Australia $1·10 New Zealand $1·20 Malaysia $3·50

PRACTICAL ELECTRONICS

AUGUST 1980

55p

PE TELETEXT with INFRA-RED REMOTE CONTROL

Also inside...

PE MAGNUM---METAL LOCATOR

PRACTICAL
ELECTRONICS

VOLUME 16 No. 8 AUGUST 1980

CONSTRUCTIONAL PROJECTS

GENERAL FEATURES

NEWS & COMMENT

OUR SEPTEMBER ISSUE WILL BE ON SALE SATURDAY, 16 AUGUST 1980
(for details of contents see page 29)

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 PDST. 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.

VAT Export orders no VAT. Applicable to U.K. Customers only. Unless stated otherwise, all prices are exclusive of VAT. Please add 15% to the total cost.

We stock many more items. It pays to visit us. We are situated behind Watford Football Ground. Nearest Underground/Br. Rail Station: Watford High Street. Open Monday to Saturday 9 a.m.-6 p.m. Ample Free Car Parking space available.

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 38p; 470n 53p; 1μF 175p.

POLYESTER RADIAL LEAD CAPACITORS: 250V;
10n, 15n, 22n, 27n 5p; 33n, 47n, 68n, 100n 7p; 150n 10p; 220n, 330n 13p; 470n 17p; 680n 19p; 1μ 22p; 1μ5 30p; 2μ2 34p.

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, 8p; 10, 15, 22 11p; 32, 47, 50 12p; 63, 100, 27p; 50V: 50, 100, 220 25p; 470 32p; 1000 60p; 40V: 22, 33μF 8p; 100 12p; 2200, 3300 85p; 4700 98p; 35V: 10, 33 7p; 330, 470 32p; 25V: 10, 22, 47, 100 8p; 160, 220, 250 15p; 470 25p; 640, 1000 35p; 1500 40p; 2200 45p; 3300 7p; 4700 85p; 16V: 10, 40, 47 7p; 100, 125 8p; 220, 330 14p; 470 20p; 1000, 1500 30p; 2200 36p.
TAG-END TYPE: 450V: 100μF 180p; 70V: 4700 165p; 64V: 2500 110p; 3300 150p; 50V: 2200 99p; 3300 135p; 40V: 4700 130p; 4000 92p; 3300 98p; 2500, 2200 90p; 2000 + 2000 120p; 30V: 4700 110p; 25V: 15,000 195p; 6400 120p; 4700 100p; 330 85p; 2200 60p.

TANTALUM BEAD CAPACITORS
35V: 0.1μF, 0.22, 0.33, 0.47, 0.68, 1.0, 1μ5, 2μ2, 3μ3, 4μ7. 25V: 10, 20V: 6μ8, 16V: 2μ2, 4μ7, 10 20p each.
16V: 22μ 32p; 47, 100 58p; 220 75p; 10V: 15μ, 22, 33 28p; 100 40p; 6V: 47μ, 68μ, 100 32p; 3V: 100 30p.

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

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

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

POTENTIOMETERS (AB or EGEN)
Carbon Track, 0·25W Log & 0·5W 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	33p

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 26p each

TRIMMERS miniature

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

COMPRESSION

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

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

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

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

TRANSISTORS

AC107	28
AC125	35
AC126	25
AC127	22
AC128	20
AC141	27
AC142	28
AC187	24
AC176	25
ACY17	60
ACY18	60
ACY19	60
ACY20	53
ACY21	60
ACY22	60
ACY28	60
ACY39	80
AD149	75
AD161	42
AD162	42
AF114	75
AF115	60
AF116	75
AF117	95
AF118	95
AF139	40
AF178	75
BC107	10
BC107B	12
BC108	10
BC108B	12
BC108C	12
BC109	10
BC109B	12
BC109C	12
BC140	26
BC142	26
BC143	26
BC147	9
BC147B	10
BC148	8
BC148B	10
BC148C	10
BC149	9
BC149C	10
BC153	20
BC154	13
BC157	10
BC158	10
BC159	11
BC160	28
BC167A	11
BC168C	10
BC169C	10
BC170	15
BC171	11
BC172	11
BC173	11
BC177	15
BC178	14
BC179	15
BC181	10
BC182	10
BC183	10
BC184	10
BC182L	10
BC183L	10
BC184L	10
BC187	25
BC212	9
BC212L	9
BC213	9
BC213L	9
BC214	10
BC214L	10
BC237	14
BC238	15
BC307B	14
BC308B	16
BC327	12
BC328	12
BC338	12
BC441	30
BC461	30
BC477	35
BC516	38
BC517	35
BC547	10
BC548	7
BC549C	10
BC557	15
BC558	15
BC559	15
BCY70	14
BCY71	18
BCY72	20
BD121	78
BD123	98
BD124	115
BD131	42
BD132	42
BD133	50
BD135	40
BD136	40
BD137	40
BD138	40
BD139	40
BD140	40
BD144	198
BD145	175
BD205	110
BD245	50
BD378	70
BD434	32
BD517	70
BD695A	85
BD696A	85
BDY56	170
BF115	26
BF167	30
BF177	24
BF178	25
BF179	30
BF180	38
BF194	10
BF195	11
BF196	12
BF197	12
BF198	16
BF199	18
BF224	24
BC337	14
BF244A	28
BF244B	29
BF245	30
BF256	50
BF257	35
BF258	35
BF259	28
BF274	42
BF336	35
BF451	35
BF594	40
BF595	40
BF910	95
BFR39	25
BFR40	25
BFR41	24
BFR79	24
BFR80	24
BFR81	24
BFR98	105
BFX29	28
BFX84	26
BFX85	28
BFX86	28
BFX87	28
BFX88	28
BFY50	21
BFY51	21
BFY52	21
BFY56	32
BFY64	40
BFY81	99
BRY39	39
BSX20	20
BSX29	45
BSY95A	18
BU105	170
BU205	170
BU208	215
E421	250
MD8001	225
MJ491	175
MJ2955	90
MJE340	54
MJE370	70
MJE371	70
MJE2955	105
MJE3055	70
MPF102	66
MPF103	36
MPF104	36
MPF105	36
MPF106	40
MPSA05	22
MPSA06	24
MPSA12	29
MPSA55	29
MPSA56	29
MPSU02	58
MPSU05	50
MPSU06	50
MPSU52	65
MPSU55	55
MPSU56	60
OC23	170
OC26	170
OC28	120
OC35	125
OC36	130
OC41	125
OC42	48
OC43	55
OC44	55
OC45	40
OC70	40
OC71	35
OC72	40
OC74	50
OC76	45
OC81	35
OC82	50
OC83	48
OC84	45
OC140	110
OC170	85
OC171	45
OC200	48
TIP29	31
TIP29A	36
TIP29B	56
TIP29C	60
TIP30	32
TIP30A	42
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	64
TIP42B	82
TIP120	90
TIP121	99
TIP141	190
TIP142	125
TIP147	195
TIP2955	60
TIP3055	60
TIS43	30
TIS44	45
TIS45	45
TIS88A	50
TIS90	30
TIS91	32
UC734	65
ZTX107	11
ZTX108	11
ZTX109	11
ZTX212	28
ZTX300	13
ZTX301	15
ZTX302	20
ZTX303	25
ZTX304	17
ZTX314	24
ZTX320	30
ZTX326	45
ZTX341	20
ZTX500	15
ZTX501	15
ZTX502	17
ZTX503	15
ZTX504	25
ZTX531	25
ZTX550	25
40250	85
40251	97
40311	60
40313	125
40315	68
40316	85
40317	65
40319	70
40320	70
40361	50
40362	50
40406	65
40407	52
40408	70
40411	280
40412	65
40467	95
40468	60
40594	95
40595	98
40603	90
40636	128
40673	95
2N697	25
2N698	40
2N699	30
2N706A	19
2N708	19
2N914	32
2N916	37
2N918	33
2N1131	23
2N1132	24
2N1303	50
2N1304	50
2N1305	35
2N1307	50
2N1308	46
2N1670	150
2N1671B	215
2N2219A	22
2N2220A	26
2N2221A	23
2N2222A	20
2N2369A	15
2N2646	48
2N2784	55
2N2904	24
2N2905A	22
2N2906	22
2N2907A	22
2N2926G	10
2N3053	19
2N3054	55
2N3055	48
2N3442	140
2N3504	55
2N3663	14
2N3702	10
2N3703	10
2N3704	10
2N3705	10
2N3706	10
2N3707	10
2N3708	11
2N3709	11
2N3710	10
2N3711	10
2N3771	179
2N3772	195
2N3773	288
2N3819	20
2N3820	45
2N3822	130
2N3823	70
2N3866	90
2N3903	20
2N3904	18
2N3905	18
2N3906	17
2N4037	52
2N4058	17
2N4061	17
2N4062	17
2N4069	45
2N4427	75
2N4829	65
2N4859	65
2N4871	50
2N4922	55
2N5135	42
2N5136	42
2N5138	20
2N5172	25
2N5179	60
2N5180	80
2N5191	70
2N5305	40
2N5457	32
2N5458	32
2N5459	32
2N5485	35
2N5642	750
2N5777	45
2N6027	40
2N6109	50
2SD234	70
3N128	112
3N140	112

ANTEX Soldering Irons

C15W	410
CX17W	410
CCN15W	420
X25W	415
Spare bits	50
Elements	200
Iron stand	180

DIL SOCKETS (TEXAS)

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

AEROSOL Cans.

Servisol	100
Freeze It	110
AeroKleen	95

Access

LINEAR IC's

702	75
709C 8 pin	35
710	67
741 8 pin	17
747C 14 pin	78
748C 8 pin	36
753 8 pin	150
B10	159
AY-1-0212	595
AY-1-1313A	660
AY-1-1320	315
AY-1-5050	190
AY-1-5051	160
AY-1-6721/6	210
AY-3-1270	840
AY-3-8500	390
AY-3-8910	875
AY-5-1224A	235
AY-5-1230	450
AY-5-1315	595
AY-5-1317A	630
AY-5-4007D	520
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	210
CA3048	214
CA3059	175
CA3075	213
CA3080E	65
CA3081	190
CA3089E	215
CA3090AQ	375
CA3123	150
CA3130	90
CA3140	48
CA3160	95
ICL7106	795
ICL7107	975
ICL8211	150
ICL8038CC	340
ICM7205	1150
ICM7215	1050
ICM7216A	1950
ICM72168	1950
ICM7217A	790
ICM7224	785
ICM7227A	885
ICM7555	89
LD130	452
LF356	90
LM10	395
LM301A	23
LM308T	70
LM311H	80
LM318H	205
LM324A	45
LM339	70
LM348	90
LM349	125
LM379	375
LM380	80
LM381N	145
LM382	125
LM386	99
LM387	150
LM389	93
LM733	125
LM384	110
LM3900	60
LM3909	70
LM3911	125
LM3914	240
LM3915	
LM13600	135
M252AA	625
M253AA	1150
MC1204	250
MC1301	79
MC1303	88
MC1304P	260
MC1310P	150
MC1312PQ	195
MC1458	45
MC1494	595
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
NE518	210
NE543	210
NE544	185
NE555	22
NE556DB	55
NE560	325
NE561	395
NE562B	410
NE564	425
NE565A	120
NE566	160
NE567	375
NE570	750
NE571	420
RC4136D	110
S566B	275
SAB3209	425
SAB3210	275
SG3402	240
SN76003N	210
SN76013N	170
SN76018	148
SN76023N	170
SN76033N	195
SN76115N	215
SN76131	110
SN76227N	95
SN76477	175
SN76660	120
SP8629	299
TAA621AX1	228
TAA661A	155
TAA960	320
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
TL061C	54
TL064CN	159
TL071	45
TL072CP	90
TL074CN	140
TL081CP	42
TL082CP	70
TL083CP	95
TL084CP	120
UAA170	150
UAA180	150
XR2206	350
XR2266	750
ZN414	80
ZN423	195
ZN424E	130
ZN423	195
ZN425E	415
ZN1034	200
ZN1040E	685

COMPUTER IC's

2101-2	225
2112-2N	250
2114-250N	299
2708	495
4116 16K	495
4047	750
6502	995
6503	850
6504	785
6505	850
6520	525
6522	825
6532	1050
6551	1150
6800	800
6810	360
6821	500
6850	485
6852	485
74L00	66
74S00	80
74S04	73
74S132	350
74S138	250
74S158	524
74S188	210
74S189	158
74S194	760
74S195	795
74S241	195
74S262	850
74S287	325
74S288	210
74S470	325
74S472	1150
74S475	825
75450	
75451	
75452	
75454	
8080A	595
8085A	1220
8251	700
8253	1275
8T26AN	235
8T28N	280
8T95N	160
8T97N	150
81LS95	135
81LS96	135
81LS97	137
AY-3-1015	395
AY-5-1013	399
AY-5-2376	980
DM8123	195
MC1488	90
MC1489	90
MC14411	958
MC14412	1520
MK4027-2	470
MK4027-4	350
MK4118-4	2099
RO-3-2513	650
SFF96364E	1050
SFC71301	820
SFS80102	205
TMS2516	1250
TMS2716	1399
TMS 4027	325
TMS 4035	250
TMS 4039	250
TMS 4047	1083
TMS 6011	355
Z80 CPU2.5	990
Z80 A4M	1099
Z80 P10	660
Z80 CTC	595
Z80A P10	720
Z80A CTC	720

TTL 74 (TEXAS)

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

74LS

LS00	13
LS01	13
LS02	15
LS03	15
LS04	20
LS05	23
LS08	23
LS09	23
LS10	20
LS11	32
LS12	32
LS13	40
LS14	75
LS15	40
LS20	21
LS21	32
LS22	40
LS26	48
LS27	45
LS28	48
LS30	24
LS32	30
LS33	39
LS37	39
LS38	39
LS40	28
LS42	80
LS47	85
LS48	120
LS49	120
LS51	25
LS54	30
LS55	70
LS63	150
LS73	40
LS74	40
LS75	48
LS76	45
LS78	45
LS83	105
LS85	105
LS86	45
LS90	50
LS91	125
LS92	75
LS93	75
LS95	115
LS96	180
LS107	45
LS109	75
LS112	80
LS113	65
LS114	49
LS122	70
LS123	95
LS124	180
LS125	60
LS126	60
LS132	95
LS136	55
LS138	70
LS139	90
LS145	120
LS147	210
LS148	175
LS151	96
LS153	85
LS155	96
LS156	96
LS157	76
LS158	85
LS160	120
LS161	98
LS162	110
LS163	118
LS164	115
LS165	155
LS166	175
LS168	210
LS169	210
LS170	288
LS173	105
LS174	147
LS175	110
LS181	296
LS183	298
LS189	120
LS190	120
LS191	120
LS192	125
LS193	125
LS194	125
LS195	125
LS196	120
LS197	120
LS199	000
LS200	345
LS202	345
LS221	120
LS240	225
LS241	225
LS242	232
LS243	232
LS244	225
LS245	270
LS247	135
LS248	135
LS249	135
LS251	130
LS253	130
LS257	115
LS258	120
LS259	160
LS261	450
LS266	75
LS273	180
LS275	320
LS279	88
LS280	250
LS283	190
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	65
LS373	180
LS374	180
LS375	150
LS377	199
LS378	185
LS379	215
LS384	50
LS385	420
LS386	85
LS390	140
LS393	140
LS395	210
LS396	199
LS398	275
LS399	230
LS445	140
LS447	195
LS490	150
LS668	105
LS669	105
LS670	270
LS673	780
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	99

CMOS (CONT.)

