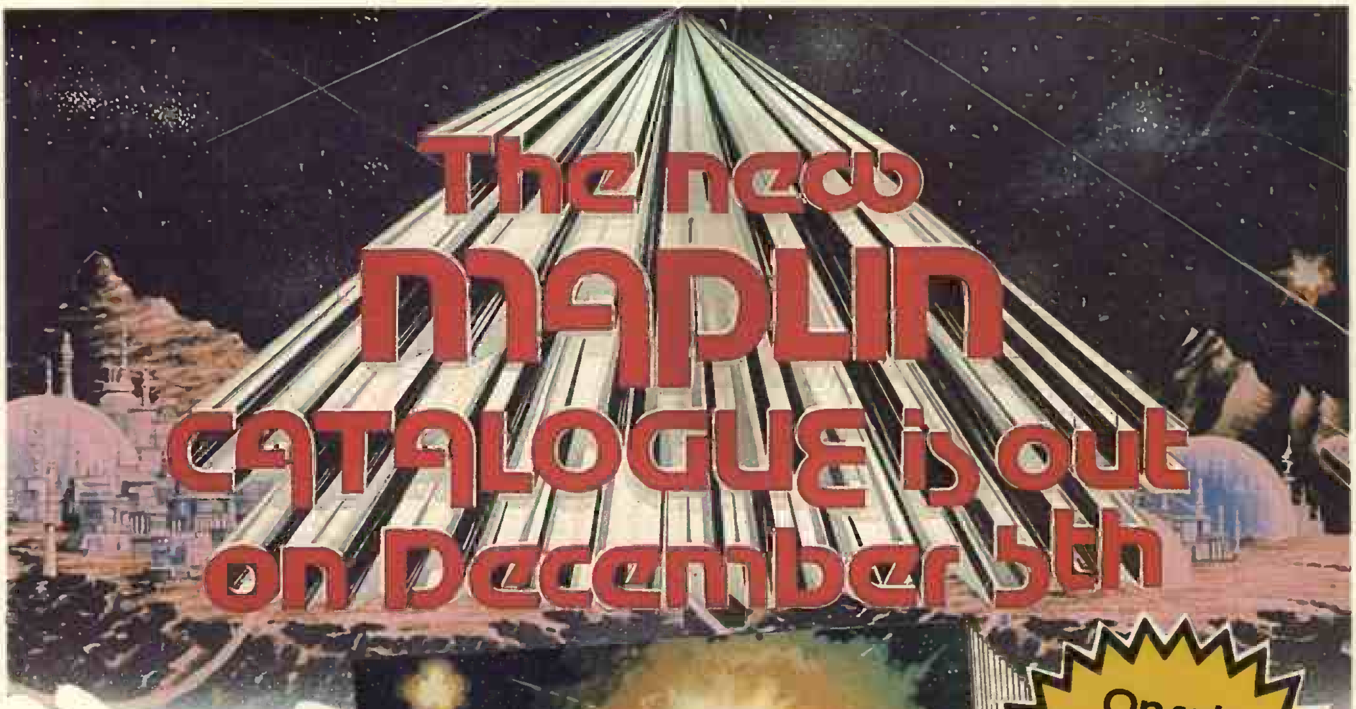

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