4077	48
4078	30
4081	28
4082	28
4085	90
4086	90
4089	150
4093	89
4094	240
4095	105
4096	105
4097	350
4098	115
4099	190
4160	125
4161	125
4162	125
4163	125
4174	130
4175	120
4194	125
4408	790
4409	790
4410	790
4411	1020
4412F	1520
4412V	1520
4415F	850
4415V	850
4419	320
4422	570
4432	1050
4435	1050
4440	999
4450	350
4451	350
4452	000
4490F	750
4490V	750
4501	28
4502	125
4503	75
4506	75
4507	60
4508	325
4510	99
4511	150
4512	98
4513	225
4514	265
4515	299
4516	120
4517	450
4518	105
4519	70
4520	115
4521	250
4522	150
4526	150
4527	160
4528	120
4529	175
4530	89
4531	165
4532	140
4534	575
4536	395
4538	160
4539	135
4541	150
4543	175
4549	296
4553	440
4554	175
4555	85
4556	75
4557	425
4558	130
4559	290
4560	235
4561	95
4562	595
4566	190
4568	299
4569	250
4572	48
4580	595
4581	350
4582	150
4583	125
4584	65
4585	140

WATFORD ELECTRONICS

(Continued from opposite side)

DIODES

AA129	25
AAZ15	15
BA102	15
BY100	24
BY127	12
CR033	158
OA9	45
OA47	18
OA70	12
OA79	12
OA81	15
OA85	15
OA90	8
OA91	8
OA95	8
OA200	9
OA202	9
IN914	4
IN916	6
IN400/2	5
IN4003	6
IN4004/5	6
IN4006/7	7
IN4148	4
IS44	20
3A/100V	18
3A/400V	20
3A/600V	27
3A/1000V	30

SCR's Thyristors

0·8A30V	28
0·8A100V	30
0·8A200V	35
1A/50V	37
1A/100V	42
1A/200V	47
1A600V	70
5A300V	35
5A600V	43
8A300V	48
8A600V	85
12A300V	59
12A500V	92
12A800V	150
15A700V	195
BT106	150
BT116	150
C106D	38
MCR101	32
TIC44	22
TIC45	28
2N4444	140

BRIDGE RECTIFIERS

(plastic case)

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

ZENERS

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

Range: 3V3 to 33V. 1·3W **15p each**

VARICAPS

MVAM2	165
MVAM115	140
BA102	25
BB105B	40
BB106	40

Noise Diode

Z5J 180

TRIACS

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

DIAC

ST2 25

SPEAKERS

8Ω 0·3W	
2"; 2½"	75
2·5; 3"	75
40Ω 2·5"	88
64Ω 2·5"	80
80Ω 2·5"	80
8Ω 5W	
7"×4"	250
8Ω 3W	
6"×4"	160

ALUM. BOXES

3×2×1"	55
2¼×5×1½"	75
4×4×1½	75
4×2¼×1½"	78
4×5¼×1½	100
4×2¼×2	75
5×4×2"	98
6×4×2"	110
7×5×2½"	185
8×6×3"	185
10×7×3"	210
10×4½×3"	198
12×5×3"	215
12×8×3"	265

VEROBOARD

	Pitch 0·1 (copper clad)	0·15 (copper clad)	0·1 (plain)	0·15 (plain)
2½×3¾"	66p	59p	47p	34p
2½×5"	75p	69p	—	39p
3¾×3¾"	75p	—	—	—
3¾×5"	86p	92p	72p	63p
3¾×17"	296p	260p	210p	178p
4¾×17"	387p	—	—	280p

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

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

FERRIC CHLORIDE
1 lb bag Anhydrous
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DALO ETCH RESIST
Pen + Spare tip 75p

BIMBOARDS £8·25

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Fibre Glass	Single-sided	Double-sided	SRBP 9·5"×8·5"
6"×6"	90p	110p	95p
6"×12"	150p	195p	

SOLDERCON PINS
100 pins 60p 500 pins 250p

OPTO ELECTRONICS

LEDS Plus. Clip

TIL209 Red 125"	13
TIL211 Grn 125"	18
TIL212 Yellow	22
TIL220 .2" Red	15
0·2" Yellow, green and Amber	18
Rectangular LEDS. Red, Green and Yellow	30
2N5777	45
OCP71	120
ORP12	63
LD271 Infra Red (emit)	40
TIL32 Infra Red (emit)	58
SFH205 (detector)	70
TIL78 (detector)	70

OPTO isolators

IL74	48
TIL 111/2 or 117	100

7 Segment Displays (Red Displays)

TIL312 & 313·3"	105
TIL321 ·5" C.An	115
TIL322 5" C.th	115
DL704 ·3" C.Cth	99
DL707 3" C.Anod	99
DL747 ·6" An	180
.8" Orange C.A.	250
FND357	120
.3" Green C.A.	150
±1·3" Red or Green	150
Bargraph 10 seg. Red	225

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

VOLTAGE REGULATORS

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

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

SWITCHES

SLIDE 250V

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

PUSH BUTTON
Spring loaded red button. Latching

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

TOGGLE 2A 250V

SPST	32
DPDT	44
4 pole on off	54

SUB-MIN TOGGLE

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

MINIATURE
Non Locking
Push to make 15p Push Break 25
Push to change cover momentary 85p

ROCKER: 5A, 250V, SPST 30p
ROCKER: (white) 5A 250V SP change-over centre off 52p
ROCKER: Lights red when on. Chrome Bezel. 3A 250V. DPST 85p
ROCKER: (White) 10A/250V DPDT 85p
ROTARY: "Make-A-Switch" Make your own multiway Switch as required. Shafting assembly has adjustable stop.
Accommodates up to 6 Wafers 90p
Break before make Wafers. Silver contacts. 1 pole/12 way; 2 pole/6 way; 3 pole/4 way; 4 pole/3 way; 6 pole/2 way 59p
Mains DPST Switch to fit 40p
Screen & Spacers 6p

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

ROTARY: Mains 250V AC, 4 Amp 52p

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100kHz	323p	26·69MHZ	390p
455kHz	385p	7·680MHz	323p
1MHz	323p	8 867MHz	323p
1·6MHz	395p	9·375MHz	323p
1·008MHz	383p	10MHz	323p
1·80MHz	385p	10·7MHz	323p
1·8432MHz	362p	12MHz	392p
2·4576MHz	362p	14·318118M	300p
3·2768MHz	323p	18MHz	323p
4MHz	290p	18·432M	392p
4·032MHz	323p	20MHz	362p
4·433619M	135p	27·648MHz	350p
5·0MHz	355p	48MHz	323p
5·24288	425p	100MHz	323p
6·5536MHZ	200p		

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Wide Bandwidth Modulator
Special for Computers 8MHz 450p
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14 pin 35p; 24 pin 85p
16 pin 39p; 40 pin 295p
(DIL Sockets on opp. page)

'D' CONNECTORS
(Cannon type)

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

DIL switches (SPST)
4 way 85p
6 way 98p
8 way 115p

EDGE CONNECTORS
double type

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

TRANSFORMERS (mains Prim. 220-240V)
6-0-6V 100mA; 9-0-9V 75mA; 12-0-12V 75mA 98p
8VA type: 6V-·5A 6V-·5A; 9V-·4A 9V-·4A; 12V-·3A 12V-·3A; 15V-·25A 15V-·25A **195p.**
12VA: 4·5-1·3A 4·5V-1·3A; 6V-1·2, **215p.** 1·2A 12V-·5A 12V-·5A **235p** (30p p&p)
24VA: 6V-1·5A 6V-1·5A; 9V-1·2A 9V-1·2A; 12V-1A 12V-1A; 15-·8A 15-·8A; 20V-·6A 20V-·6A **320p** (55p p&P)
50VA: 6V-4A 6V-4A; 9V-2·5A 9V-2·5A; 12V-2A 12V-2A; 15V-1·5A 15V-1·5A; 20V-1·2A 20V-1·2A; 25V-1A 25V-1A; 30V-·8A 30V-·8A **365p** (60p p&p)
100VA: 12V-4A 12V-4A; 15V-3A 15V-3A; 20V-2·5A 20V-2·5A; 30V-1·5A 30V-1·5A; 40V-1·25A 40V-1·25A; 50V-1A 50V-1A **695p** (74p p&p)
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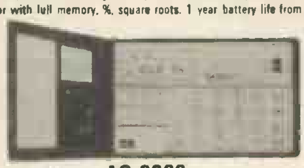
Clock, 200 year auto calendar, 1 musical alarm, countdown timer and hourly chimes, 1/10 second stopwatch measuring net, lap and 1st and 2nd place times to 24 hours. Calculator with full memory, %, square roots. 1 year battery life from two RW49 batteries.

RRP (£24.95)
£22.45



AQ-2200

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Permanent display of full month calendar. Clock alarm, hourly chimes. Stopwatch from 1/10 second to 12 hours; net, lap, 1st and 2nd place times. Calculator with full memory; %, √. 1 year batteries

MQ-12

RRP (£21.95)
£19.45

Card version of AQ2200. No √.

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P.E. 128-NOTE SEQUENCER

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

Set of basic comps, PCBs and charts KIT76-7 £35.56

Set of text photocopies £1.36

P.E. 16-NOTE SEQUENCER

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

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

Set text photocopies £1.84

P.E. STRING ENSEMBLE

A multivoiced polyphonic string instrument synthesiser.

Set of basic comps, PCBs & charts KIT 77-8 £107.66

ELEKTOR ELECTRONIC PIANO

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

5-octave set of basic comps and OCBs (as publ.) KIT 80-9 £146.66

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Set of text photocopies £7.83

ELEKTOR DIGITAL REVERB UNIT

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

Main unit basic comps and PCB (as publ.) KIT 78-3 £55.40

Extension unit basic comps and PCB (as publ.) KIT 78-4 £58.77

Text photocopy 86p

ELEKTOR ANALOGUE REVERB

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

Main unit basic component set KIT 83-1 £29.49

Additional Delay basic components KIT 83-2 £20.07

PCB (as publ.) to hold both kits PCB9973 £4.52

Text photocopy 67p

ELEKTOR RING MODULATOR

Compatible with the Formant & most other synthesisers.

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

Text photocopy 38p

NEW KITS

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

Basic comps, PCBs and charts but excl. sw's KIT 1008 £44.39

Text photocopy 70p

ELEKTOR SEWAR

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

Basic comps, PCB (as publ.) KIT 101-1 £22.53

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

Basic comps, PCB (as publ.) KIT 99-1 £9.60

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ELEKTOR FREQUENCY DOUBLER

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

Basic comps, PCB (as publ.) KIT 98-1 £5.48

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

Basic comps, PCB & chart KIT 102-3 £17.58

Text photocopy 65p

P.E. MINISONIC WAVEFORM CONVERTER

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

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

DISCO-CROSS FADER

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

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

P.E. GUITAR MULTIPROCESSOR

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

Set of basic comps, PCBs & charts KIT 85-5 £54.56

Set of text photocopies £2.52

P.E. PHASER

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

Basic components, PCB & chart KIT 88-1 £10.69

2-Notch extension, PCB & chart KIT 88-2 £6.36

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ELEKTOR PHASING & VIBRATO

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

Set of basic comps, PCB & chart KIT 70-2 £21.67

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ELEKTOR RESONANCE FILTER

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

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

Text photocopy 57p

P.E. GUITAR EFFECTS UNIT

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

Basic comps, PCB & chart KIT 42-3 £10.37

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P.E. SMOOTH FUZZ

Basic components, PCB & chart KIT 91-1 £6.40

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TREMOLO UNIT

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

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

GUITAR FREQUENCY DOUBLER

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

Basic components, PCB & chart KIT 74-1 £5.19

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P.E. GUITAR SUSTAIN

Maintains the natural attack whilst extending note duration.

Basic components, PCB & chart KIT 75-1 £6.73

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

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Automatically gives Wah or Swell sounds with each note played.

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

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

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AND OTHER PROJECTS

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

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

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

KIMBER-ALLEN KEYBOARDS AND CONTACTS

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

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

CONTACT ASSEMBLIES (gold-clad wire) – 1 required for each KBD note: Type GJ – SPCO 33p ea. Type GA – 1 pr of contacts, normally open 33p ea. Type GB – 2 pr N/O 37½p ea. Type 4PS – 3 pr N/O plus SPCO 78p ea.

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

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

WIND & RAIN EFFECTS UNIT
A slightly modified version of the original P.E. unit.
Basic comps, PCB & chart KIT 28-1 £4.84
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Basic comps, PCB & chart KIT 44-1 £5.73
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P.E. ENVELOPE SHAPER WITH VCA
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P.E. TRANSIENT GENERATOR
An ADSR envelope shaper without VCA, and additionally providing Repeat-triggering enabling a synthesiser to be programmed for mandolin or banjo effects.
Basic comps, PCB & chart KIT 63-2 £7.62
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Allows external inputs such as guitars, microphone etc., to be processed by synthesiser circuits.
Basic comps, PCB & chart KIT 81-1 £3.90

P.E. TUNING FORK
Produces 84 switch-selected frequency-accurate tones with an LED monitor clearly displaying beat-note adjustments.
Set of basic components, incl. power supply, PCBs & charts KIT 46-3 £23.32
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P.E. TUNING INDICATOR
A simple 4-octave frequency comparitor for use with synthesisers and other instruments where the full versatility of KIT 46 is not required.
Basic components, PCB & chart, but excl. sw. KIT 69-1 £8.19
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P.E. DYNAMIC RANGE LIMITER
Preset to automatically control sound output levels.
Basic comps, PCB & chart KIT 62-1 £5.31

P.E. CONSTANT DISPLAY FREQUENCY COUNTER
A 4-digit counter for 1Hz to 99kHz with 1Hz sampling rate. Readout does not count visibly or flicker due to blanking.
Basic components, PCB & chart KIT 79-4 £31.35
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A high specification stereo mixer with variable input impedances.
Basic components, (excl.sw's,) and set of PCBs and charts. KIT 90-8 £61.25
Extra 2-channel set with PCB KIT 90-9 £11.62
Set of Text photocopies £1.50

STEREO HEADPHONE AMPLIFIER
Extracted from P.E. 6-channel mixer.
Basic components, PCB & chart KIT 92-1 £5.68

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Controls up to 750 watts in ½ second steps up to 10 minutes, with built-in audio alarm.
Basic components, PCBs & charts KIT 93-3 £23.27
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P.E. DISCOSTROBE
A 4-channel light show controller giving a choice of sequential, random, or full strobe mode of operation, and with extra audio input.
Basic components, PCB & chart KIT 57-2 £25.12
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Several available, including programmable 16 beat 64000 pattern, 128 beat almost infinite pattern, and pre-programmed 15 pattern using either M252 or M253 rhythm chips. A selection of effects instrument circuits is also available.

P.E VOICE OPERATED FADER
For automatically reducing music volume during talkover – particularly useful for discos.
Basic components, PCB & chart KIT 30-1 £4.37
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P.E. DYNAMIC NOISE LIMITER
Very effective stereo circuit for reducing the hiss found in most tape recordings.
Basic components, PCB & chart KIT 97-1 £8.07
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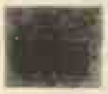
CT4000 CLOCK/APPLIANCE TIMER KIT

The CT4000 has been designed to preset the state (on or off) of four outputs at four times per day for up to 7 days in advance, enabling the unit to control tape recorders, appliances, central heating, lights, etc. The times are set on a 0.1" high red LED display by means of a keyboard and the output states are displayed on four LEDs. Each output can switch up to 20mA at 9V. For mains loads use our Solid State Relay Kit (MK2). The kit includes a PCB, keyswitches, I.C., 4 digit LED display, transformer, plus all other components and a screen printed and drilled box which can also accommodate up to 4 Solid State Relay Kits. **£25.25**

Size: 10x12x4.5 cms
Colour: Black.
NEW

D.V.M. THERMOMETER KIT



Based on the ICL7106. This kit contains a PCB, resistors, presets, capacitors, diodes, IC and 0.5" liquid crystal display. Components are also included to enable the basic DVM kit to be modified to a Digital Thermometer using a single diode as the sensor. Requires a 3mA 9V supply (PP3 battery). **£20.75**

MINI KITS

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

MK1 TEMPERATURE CONTROLLER/ THERMOSTAT
Uses LM3911 IC to sense temperature (80°C max), and triac to switch heater.
500W **£3.20** 1KW **£3.50**

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

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

MK4 PROPORTIONAL TEMPERATURE CONTROLLER
Based on the TDA1024 Zero voltage switch, this kit may be wired to form a "burst fire" power controller or a "proportional temperature" controller enabling the temperature of an enclosure to be maintained to within 0.5°C.
1.5KW **£5.25** 3KW **£5.55**

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

TOUCH CONTROL LIGHTING KITS

These KITS replace light switches and control up to 300 Watts of lighting. No rewiring, fit plaster depth boxes, insulated touchplates. Easy to follow instructions.

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TSA300K TIME DELAY TOUCHSWITCH. Turns off after preset delay (2 secs. to 3½ mins.) **£4.30**
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LM382 Dual low noise Preamp	£1.00
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LM1830 Fluid Level Detector	£1.50
LM2907 f-v Converter (8 pin)	£1.40
LM2917 f-v Converter (14 pin)	£1.60
LM3909 LED Flasher/Oscillator	55p
LM3911 Thermometer	£1.20
LM3914 Dot/Bar Driver	£2.10
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MM74C915 7 segment-BCD converter	96p
MM74C926 4 digit counter with 7 seg. o/p	£4.50
S566B Touchdimmer	£2.50
S9263 Touchswitch 16-way	£4.85
SN76477 Complex Sound Generator	£2.52
TBA800 5W Audio Amp.	58p
TBA810AS 7W Audio Amp.	85p
TDA1024 Zero Voltage Switch	£1.20
TDA2020 20W Audio Amp.	£2.85
ZN1034E Timer	£1.80

All ICs supplied with data sheets.
Data Sheets only, 5p each device.

DO MAGAZINE REMOTE CONTROL PROJECTS MAKE YOU SEE INFRA RED?

How many times have you considered building a remote control project but were put off by the dozens of ICs, special coils, lenses and other hard to get components, not to mention the need for a well equipped lab. to set the unit up. T. K. ELECTRONICS have changed all that. Three ICs can build a sophisticated system that requires only a capacitor and resistor to set the clock frequency (which can drift by up to 20% without affecting performance). Control radios, hi-fi (including bass, treble and volume), lighting, toys, garage doors, etc. Still not convinced? then look at the prices!

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ML928	16-channel Receiver (4 latched binary outputs)	£1.40
	Data sheets (per device)	5p

These ICs can also be used with ultrasonic and radio links, depending on range, cost and speed of operation. For more details, why not give us a ring – we will be pleased to advise you.

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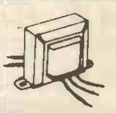

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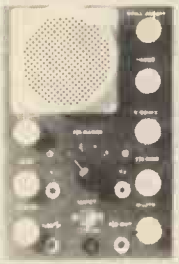

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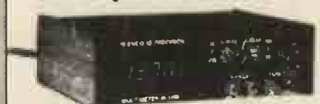

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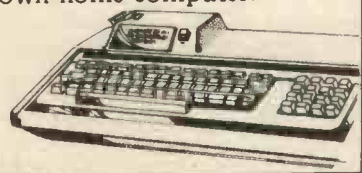

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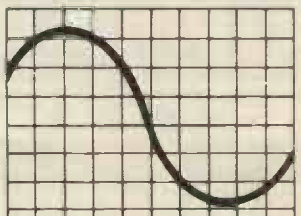

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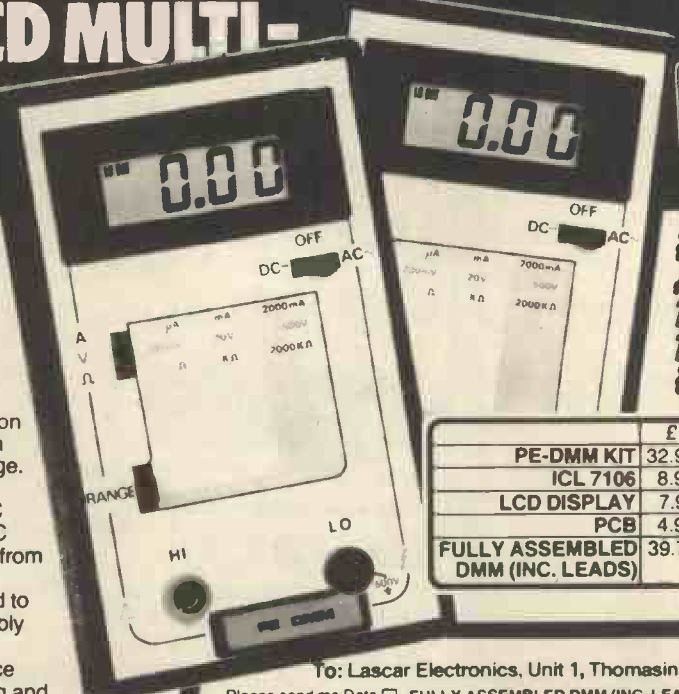

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Lascar Electronics Ltd., Unit 1, Thomasin Road, Basildon, Essex. Telephone No: Basildon (0268) 727383.

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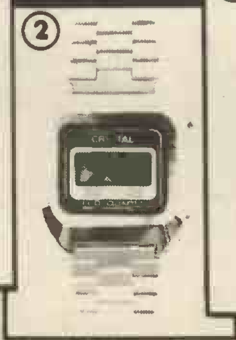

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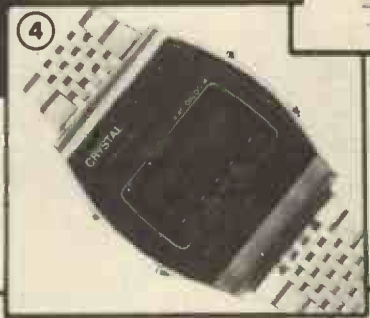

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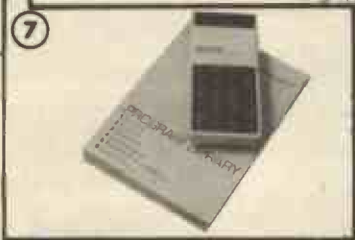

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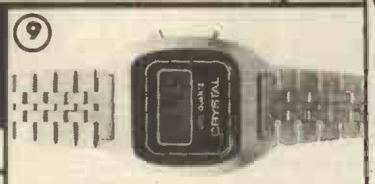

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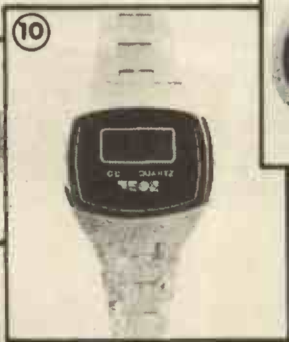

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You've seen the reviews... you've heard the excitement... now make the kit!

This is the ZX80. 'Personal Computer World' gave it 5 stars for 'excellent value.' Benchmark tests say it's faster than all previous personal computers. And the response from kit enthusiasts has been tremendous.

To help you appreciate its value, the price is shown above with and without VAT. This is so you can compare the ZX80 with competitive kits that don't appear with inclusive prices.

'Excellent value' indeed!

For just £79.95 (*including* VAT and p&p) you get everything you need to build a personal computer at home...PCB, with IC sockets for all ICs; case; leads for direct connection to a cassette recorder and television (black and white or colour); *everything*!

Yet the ZX80 really is a complete, powerful, full-facility computer, matching or surpassing other personal computers at several times the price.

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

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Your ZX80 kit contains...
- Printed circuit board, with IC sockets for all ICs.
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*Use a 600 mA at 9 V DC nominal unregulated mains adaptor. Available from Sinclair if desired (see coupon).

The unique and valuable components of the Sinclair ZX80.

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

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

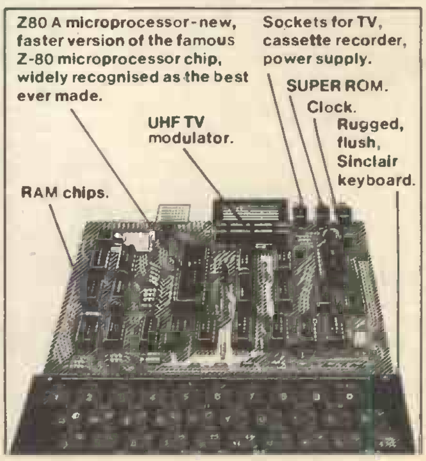
Fewer chips, compact design, volume production – more power per pound!

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

The display shows 32 characters by 24 lines.

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

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



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ZX80 software – now available!

See the advertisements in Personal Computer World (June) and Electronics Today International (July).

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

The Sinclair teach-yourself BASIC manual.

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

The Sinclair ZX80. Kit: £79.95. Assembled: £99.95. Complete!

The ZX80 kit costs a mere £79.95. Can't wait to have a ZX80 up and running? No problem! It's also available, ready assembled, for only £99.95.

Demand for the ZX80 is very high: use the coupon to order today for the earliest possible delivery. All orders will be despatched in strict rotation. We'll acknowledge each order by return, and tell you exactly when your ZX80 will be delivered. If you choose not to wait, you can cancel your order immediately, and your money will be refunded at once. Again, of course, you may return your ZX80 as received within 14 days for a full refund. We want you to be satisfied beyond all doubt – and we have no doubt that you will be.

sinclair ZX80

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	Ready-assembled Sinclair ZX80 Personal Computer(s). Price includes ZX80 BASIC manual, excludes mains adaptor.	£99.95	
	Mains Adaptor(s) (600 mA at 9 V DC nominal unregulated).	8.95	
	Memory Expansion Board(s) (each one takes up to 3K bytes).	12.00	
	RAM Memory chips – standard 1K bytes capacity.	16.00	
	Sinclair ZX80 Manual(s) (manual free with every ZX80 kit or ready-made computer).	5.00	
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The P.E. Traveller fits easily in or under dashboards.
Complete with instructions.
£10.50 p&p £1.75
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£1.95 Per Pack, p & p £1.00.
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NOTE: for use with 4 to 8 ohms speakers.
p&p £2.55 £13.95
TWO WAY SPEAKER KIT To suit above amp. Comprising 2, 8" approx Phillips base unit, and 2, 3½" approx tweeters with 2 crossover capacitors £4.95 p&p £1.65.
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Viscount IV unit in teak simulate cabinet Silver finish rotary controls and pushbuttons with matching fascia red mains indicator and stero jack socket. Functions switch for mic magnetic and crystal pickups, tape tuner and auxiliary. Rear panel features fuse holder, DIN speaker and input socket 30 + 30 watts RMS 60 + 60 watts peak for use with 4 to 8 ohm speakers.
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ACTON: Mail Order only. No callers
ALL PRICES INCLUDE VAT AT 15%
All items subject to availability. Price correct at and subject to change without notice.
All enquires Stamped Addressed Envelope.
NOTE: Persons under 16 years not served without parent's authorisation.
£76.00 p&p £4.00
100 WATT MONO DISCO AMP Brushed aluminium fascia and rotary controls. Size approx. 14" x 4" x 10¼"
Five vertical slide controls, master volume, tape level, mic level, deck level. PLUS INTER DECK FADER for perfect graduated change from record deck No. 1 to No. 2, or vice versa. Pre fade level control (PFL) lets YOU hear next disc before fading it in. VU meter monitors output level. Output 100 watts RMS 200 watts peak
EMI SPEAKER BARGAIN
Stereo pair 350 kit System consists of 13" x 8" approx woofer with rolled surround, 3½" Goodman tweeter crossover components and circuit diagram Frequency response 20 Hz to 20 KHz Power handling 15 watts RMS 20 watts max 8 ohm impedance
£18.25 Per stereo pair p&p £4.20
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Belt drive chassis turntable unit semi-automatic, cueing device. p&p £3.00
Shure M75 6 Magnetic Cartridge to suit. £7.95
BSR Manual single play record deck with auto return and cueing lever, fitted with stereo ceramic cartridge 2 speeds with 45 r p m spindle adaptor ideally suited for, home or disco use
OUR PRICE £12.25 p&p £2.75
PHILLIPS RECORD PLAYER DECK GC037
HiFi record player deck, belt drive complete with GP401 magnetic cartridge—LIMITED STOCK. UNBEATABLE OFFER AT £27.50 complete.
BUYER COLLECT ONLY.
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Complete with headshell.
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OUR PRICE £11.95 p&p £2.50
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PE VOLUME 16 No. 8 AUGUST 1980

PE TELETEXT

BACK in June '79 an announcement was made that we would be publishing a Teletext system in the near future. A lecture on Teletext was presented by PE at the Great British Electronics Bazaar and development was under way. Since that time our Projects Editor David Shortland has been developing a system. Why has it taken so long? A brief look at the problems we have had to overcome will answer this question and we are sure will be interesting to all readers.

The *PE Teletext* was first discussed at a meeting in London involving two representatives of Mullard (who had developed the chips and system we were to use), a director and technical representative of Marshall's (who were, as a Mullard distributor, to provide parts and technical expertise) and the Editor.

After that meeting things started to move quite fast, a range of components and boards were supplied by Marshall's and David set to work building a system that would interface directly to the set. It was felt that this was the most satisfactory way to obtain the quality of picture we required, and Mullard claimed to have a number of interface circuits for various sets that they would make available to us.

Work proceeded at a reasonable pace until David came to build the interface board to match the system to his own Philips set. Mullard provided a "circuit idea" which did not give enough information, so David approached Philips who were using the chips in their set. Philips of course own Mullard so we expected some "company" line and agreement.

Philips informed us that what we were trying to do would not work. A visit to Philips followed. More investigation and more questions to Mullard indicated that the interface circuits they had supplied were theoretical. What was more worrying was that we were discovering a very high proportion of existing sets were not suitable for a direct interface, mainly due to the i.f. not being good enough.

Having wasted a few months because of misleading information we decided that we had two options: 1) Drop the whole thing, 2) Redesign to incorporate a u.h.f. modulator so that the system could plug in the aerial socket of any set.

We chose the latter option, Marshall's supplied more parts and David started work again. The system looked good, we planned publication for the April issue and were only waiting for a colour modulator board to set the whole thing up for cover shots. Then more problems, the quality of the final picture was not up to the standard we required and relied too heavily on a high signal strength. A criticism we had of other systems and a problem we were determined to avoid.

It looked for the second time as if the whole project would come to grief. This time we were saved by some developments at Mullard. A new PAL encoder chip had been developed and Mullard kindly supplied us with pre-production units to try in our system. The new chips worked well and at last we had the quality we were after.

But wait! Mullard had yet to decide to produce the chip so again we were in danger of loosing the project. Luckily they have gone ahead and we are finally able to publish the long awaited system.

The change to an external plug-in unit and the use of the new developments from Mullard have pushed up the anticipated price. But we believe the quality now available is better than any other plug-in system and we are proud to bring you *PE Teletext*.

The story has been shortened—for instance, our main contact at Mullard left and Marshalls' technical man left before we had got very far. Some of the chips originally used are now in short supply, so alternatives have had to be found. David's wife gave birth to twins, severely testing his development time and concentration! Looking back it's a wonder anything came forth. Part one starts on page 38.

Mike Kenward.

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

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

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

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Market Place

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

by David Shortland and Jasper Scott

GUNNED DOWN

Anyone who is rewiring their house, or installing microbore central heating pipes would find their job made easier by the use of one of the Arrow range of tacking guns, now available from Telequip of Bristol.

Four different sizes of gun and twelve different sizes of staple are available, and cable sizes from 5 to 15mm diameter can be fastened with a considerable saving in time and money over conventional cable clips.

All guns retail at £20·90 plus VAT, and further details of the range can be obtained from: **Telequip, 2 Oakfields Road, Clifton, Bristol BS8 2AL. (0272 312271)**

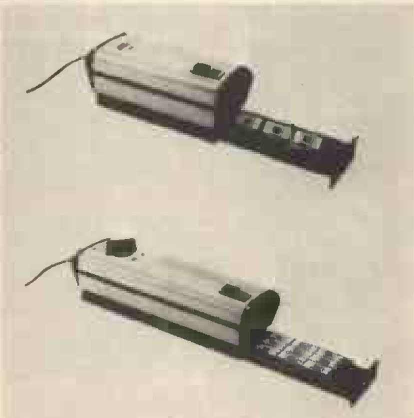
ERASE YOUR EPROMS

A range of ultraviolet EPROM erasers, manufactured by the U.S. Spectronics Corporation, is now available in this country from Chiptech Ltd.

Claimed to be the fastest and most efficient erasers of their size on the market, they have been designed primarily for the small systems and computer hobbyist at a cost which is well within their reach.

The cheapest of the range, the PE-14. has the capacity to erase up to 6 EPROM chips in as little as 19 minutes. A similarly rated unit, the PE-14T, is fitted with a 60-minute timer to automatically shut off the unit.

The PE-24T, which is a faster and more powerful version of the PE-14 series, will erase up to 9 EPROMS at once, in as little as 15 minutes.



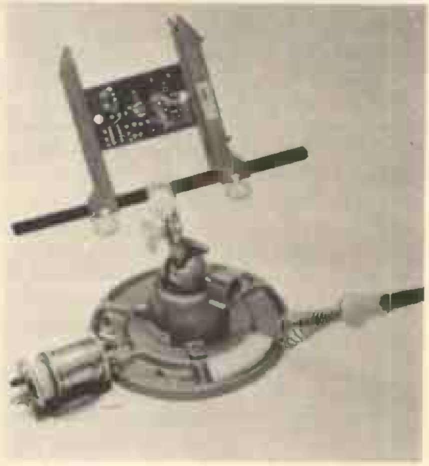
All erasers are fitted with safety interlocks and housed in gold anodised aluminium casings, which combine to make them extremely safe.

Prices for the range are as follows: PE-14—£56; PE-14T—£76·58; PE-24T—£111·22. Further information is available from: **Chiptech Ltd., Unit 1, Tewin Court, Welwyn Garden City, Hertfordshire AL7 1AU. (07073 33260)**

WORK CENTRE

One of the best multi-position work holders to come on the market so far is the new 324 work-centre, made by Panavise and distributed by Toolrange, which provides a versatile and compact unit for constructors working on p.c.b.s.

The 324 consists of the 312 Tray Base mount with six useful component compartments, the standard 300 vice base, permitting positioning through a 360 degrees hemisphere, the 315 p.c.b. Holder and the 371 Solder Station.



The 315 p.c.b. Holder handles circuit boards up to 200mm wide and 4mm thick and extra pairs of arms and an extension bar are available to enable several p.c.b.'s to be worked on at once. The 371 Solder Station consists of a wire spring soldering iron holder, capable of holding most popular irons, a shaped sponge which fits the tray base and a combined wire and solder reel holder. (Soldering iron, reel of solder and wire not supplied).

The price of the complete station is £35·00 + VAT and delivery is ex-stock from: **Toolrange Ltd., Upton Road, Reading, Berks. RG3 2JA (0734 29446)**

SAXON CATALOGUE

Saxon Entertainments are well known among the disco fraternity, and their 1980 catalogue is now available, and packed with everything from jack plugs to complete disco consoles.

Saxon's comprehensive range includes some exciting lighting effects units, and as well as the "pay and play" complete systems, there are chassis speakers, turntables, cabinet fittings—in fact everything you need to build your own disco system.

The catalogue also contains ten vouchers worth a total of £30. One voucher may be used towards each £30 worth of equipment purchased.

To obtain your copy of the catalogue, send £1 to: **Saxon Entertainments 327/333 Whitehorse Road, West Croydon, CR0 2HS (01-684 0098)**

PET PROGRAMMER

A hardware/software package which turns the Commodore Pet into a powerful and flexible programmer for 4K type 2532/2732 EPROMs is now available from GR Electronics Ltd. of Newport, Gwent. It complements the company's existing programmer for

2516/2716 devices, both allowing Pet users to produce firmware to run on their own, or other microcomputer systems.

Owners of the 3016, large keyboard Pet can use the package to give themselves up to 12K of custom-written firmware housed in the machine's three spare EPROM sockets. Older type 2001 Pets can also benefit, but using an adaptor for the memory expansion connector.

The new programmer is for 5V rail type 2532/2732 EPROMs, and comprises a plug-in circuit board which uses the IEEE port for data, the user port for control lines and takes 5V power from the Pet's external cassette drive. Full EPROM programming software is supplied on cassette, with functions including READ/WRITE to and from RAM and EPROM, sequencing, verification and READ/WRITE/MODIFY with addresses and data in hex.

And extension socket is also available for the convenience of users programming EPROMS in batches. It incorporates a header, extension cable and plinth-mounted zero insertion force socket which allows all device handling to be carried out adjacent to the Pet's keyboard.

Although both 2532 and 2732 (Intel) EPROMs can be programmed with the GR Electronics device, only the 2532 is directly compatible with the new Pet's internal ROM sockets.

The price of the programmer board and software is £80 plus VAT, and the extension is £35 plus VAT. Both may be obtained direct from: **GR Electronics Ltd., Fairoak House, Church Road, Newport, Gwent NPT 7EJ. (0633 214147)**

SIMWOOD

The latest DMM from Simwood is the MC545. This $4\frac{1}{2}$ digit meter has a measurement capability of 19999 and a basic d.c. accuracy of 0·05 per cent. The 545 will operate from either a.c. mains or batteries with rechargeable cells available as an option.

Press-button selection is available for all functions and ranges (five funtions and 26 ranges). Typical measurement accuracies are:

between 0·15 and 0·8 per cent on the resistance range; 0·05 per cent on the d.c. voltage range and 0·5 per cent on the a.c. voltage range.

The 545 which has overload protection on every function and range measure 180×64×200mm and weighs approximately 1 42 kg. Each instrument is supplied complete with an operator's manual, test leads, spare fuses and batteries. The 545 is priced at £139·00.

Simwood Limited, Garretta Hall, Shalford Green, Essex.

GOT A LIGHT, MIC?

A new, small, lightweight microphone, with appearance, handling and performance features ideally suited to highly professional on-cameras or on-stage use, has been announced by Shure Electronics Limited.

Designated the SM63-CN, the new unit is less than six inches long and weighs only 2·8 oz., making it significantly more comfortable to handle and considerably less obtrusive in performing situations than any other comparable microphone.

The SM63-CN is a dynamic, omnidirectional type with an output that is about 6dB higher than larger, comparable units. Other performance advantages include a controlled low-frequency rolloff to ensure natural sounding voice and music pickup, as well as smooth high frequency response for an overall clear, crisp clean sound similar to some condenser microphones.

Additionally, the SM63-CN features a hum-bucking coil that makes it insensitive to strong hum fields, such as those produced by studio lighting; a mechanical-elastomer isolation system that makes it resistant to handling noise; built-in breath and pop filter; and a robust polyester grille that is impervious to dents, rust and moisture.

Normal list price of the SM63-CN is £57·00 plus VAT, which includes a swivel adapter, windscreen and three-pin audio connectors on both ends of the cable. For further information contact: **Shure Electronics Ltd, Eccleston Road, Maidstone, ME15 6AU (0622 59881)**

HI-FI ON THE MOVE

If high fidelity is important to you wherever you are, you will no doubt drool over the three new portable radio/cassette recorders recently introduced by JVC. All three models have the facility of metal tape compatibility which will certainly help to give you the sound quality you're after.

The RC M80L (FM/ MW/ LW/ SW) uses a portable version of the JVC synthesiser tuning system with 32 l.e.d. indicators, and has a 12 station random preset capability, with automatic station scanning.

A twin motor, full logic, solenoid operated tape transport, and optional remote control are particularly noteworthy features of the RC M60L, while the 15 watts per channel RC M70L has a 16 programme multi music scanner.

Once you have decided which model best suits your needs, all you then need to do is find between two and three hundred pounds. Recommended prices for the three models are as follows: RC M60L—£220; RC M70L—£240; RC M80L—£290, though if you shop around, you should be able to get about ten per cent off. Pictured above is by far the best looking of the three, the RC M70L.

SOUND BOX

A simple tone generator sound box which is suitable for use with both the UK101 and the Ohio Superboard II is now available from John Mortimer Electronics.

The unit is *not* based on the GIM AY-3-8910 sound chip, but employs a VCO which can be activated direct from the keyboard. It is available either ready assembled and tested or in kit form. All that is required to construct the kit, comprising a couple of CMOS chips, transistors, and about ten potentiometers, is a soldering iron, solder and wire cutters. When asembled the unit is easily connected to either computer and will run off the on-board power supply unit. Unlike more sophisticated sound generators, this unit is easy to control, with hardware volume control and tuning, and can produce music from a simple program of keyboard row address POKEing.

Each box comes complete with full instructions and a cassette of interesting effects. The kit is priced at £14·95 or assembled for £19·95 (including VAT and p&p).

John Mortimer Electronics, PO Box 71, Norwich NR6 7JE.

MK14

The long awaited full-length programming guide for the Science of Cambridge MK14 will be available in September. The book which is called *Understanding Microprocessors with the MK14* contains just about every aspect of MK14 Assembly language/machine code programming, from number systems and addressing modes to number crunching, interrupts, DMA, multiprocessing and real-time applications. The appendices include a useful instruction set summary, a full listing for the "Hi-lo Game" (used in the text as an example of designing a complex program), and circuits for a $1\frac{1}{2}$K memory expansion.

Priced at £5·95 plus 35p p&p the book will be available direct from Tony Watson, **Globe Book Services, Little Essex Street, London WC2.**

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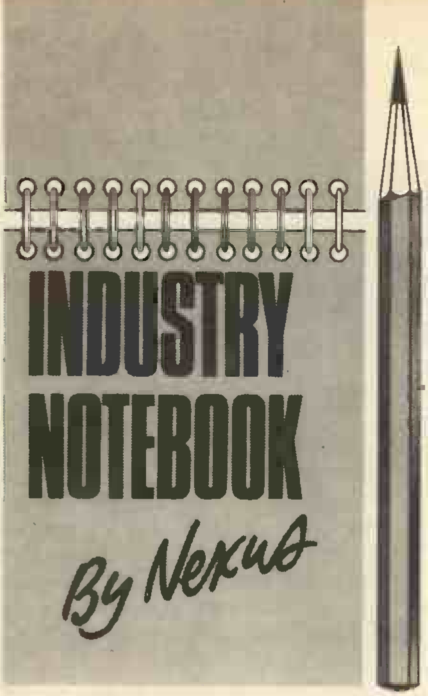


Irish Expansion

Ireland's Industrial Development Authority (IDA) is reported as having forecast that the Republic will be Europe's 'Silicon Valley' by the early 1980s. A touch of euphoria is perhaps forgivable since Mostek decided to set up a plant on the outskirts of Dublin as the best backdoor through which to enter the European Common Market.

The immediate work flow is wafer fabrication in Dallas, dicing and assembly in Malaysia and final test in Dublin. Future development is expected to result in wafer fabrication in Ireland by 1983 and some 1,200 people employed by 1984.

There are now some 70 electronics manufacturing plants in the Republic, over 60 percent being American with the balance almost entirely from Europe. This is a remarkable performance by the IDA in selling Ireland as an electronics base. Particularly so as the country has no history or reputation in engineering industry of any sort compared, for example, with Scotland which has also been dubbed a 'Silicon Valley' with its first semiconductor plants set up some 20 years ago and since mightily expanded.

Ireland is a fine country for both visiting executives and local workforce. A good vacation area with marvellous fishing, riding and other outdoor amenities. But the real attraction appears to be the low cost of entry. The IDA smooths the path with incentives such as low-cost factories and tax-free arrangements for profits on exports amounting to indirect subsidy. The IDA has spent £75 million on factories for the immigrant companies.

On the debit side there is no great pool of cheap labour as in offshore operations in the Far East, inflation is high, the cost of living is higher and industrial unrest greater than in the UK. There is also a chronic shortage of engineers and technicians, so much so that the Irish Government pays £2,000 towards the cost of a house to attract key people, mainly from the UK.

Ireland has an export growth rate in electronics of 50 percent per annum. It sounds fantastic until you remember the base line of absolute zero only ten years ago. In fact by world standards the true figures of size are not outstanding. One of the oldest-established American companies in Ireland is Digital Equipment Corporation who set up an operation in Galway in 1971 but still employs only just over 1,000 workers.

Present projections are that total electronic exports of all types will reach a level of £400 million this year, roughly equivalent to the turnover of a company the size of Racal in the UK.

Ireland has done remarkably well as an off-shore assembly area but has as yet little indigenous innovative capability. There is therefore no real threat to high technology countries. Nonetheless Ireland has a foot on the ladder and deserves watching.

UK Employment

With so much talk of recession and redundancy a heartening note appeared in the annual report of the Electronic Engineering Association which covers the activities of companies solely engaged in the electronic capital goods sector of the market. The employment trend remains upwards with almost 100,000 people employed (a two percent increase) and this despite the fact that widespread use of ICs and now LSI is continually reducing the labour content of assembly and wiring.

Output of the capital goods sector rose by 20 percent in 1979 to over £1·4 billion which allowing for inflation is an underlying growth rate of five percent. Direct exports are running at the rate of 42 percent to which should be added the equipment sold to others in the UK for export in their own products such as aircraft and ships.

Forward order books are at their highest ever level and still lengthening. The only serious difficulty is, 'Too many employers competing for too small a pool of high skilled people', a situation in which the EEA's outgoing President, J. W. Sutherland, comments that 'the scope for immediate remedy is sorely limited'.

This year's EEA President is Dr. P. E. Trier who graduated as a Mathematical Wrangler from Cambridge. After war-time and post-war employment with the Royal Naval Scientific Service he joined the Philips Group and was director of the Mullard (now re-named Philips) Research Laboratories at Redhill from 1953-69. He is now a director of Philips Industries, the parent organisation of all the Philips Companies in the UK.

As a mathematician, engineer and industrialist, Dr. Trier ought to be uniquely qualified to find out why there are always conflicts between industry and Customs and Excise exports statistics. Even if improved correlation of the figures won't tell us where we are going it would as least tell us with greater certainty where we have been.

Scanner Sold

The sale by Thorn-EMI of their X-ray scanner business to US General Electric for £17 million is a sad end to an enterprise once so full of promise. EMI's breakthrough in medical diagnostics was sensational. So, at first, were the profits. US GE came in as a me-too company and then still more companies elbowed into the business. In the end EMI couldn't stand the losses, some £26 million in the past two years, and the recently formed Thorn-EMI just had to give up.

It is a pity that a brilliant invention which has done so much for suffering humanity should have seen such vicious in-fighting for market shares. There were patent disputes all round and part of the deal with US GE is that Thorn-EMI will now receive royalties in return for a licence on the patents.

Thorn-EMI is not, however, entirely out of the business. They still have their latest model which, apparently, US GE didn't want, and they have an interest in a new body-scanning technique using the principle of nuclear magnetic resonance in place of traditional X-rays. An experimental machine is to be tried out at Hammersmith Hospital. But it is clear that Thorn-EMI will approach further entry into the scanner market with more than usual caution.

Good News

Britain's first System X telephone exchange is entering service this month (July) six months ahead of schedule. Other big BPO up-date programmes include extending the radio paging system to cover most of the UK through more than 250 VHF transmitters, and replacement of all the pay phones with a new type controlled by microprocessor. On the broad front there will be a 50 percent increase in telephone system capacity by 1990.

Among recent defence orders is one worth £50 million for Type 2016 sonar systems for the Royal Navy and a £75 million development contract for a Mk 2 version of the British Aerospace Sky Flash radar-guided air-to-air missile. The aerospace sector of industry which includes radar, radio and electronic navigation aids exported nearly £400 million of equipment in the first quarter, all set for yet another record year.

New Scotland Yard is to have a £40 million up-date of command and control systems for the Metropolitan Police. The BPO has ordered 215 noise measuring sets from Eddystone Radio to enhance detection and rectification of radio interference sources. Robot enthusiasts will be delighted to hear that 28 of them are being installed on the new Mini Metro production lines at BL cars. And Marconi Communications Systems has completed ahead of schedule a second earth satellite terminal worth £1·75 million in Bahrain, the 17th Marconi major earth terminal to enter service throughout the world.

ACORN Review...

Dr. A.A. BERK

THIS REVIEW should start—"from little acorns, giant oak trees grow". The machine is Science of Cambridge's modular computer system, starting with *System One* and ending with *System Four*. The photographs show the System Three level lent by S. of C. for review. To a great extent it is the Software which distinguishes this machine; and, as the photograph shows, its compatibility as a Prestel terminal for the Post Office's new remote processing link. The video from the machine is in full colour, which unfortunately cannot be appreciated from accompanying photos.

HARDWARE AND PRICES

There are four system levels of the computer—the first, called System One, is more commonly known as the Acorn Computer (see PE review Sept. 79). This consists of two boards—a 6502-based processor and memory board, plus the display, keyboard and cassette interface p.c.b. The photograph here shows what happens to the basic Acorn when it is expanded. Facia panels are added along with sockets to fit a backplane. The keyboard and display sections are removed and the two p.c.b.s slotted into a backplane and rack of the 19in. Eurocard variety.

The System One costs £65, and the System Two with card frame, backplane (and four sockets), CPU board, cassette and VDU interface, 4K RAM, Software monitor and 4K BASIC will set you back £285 as a kit. A *further* £200 will buy a fully assembled and tested version, with the additions of case, 5V 3A PSU, buffered backplane and 8 sockets, 4K more of RAM, front panels, connectors and an 8K BASIC. At the time of writing, software was being supplied in EPROM (2732's) and an EPROM surcharge of £50 on the System Two was in force. Each additional component is available separately from S. of C., and this is one of the great advantages of the device, a small start does not imply that you'll need to buy a different computer to gain greater sophistication.

The System Three takes the user to mini-floppy disk storage, all neatly fitting into the rack, and the System Four adds another rack to give maximum expandability for the system up to full memory and two $5\frac{1}{4}$" drives. The System Three photographed here has three 8K RAM boards, CPU card, cassette interface card, VDU card, PSU, fully socketed card rack (with one blank panel here) and mini floppy. The total cost without TV monitor would be around £1,300 assembled and tested (including an ASC11 keyboard, which comes cased). S. of C. will also sell you a Sony Trinitron colour monitor for £350. The total disk storage included is 80–90K.

Physically, the p.c.b.s are a high-quality plated-through product which seem easy enough to assemble and are, of course, fully solder-resist coated. The VDU Controller used is the 6845, which is fast becoming the industry standard, and the disk controller—the 8271 chip. S. of C. supply data sheets on all the devices used within their system at £1 each.

Expansions to the basic system include a Universal Interface board with parallel and serial ports, for hardware control, and a 6809 board to evaluate this processor via a software monitor (which is also included).

The photographs of the working system show a picture of the Post Office's "Busby" logo for a very good reason—S. of C. provide software and hardware to interface with the Prestel and Teletext System.

DISK OPERATING SYSTEM

The Disk Operating System (DOS) has some pleasant and sophisticated features which make its operation neat and less time-consuming than some others. Generous abbreviations are allowed, and qualifiers may be used to separate out a portion of the catalogue for special use. All the usual features are present—definition of drive number (0 and 1 only, as a maximum of 2 drives exist), protection for given files etc. Eight

characters are allowed for a file name on disk, and these may be non alpha-numeric. Error messages are quite informative and not just numeric.

Automatic "booting" of a program stored on disk is possible on RESET, and the disk is given an "option" number by the OPTION command to allow the following modes:

Option 0: do nothing upon RESET (i.e. stay in DOS)
Option 1: load the file "BOOT"
Option 2: run the file "BOOT"
Option 3: execute the file "BOOT".

The last option allows the file called "BOOT" to contain Commands as if typed in from the keyboard. Thus, if BOOT contains the Bytes "BASIC" (a five-byte string: B,A,S,I,C,); then, assuming the BASIC interpreter is resident on the disk, BASIC will be booted in automatically on RESET.

Any other commands may be contained in "BOOT" for this option, and BOOT is called a "command" file—very useful for some clever software tricks.

Automatic messages may be produced upon accessing given files, and these give programs a more professional and "turnkey" air when used along with Option 3 above. Other DOS commands available are the usual LOAD, SAVE and DELETE for disk files; EXEC and GO for executing machine-code routines directly and INFO to find out about the files stored in a disk, usually after a CAT command, to display the catalogue of existing files. The information returned is: qualifier, whether or not protected, file name, LOAD and RUN addresses, length of file and start-sector on disk.

The DOS also produces a familiar set of disk error messages such as "clock error", "sector not found" etc., which can help to locate bugs in the hardware of the drive if necessary.

SOFTWARE AVAILABLE ON THE SYSTEM

The languages available for the system are BASIC, LISP and 6502 Assembler, while the potentially ubiquitous PASCAL is in preparation. In addition to these, many games are in existence, and a word-processing package (described below) is also in existence.

BASIC

The Basic on disk has some very interesting and uncommon features, as it was originally conceived to control psychology experiments. Multi-statement lines are allowed, separated by semicolons; and abbreviations (with a full stop) are allowed for all the BASIC keywords, down to the minimum number of letters necessary to make the word unique (this is as for DOS). Additionally, spaces are more important than usual in BASIC. A useful feature is that the "@" sign stands for a variable which determines the fields within which numbers in a PRINT statement are printed. If @ equals 5, for instance, then 5 spaces (including sign if negative) are reserved for printing each number (right justified) when commas are used in the PRINT list.

The processor card contains 1K of RAM and 104 of these locations are reserved especially for the upper-case single-letter variable names (A,B,C, etc.). These are always tested first, and provide a set of fast-access variables. In addition, single lower-case letters are available for line labels. Thus:

```
10 a PRINT "hello"
20   Goto a
```

would put "hello" endlessly onto the screen.

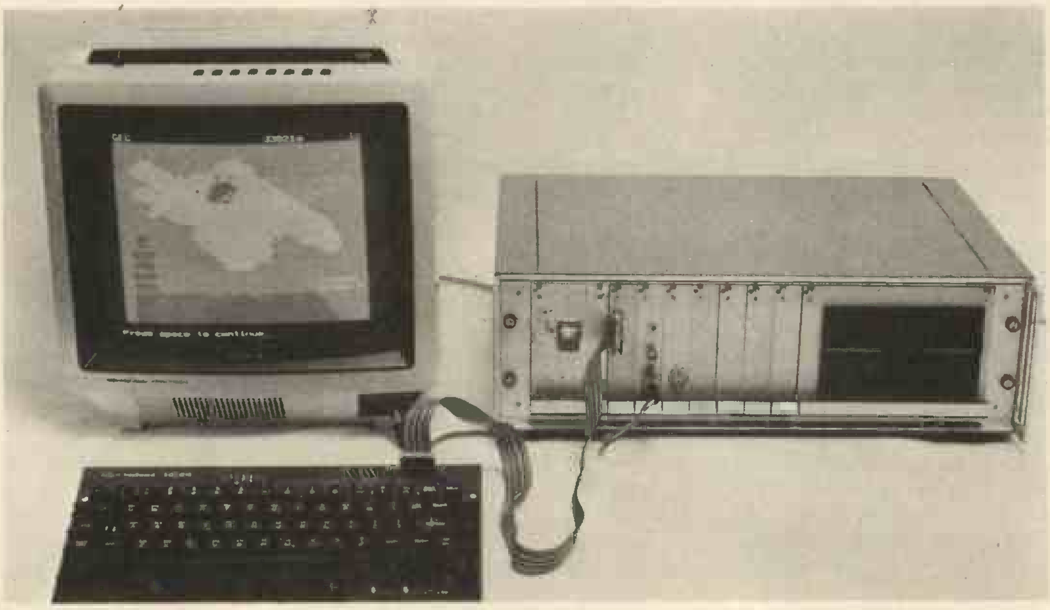
A feature called "word indirection" is available whereby the result of a calculation can be stored directly into a given set of four contiguously addressed bytes. In such a process, direct access to the Addresses of data bytes is thus greatly simplified. In addition, hexadecimal numbers may be used directly within a calculation by using the £ sign as a prefix. Thus, PRINT £AF gives the result 175, on the screen. Thus Hex numbers may be added and printed using:

```
PRINT £AF + £13
```

this gives the result C2—*great for hex calculations!* The DO—UNTIL statement is provided in System Three BASIC, allowing loops to be processed until a given condition is satisfied. This can be useful in numerical methods for instance, or in control functions.

The statement "LINK" allows machine code statements to be run from BASIC, in a similar manner to the more familiar "USR" function. Bytes, complete frames of 4 bytes and strings, may be "got" from and "put" to sequential data files using the usual variety of statements which one would expect in a disk BASIC. All the familiar BASIC statements are available, with the usual optional use of LET and END statements. No ELSE is allowed in IF statements, and the basic BASIC supplied has no floating point package. This is available as an extension.

Another extension is the graphic package which functions as follows: The screen is divided into 78 × 75 dots or Pixels (picture elements). The Busby picture shows the resolution of the system. Individual pixels are rather large, but adequate for Teletext and Prestel.



To set up a pattern on the screen, several commands are available. CLEAR clears the screen and places it in graphics mode, as well as setting the colour of the pixels to be plotted. PLOP, MOVE and DRAW then allow lines and points to be displayed on an X,Y Co-ordinate system based at the bottom left-hand corner of the screen.

LISP

Finally, the language LISP is supplied if required. This package, produced by OWL Computers, appears to be well thought out and reasonably documented, though perhaps a little difficult to follow for the beginner—the program is adapted from a version written for the Apple computer.

Science of Cambridge can provide software and hardware which will interface the Acorn system with Prestel and Teletext

FLOATING POINT EXTENSION

The F.P.E. allows accuracy of $9\frac{1}{2}$ digits in a range from 10^{-38} to 10^{+38}, approximately. All the standard integer BASIC statements have F.P. equivalents—mostly using the prefix F. For instance, FINPUT is as for INPUT, but uses a floating point variable only. In this way, the F.P.E. is a true add-on and is not fully integrated into the BASIC on the machine.

SCREEN EDITOR

This program allows the computer to be used, effectively, as a word-processor. Files containing letters or documents may be input from the keyboard and printed out on a hard-copy printer. Normally, a word-processor would organise words on the screen to prevent their being split from one line to the next. This does not appear to be the case with the screen editor, though upon print-out the words are organised so that no splits occur, and the text can be justified. The absence of "arrow keys" to move the cursor around the screen is a drawback from the operator point of view. He has to memorise which of the keys perform which cursor movement commands—though the keys are arranged in a logical manner on the keyboard.

Special letters are left in the text to signal particular printing modes, such as justification, given line-widths and the centering of a heading on the page. Strings may be located, deleted, and changed as normal. Only one character may be inserted after the cursor for each use of the insert command, which is rather limiting as far as speed is concerned. Text is entered one page at a time, and the operator must not exceed this limit, or an overflow message occurs. A page is defined as a full screen.

The version of the editor supplied with the machine for review appeared rather combersome and slow to use compared with other packages, but this may well have been due to the rather scant and embryonic documentation accompanying the program.

LISP is a language which is orientated towards the processing of strings and lists of characters as opposed to scientific and numerical calculations, though calculations are possible. Complex data structures are easy to construct, and the language can process and act upon complex "Boolean" or logical conditions. This type of programming is suitable for highly interactive routines using human language for communication. The computer can easily be made to act as if it understands syntax and grammar. As an example, as a demonstration of LISP's capabilities, OWL computers have a program called DOCTOR which pretends to be your psychiatrist, and asks personal questions in an English conversation—could become addictive!

CONCLUSION

The system is modular, as mentioned before, and appears to be well conceived from a hardware point of view, if rather expensive. The software is still in development, but is quite wide. My version only ran a converted colour monitor, and it would be interesting to see the resolution through the encoder and UHF modulator on a domestic TV.

The exact market place of the machine is difficult to assess. Medium-sized business applications would be difficult with such small disk space, and the system would have to be cheaper for the hobbyist to buy it. That leaves Education and hardware control. Both of these would surely benefit from the modularity and Input/Output expansions available. ★

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Strictly Instrumental

by K. Lenton-Smith

A problem that can confront the electronic musician is fitting a further amplifier and speaker system to an existing installation. Though apparently simply in theory, the task can be complicated if the instrument is not provided with a pre-amplified output and the end product is supplied only to the speaker terminals.

MATCHED PAIR

The practical difficulty is matching the main speaker signal to a further amplifier. It is possible, of course, to find a preamplified source somewhere in the instrument's circuitry but the main speaker signal can be useful in other respects: for the moment we will assume that the speaker signal has to be the starting point.

Another speaker in parallel would seem to be the simplest solution, but would not only result in a mismatch but probably endanger the output transistors. Placing a (say) 50k potentiometer across the main speaker and feeding the extension amplifier from its slider will give results of sorts but losses in tonal quality will perhaps be unacceptable.

Ruling that out, we try a step-up transformer: here the primary can act as a dummy load if the main speaker is to be switched out. Although this will give better results than using a simple pot., there will still be losses in tonal quality.

UNCOMMON

In the early days of the transistor, available types were of low gain, high leakage and very restricted in their cut-off frequency. It was not unusual to have to resort to *common base* configuration in order to handle even the i.f. of a suphet receiver—perhaps operating at 470kHz. Today's device is a totally different matter and alpha cut-off is no problem anyway where audio frequencies are concerned. Where common (or grounded) base is employed, the stage will handle low impedance inputs and provide a high impedance output with voltage gain—which is precisely what we are looking for in this instance. The input signal is fed to the emitter, the base ground to a.c. but biased as usual and the signal taken from the collector. A suggested circuit is shown in Fig. 1.

Power for this stage can be derived from the extension amplifier, using a suitable series resistor to ensure that the Zener diode's dissipation is within bounds. If the constructor intends to use the extension system for a doppler-effect speaker, a dummy load must be presented to the main amplifier if switching is envisaged.

LIMITER

The main speaker signal is useful as the source for driving a spring unit, so both this drive and the signal for the common base amplifier can come from the same point. Assuming that one side of the main speaker signal is earthed, Fig. 2 shows a suitable system that was used by Hammond in their M-100 series instruments. An appropriate lamp to use is 6V 0·36W, where the filament has a d.c. resistance of some 14Ω. It acts as the volume limiter and is only likely to glow on loud passages. The reverberation spring can be driven directly as indicated in Fig. 2 or this same signal can be reduced resistively and fed to the reverberation drive amplifier if it is already incorporated in the spring unit.

With a little care, the pre-amplified signal from the spring unit can be mixed with the output from the common base stage so that the extension amplifier handles both signals. It is a wise precaution to refer to the instrument's service manual to ensure that the main speaker is not provided with a push-pull, centre tapped to earth, signal. If this is the case, suitable resistors will have to be inserted after the limiter to avoid losing half of the signal because of the common earth between the main and extension amplifiers.

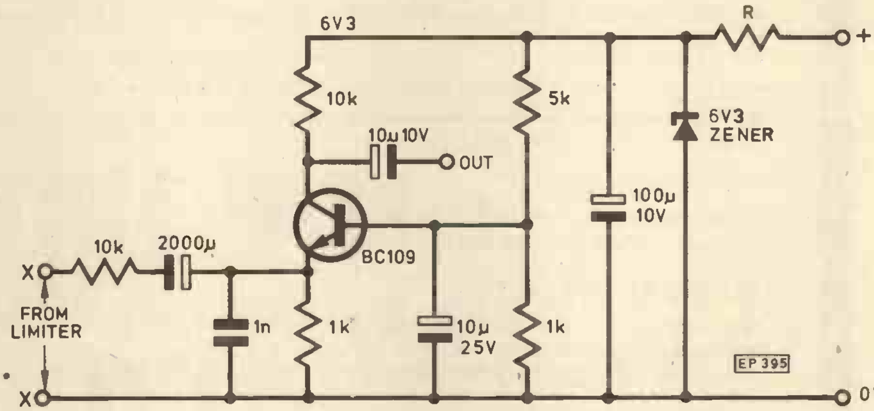

Fig. 1. Common Base Stage

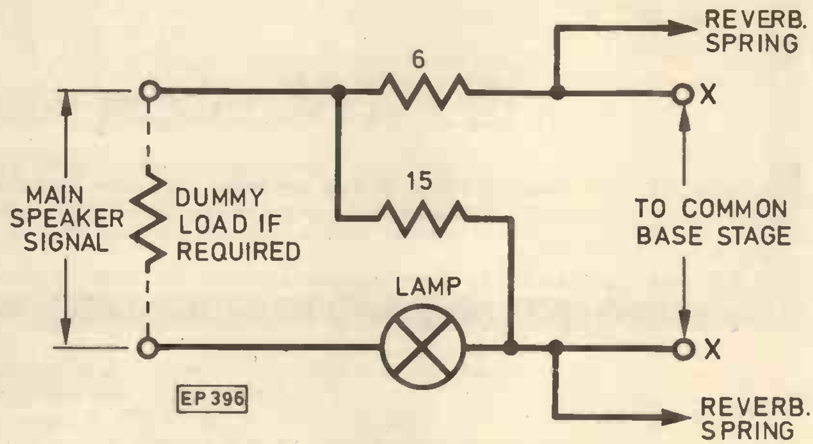

Fig. 2. Limiter

MONITOR

Whilst dealing with practical aspects, the musician reader will hardly need reminding that recording at the keyboard can be problematcial at the best of times. However, nothing is more annoying than having to use a pre-amplified tape recorder that has to be carted to the hi-fi system (possibly in another room?) to check each result. Some organs can be used to play back tape—though this may have to be monophonic—but headphone facilities are ideal. In order to preserve the musical train of thought, the simple circuitry of Fig. 3 may be found useful.

This can be built in mono or stereo form on the smallest stripboard available (both amplifiers being identical) and possibly mounted somewhere inside the recorder, borrowing power from that source. The nominal 10V is not critical but allows small electrolytics to be used: the series resistor must again be chosen to limit the zener diode's dissipation. Quiescent current is some 2mA and the quality of reproduction is excellent for this purpose. Two components call for comment: the 1MΩ feedback resistor controls volume and can be varied to suit individual taste, whilst the 330K inverting Input resistor may require amendment according to the tape recorder's output signal.

Headphones with mylar diaphragms can be extremely sensitive and, should there be any tendency to overload, a series resistor—say 100Ω—in each output lead of this type of phone will overcome the problem. A simple but effective system of checking musical efforts quickly is a great help in getting the required result—eventually!

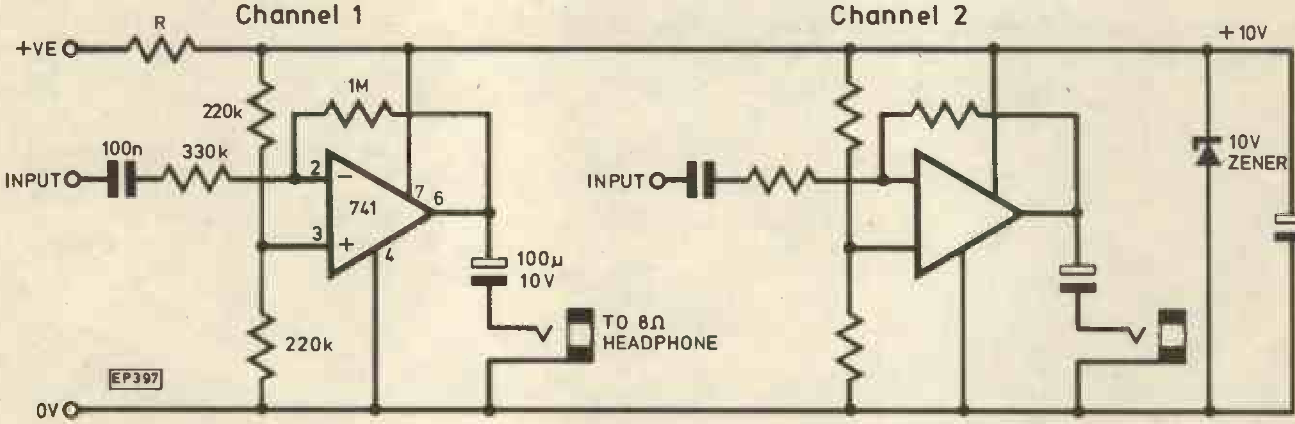

Fig. 3. Stereo Headphone Amplifier

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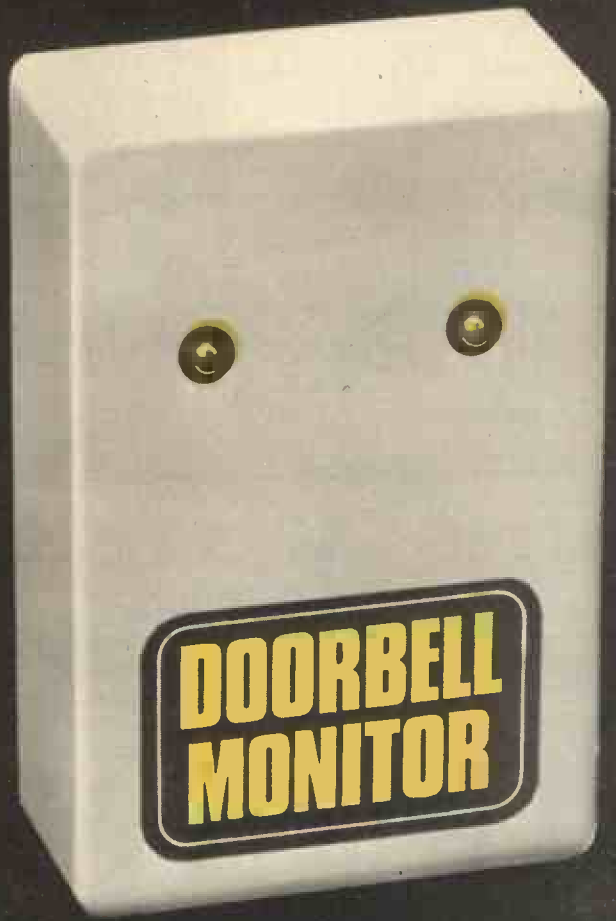


J.A. Barrow describes-

An indicator which gives a silent flashing display to the hard of hearing or in noisy environments and logs calls in your absence

HERE is a useful gadget for the deaf, the hard of hearing, or, the enthusiast who likes to play music very loudly! Primarily designed to overcome the problem of not hearing someone at the door by providing a visual indication, it has the additional feature of a memory, which indicates whether you missed a caller while you were out.

The complete unit can be made very compact as it can be simply connected to the existing bell-push wires.

CIRCUIT

IC1a and b, R3, R4 and C3 in Fig. 1 form a low frequency oscillator which is switched on when the threshold voltage at pin 2/IC1a is exceeded. The output is connected to TR1 via R5 which drives the l.e.d.s D3 and D4. The power for the circuit is from the bell battery.

Consider the circuit in the following state with C2 fully charged and pin 4/IC1d at logic '1'. A logic '0' at pin 2/IC1a ensures the oscillator is off. Pin 11/IC1b is at logic '0' so no l.e.d.s are lit. Shorting point 'A' to 'B' causes C2 to discharge rapidly through D2, so when the power returns to the circuit (i.e. when the bell push is released) C2 starts to charge via R2 causing a logic '1' to be present at pin 2/IC1a—the oscillator then functions and the l.e.d.s flash for a period determined by R2, C2 (about 30 seconds with values shown). During oscillations pin 3/IC1a goes to a logic '0' causing the latch (gates c and d) to change state. Pin 4/IC1d becomes logic '0'. This state remains until S1 is pressed when pin 11/IC1b then becomes a logic '1' and the l.e.d.s light, indicating that the oscillator has been activated. While the switch is held depressed, capacitor C4 will charge via R8 and the logic level at pin 6/IC1d will change to a '0' after about 2 seconds, resetting the latch and cancelling the lit l.e.d.s.

ALTERNATIVE SUPPLY

The circuit was designed for use with battery operated bells, but use with a.c. types up to a maximum of 10V r.m.s. is possible using additional circuitry shown in Fig. 1.

Diode D1 prevents circuit damage if input connections are reversed during installation, in which case the bell will ring continually.

CONSTRUCTION

The components are mounted on 0·1 in Veroboard as shown (in Fig. 2) which in turn is mounted onto the lid of a small plastic box. Two holes were drilled in the lid to form a

COMPONENTS

Resistors

R1	1k 0·5W
R2	3M6
R3	56k
R4	2M
R5	10k
R6	100k
R7*	180
R8	10M
R9*	

All resistors 0·25W carbon except where otherwise stated
*Selected for 6V operation

Capacitors

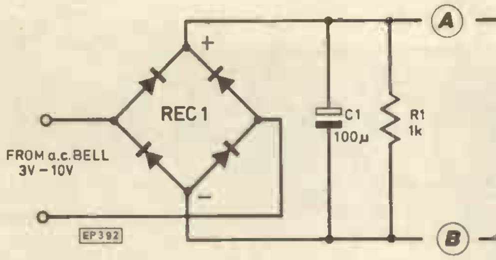
C1	100µ 16V elect
C2	10µ tantalum 16V
C3	100n polyester
C4	220n polyester

Semiconductors

TR1	BC109
IC1	4093
D1	1N4006
D2	OA200
D3, D4	Hi brightness l.e.d.s

Miscellaneous

S1 D.p.d.t. push switch (miniature) Veroboard (0·1in) 3in x 2·2in REC1 — 100 mA bridge rectifier. Plastic box.



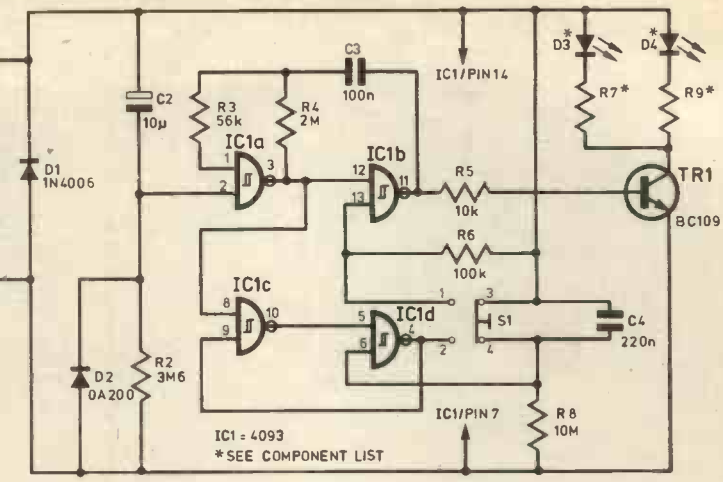
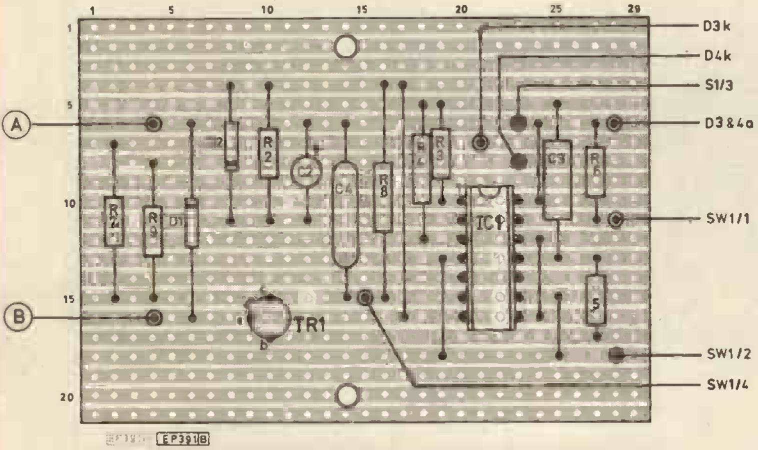
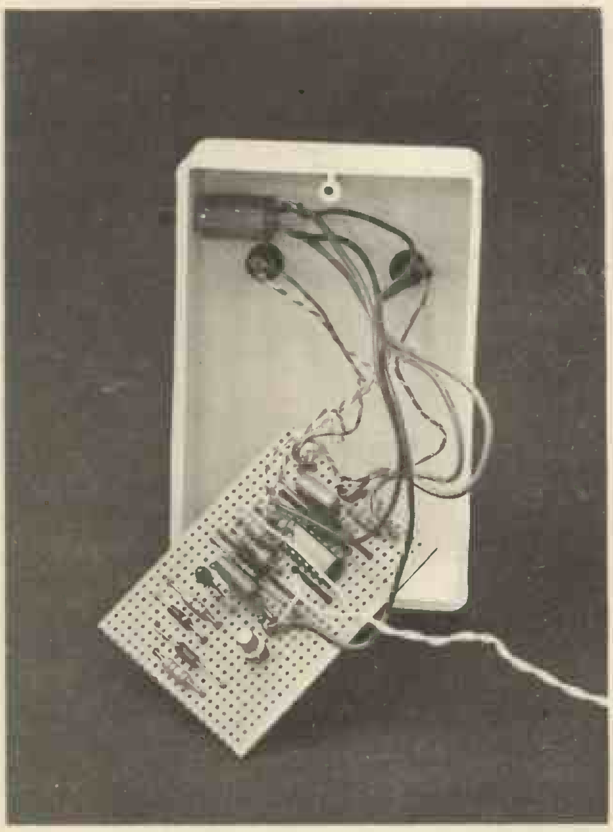


Fig. 1. If used with a battery operated bell connect A and B to the existing bell-push switch wires. For a.c. bells (3–10V) connect the rectifier circuit as shown.

Fig. 2. (Below) Veroboard layout for monitor





'key-hole', which enabled the unit to be fitted on a wall with one round-headed screw—the keyhole locating over the head of the screw.

CHECKING

After making connections to the bell-push wires, press the switch and release. L.e.d.s should flash for about 30 seconds then extinguish. Press S1 and hold, the l.e.d.s should light for about 2 seconds then extinguish. Press S1 again and the l.e.d.s should remain off.

The unit should be sited, of course, where it can be easily seen—perhaps close to the television or stereo.

In normal operation it looks after itself—switching itself off 30 seconds or so after the bell push was pressed. When, however, the memory facility is required, the push button on the unit should be depressed until the l.e.d.s extinguish before going out. Then, on your return, press the button again—if the l.e.d.s do not light, then visitors did not call in your absence. ★

POINTS ARISING

SPLIT-PHASE TREMOLO *(May 1980)*

1) The bottom end of VR1 should go to earth (as defined by the centre point between the power supply lines) and not to the −6V supply.
2) The 'In' and 'Out' positions on switch S1, as marked on the circuit diagram, should be interchanged.
3) The three jack sockets (JK1, 2 and 3) should all have their screens connected to earth, and not to the −6V supply.

Either R10 or R13 may be replaced by a preset variable resistor of value around 4k7. The setting of this variable resistor should be so as to cause the signal amplitude across it to be the same as the signal amplitude across the remaining fixed resistor. Omission of this adjustment may cause the extremely discerning listener to observe that the modulation depths on the two channels is not quite identical. The difference in modulation depths is, of course, caused by the emitter load having a signal generated across it by virtue of the base current which flows through it. Adjustment of the preset variable resistor as described above results in the cancellation of this effect.

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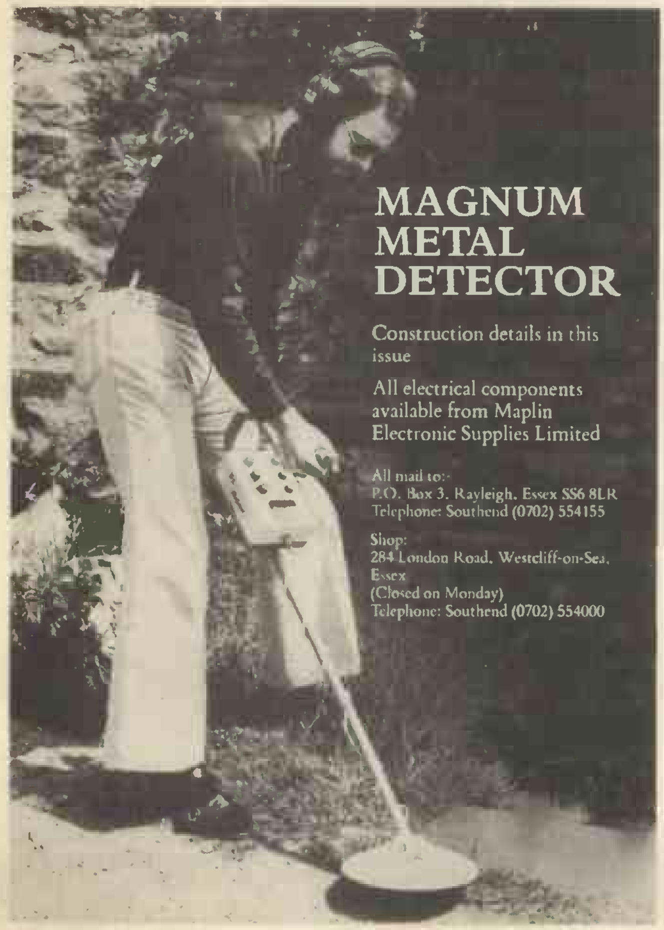

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Semiconductor UPDATE...

FEATURING 7910 UAA1003 MN9106

R. W. Coles

DESERT ISLAND CHIPS

If like me, you feel that some things are better left as they are, unimproved by generous helpings of electronic technology, then your interest in my first two devices this month may be tinged with something of a sense of foreboding.

The Stylophone was tolerable, no worse in fact than the kids tin drums and xylophones which preceded it, I even manage a wry smile when greeted by a perky rendition of "Colonel Bogey" from one of those dreadful musical door bells. I do get just a little peeved, though, when forced into a corner with one of those "Space Invaders" games which makes continuous rude noises while I'm trying to enjoy my pint, but at least I can leave them behind in the pub.

The thing that worries me about the new 7910 series of six integrated-circuit-music-makers is that they are so easy to use and so cheap that I have a vision of our homes being inundated with musical food mixers, vacuum cleaners, clocks, tooth brushes, and biscuit tins in the not too distant future.

The 7910 series can provide a tune for every occasion including "Home on the Range", "Mary had a little Lamb" and "Greensleeves", and four of the chips can also imitate door chimes and produce bleeping alarm noises. Two specials in the range are dedicated for clock applications, producing ersatz "Westminster Chimes" no less.

The thing which sets these chips apart from the microprocessor door bells of yesteryear is the fact that they (a) come in diddy 16 pin DIP packages (b) run from a *single* 1.5V battery, with a standby drain of typically 2 micro amps and (c) they are selling; even in small quantities, at less than £2 each.

The secret seems to be that the 7910 series is *not* based on a true microprocessor architecture but on a dedicated design with no "fat". The tunes are produced by an on chip combo which consists of an oscillator, two envelope generators, an output pre-amp and a collection of ROMs. The ROMs define the tunes, and custom programming is therefore possible at the mask level. The melody ROM, twelve bits wide and 128 words deep, can store 128 notes or rests, the tempo ROM provides cadences from prestissimo to largo, and the control ROM welds the whole thing together by keeping track of start addresses, tune selections, and sequence repetitions.

The pre-amp provides at least 150 microamps of base current for an external pair of transistors in a push-pull configuration, but apart from those devices, only a few cheap passives and a pen cell are all you need to drive you and your friends crazy.

The 7910 series are only available in the U.S.A. at the moment, from Epson America Inc., (who I've never heard of). If you can't wait, they live at 23844 Hawthorne Blvd., Torrance, CA 90505.

SPEAKING CLOCK

As if the threat of musical biscuit tins were not enough, it seems we are also faced with the prospect of alarm clocks which rouse us from our slumbers with a spoken announcement of the time, no doubt delivered in a supercilious tone of "voice". This terrifying prospect is brought to us courtesy of ITT Semiconductors, in the shape of a forty pin NMOS integrated circuit coded UAA1003.

All those pins are needed because the new device is designed to be connected to the seven-segment multiplexed display outputs of your favourite digital clock chip in parallel with the display LEDs. Yes, that's right, it not only speaks, it understands digital clock-ese too.

The UAA1003 can speak up to 25 separate words, and can be programmed to string these in any sequence to amaze and delight your friends. Each word consists of a number of staircase shaped pulses lasting 10 milliseconds and produced via an on-chip 7 bit digital-to-analogue converter to give 128 possible amplitude levels.

One problem though, they haven't taught the UAA1003 to speak English yet, only French and German, so unless you relish the thought of being awakened by "Bonjour. Il est sept heurs et demi" (Followed no doubt by a quick burst of "Mary had a little Lamb" from the Teasmaid), you will have to wait a few weeks before "modding" your trusty alarm clock. Your alarm clock should have no trouble powering the UAA1003 when it arrives though, it only needs five millamps at 5 volts.

Personally I am working on suitable countermeasures. In my wardrobe there is a well used hob-nail boot which I occasionally fling with unerring accuracy at the frisky cats who sometimes frequent my garden at night. I wonder if the UAA1003 could stand a direct hit from *that!*

NOVOL CHIP

I have mentioned the ingenious NOVOL devices before in this column. They are made by Plessey (yes they really are *British*) and their strength lies in the clever combination of high speed but volatile MOS memory and slower but non-volatile MNOS latches. The mixture yields memory devices which can be written-to and read-from like any other memory part in normal operation, with the added advantage that the contents of the memory can be saved almost indefinitely, even without power, after the application of a short SAVE pulse to effect a transfer to the MNOS section. This technology is invaluable where the loss of data due to power loss must be avoided and the data must also be easily changed during normal operation with power applied.

When power is reapplied to a NOVOL device, the data stored in the long-term MNOS latches can be recalled by applying a five micro second pulse to a RECALL input.

The only reservations I have had about NOVOL in the past have concerned the limited number of "save" cycles possible (about a million), and the fact that only small arrays, such as four bit latches for example, were available.

Well, the first problem is a fact of life with MNOS, but I withdraw my second reservation now that I have seen data on the MN9106/7/8 series of NOVOL counter chips. The MN9106 is a six decade up-counter complete with a multiplexed seven segment display driver and overflow logic, capable of counting at up to 200KhZ. The 25 bits of count data (6 x 4 bits and 1 bit for overflow status) can be stored in an MNOS array by application of a 10 millisecond SAVE pulse, and recalled rapidly when required so that the count can continue from where it had stopped, when the power failed for example.

The other devices in the series have certain decades changed into divide by six counters to provide a timer function. The MN9107 counts 99 hours, 59 minutes, 59 seconds and the MN9108 counts 9999 hours 59 minutes (or 9999 minutes 59 seconds).

The nonvolatility of these counters makes them suitable for applications where in the past only electro-mechanical gadgets could be used, things like car odometers, hours-run indicators and production line parts counting could all benefit from NOVOL technology.

The MN9106 series all operate from a 12 volt supply, can be interfaced to CMOS or TTL logic, and come in 24 pin packages.

Hands off.

We mean it.

The new 30AX colour tube system from Mullard doesn't need innumerable twists and turns of a screwdriver to set it up.

It needs no adjustments at all. Because every one has been 'designed out'. Every tube that leaves our factory is completely pre-adjusted by us. Leaving only the turn of one screw to affix or remove the coil.

No dynamic convergence adjustments.

No colour purity adjustments.

And no raster orientation adjustment.

As for what it has to offer, the 30AX's focus is sharper and its definition greatly improved.

Its in-line guns and specially built coil provide the best picture shape yet.

And rest assured it'll stay that way. In a slim 110° package that trims about 3" off conventional 22" 90° TV cabinet depths.

Some features of the 30AX however, are a little more established.

Like its excellent colour registration. High brightness. Soft flash protection. Fast warm-up. And of course, greater overall reliability. This is the new 30AX colour tube system.

If you'd like more information about it simply write to us here at Department MCG, Mullard Limited, Mullard House, Torrington Place, London, WC1E 7HD.

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30AX. The perfect slimline.

Electrochemistry
and the instrumentation it needs

A.T. Kuhn M.A. DPhil.

WHAT IS electrochemistry? And whatever it is, why is chemistry rearing its ugly head in a magazine devoted to electronics? Taking the quick answers to these questions, we can say first that electrochemistry is that branch of science which deals with the frontiers between electricity and chemistry. Just how important this little branch of science is, one must judge for oneself. Suffice to say that it underlies the working of batteries, and accumulators; it provides the explanation of corrosion, and at the same time suggests how we might combat it. It is the means used for production of all the world's aluminium, much of its magnesium, all of its chlorine and many other vital chemicals besides. Electroplating and anodising, electrophoretic paint deposition on cars or refrigerators, the monitoring of medical parameters, prevention of damp in old buildings by electro-osmotic action—one could go on and on!

As for the second question, the Editor has decided to run a series of projects (*not* consecutively) which will encompass the complete range of the major instruments required to study or demonstrate this important discipline, either in research laboratories or in colleges or secondary schools. These instruments will be specified to the full professional level required for research at the highest level. In many cases, they will not be cheap to build—but then their commercial counterparts with comparable performance would cost many times the same amount. In many cases too, options will be shown by means of which the builder can construct a less expensive machine, to be upgraded at a later date when funds permit.

THE SCOPE OF ELECTROCHEMISTRY

One of the best-known electrochemists today, Professor J. O'M. Bockris, of Texas, has shown how the subject can be divided into "Ionics" and "Electrodics". The first term relates to events taking place in solutions of conducting media, for example salts or acids dissolved in water, while the second relates to the interface between a metal or other conductor, and the solution in which it is immersed.

IONICS

Far and away the most important measurement we make in relation to water and other species dissolved in it, is pH, or acidity. To a first approximation, we can define this as:

$$pH = -\log [H^+]$$

and in the laboratory, in the food, drug or chemical industry, we are constantly concerned with the acidity of whatever we are making, for not only must the value be *right* but also we can use it as a guide to all sorts of other things happening. But then the biologist, the gardener or soil scientist, the aquarist, the doctor and vet, are all concerned with the application of this same term to their own discipline. There are many ways in which we can measure this quantity. But the most commonly used one is to use a pH *electrode*, and, having first calibrated it against solutions whose pH is known, we can measure pH by measuring the potential difference generated between this electrode and another one, the response of which is not affected by the pH of a solution. This voltage must be measured with a circuit of moderately high impedance, of the order of 10^8 Ohms or so, and this requires special design. Formerly this was done with electrometer valves, but now we have FET op. amps. The technique of pH measurement with an electrode is some 40 years old or so. But in the last decade a staggering advance has been made, in that we now have a series of ***Ion-specific*** Electrodes which can be used in very much the same way, to measure the concentrations of Cl^-, F^- or Na^+ in a solution.

Numerous ion-selective electrodes are now available. Their number increases every year. There cannot be an easier way of measuring the calcium levels in milk or the amount of nitrate in drinking water than by using one of these new electrodes. The principles on which they operate are very similar to the glass electrodes used to measure pH, and both devices follow more or less closely the relationship known as Nernst's Equation:

$$E = E_0 + \frac{2{\cdot}3RT}{nF} \log [Cl^-] \qquad (1)$$

where E_0 is a constant, and E is the measured voltage. The other terms relate to the concentrations of the ions we wish to measure. In practical terms, these electrodes are still a little more difficult to use than the pH electrodes which preceded them. The actual slope of the relationship between log (X), where X is a species and the measured voltage is not always that suggested by equation (1), where the factor

$$\frac{2{\cdot}3rt}{nF} = 0{\cdot}059\text{V at room temperature.}$$

but can deviate some way from it. Therefore these instruments must incorporate variable slope controls.

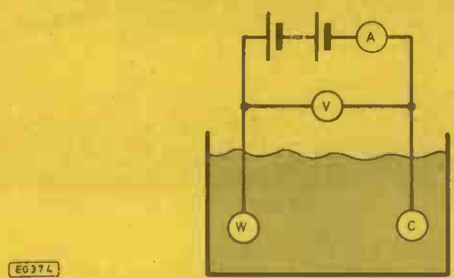


Fig. 1. Two electrode system

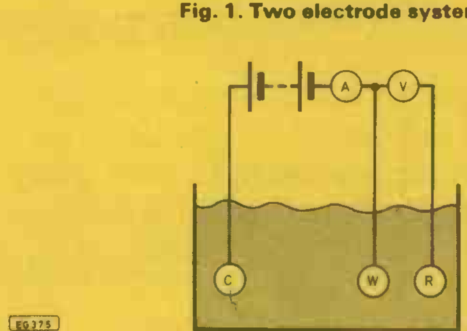


Fig. 2. Three electrode system showing working counter, and reference electrodes

From the measurement of pH or pX, it is only a step to an instrument which uses this information to actuate some means for controlling the same parameter. This is sometimes known as a *pH stat* or auto-titrator and the commonest use is perhaps in the treatment of effluent discharges from factories, where a discharge must be held between pH 6 and 8 to be acceptable. The actual pH of the effluent is measured and if it is too acid, a valve is actuated, to effect addition of some alkali.

ELECTRODICS

The second major branch of electrochemistry, electrodics, deals with the passage of a current from a metal electrode and into solution. Though much research has been published in the past hundred years in this exciting field, a great deal remains to be done, not least in the field of electro-organic chemistry; that branch which deals with the reactions of organic molecules at electrodes, where they are reduced or oxidised (at the cathode or anode respectively) or can undergo a range of other fascinating reactions such as dimerisation (doubling up). Here is a vast territory for novel ideas and research, and what is more, as such things go, the tools for this research are far less costly than those required for almost any other branch of chemistry. Indeed, apart from certain items of glassware, the instruments required will be those it is planned to present in the coming series.

The first laws of electrolysis are those laid down by Sir Michael Faraday, over a hundred years ago, in which he stated that a given quantity of electrical charge (the Faraday 96,500 coulombs) will liberate one gramme-molecule of a given substance for every electron required in the reaction. This opens up a number of important experiments, for we now know that by passing a certain charge (a known current for a known time), we can release precisely determined amounts of material. Indeed, the ampere is defined as a standard in these terms, as the current, passed for one second, which will deposit the appropriate amount of silver from a solution of this metal. However in practical terms, we face a problem, since the effective resistance of an electrolyte solution with two electrodes immersed in it, is rarely constant, and varies not only with temperature but also with time, as substances deposit on the electrodes the latter change their behaviour thus simulating a change in resistance. For this reason, and unlike the electronics scientist, the electrochemist frequently requires the constant current device in place of the constant voltage source more commonly found in physics. With a constant current device, we can set up a current of, say, 50mA and know that it will hold at this value even though the voltage required to drive that current changes from perhaps 10 volts initially to as much as 18 volts after 30 minutes. Designs for two such units are presented in this issue. One is a simple single transistor unit with an output from 0–20mA or so. The second is a more advanced unit with switchable ranged outputs up to 3A.

If we wish to learn more about what is taking place during an electrolysis with two electrodes dipping into an electrolyte, we soon recognise that, in such a simple system, we cannot distinguish between what is happening at one electrode from that happening at the other. The reason for this is the voltage required to drive a current from an electrode into solution or vice-versa is related to it by:

$$V = a + b \log i$$

where a and b are constants which depend on the metal used, its size, condition (roughness) and what electrolysis reaction is taking place. We can describe an electrode whose voltage is changed as current flows according to this equation, as being *polarised.* Note that it is a non-linear relationship between current and voltage; in other words, one of the few cases where Ohm's Law is not obeyed. So with two electrodes in a beaker, each obeying the above law, and the ohmic drop through the solution as well, we end up with:

(anode or positive electrode) $V = a + b \log i$
(cathode, negative electrode) $V' = a' + b' \log i$

All the constants are different, but the same current, i, must flow into the solution at one electrode and and out at the other.

Adding these two terms together, we get an equation that describes the voltage across a cell:

$$V_{cell} = a'' + b'' \log i + iR$$

where the last term expresses the ohmic resistance of the electrolyte in the cell and leads etc. V_{cell} is what we measure with a voltmeter across the two electrodes when current i flows, E is the voltage across the same two electrodes before we pass voltage and V and V' apply to each of the two electrodes. R is the resistance of the electrolyte. The "Working" electrode is the one we are interested in, the one whose current-voltage characteristics (measured against the reference electrode) are plotted in Figs. 3 and 4. The "Counter" electrode we must have to ensure continuity of current flow through the solution. The "reference" electrode, because it passes no current, other than the leakage through the high impedance voltmeter, is assumed to be constant. Because three things are changing all at the same time, it is not possible to isolate any one effect. The solution is simple. Instead of adopting the circuit as in Fig. 1, we go rather for the three-electrode system shown in Fig. 2. The third electrode is called a *reference electrode.* Because no current flows through it, other than the minute drain due to the voltage measurement circuit, it is not polarised and remains at the same voltage even though the voltage of the other two electrodes, through which we are forcing current, does change.

If we take two electrodes, and lead is the most easily obtainable metal, dip them into weak sulphuric acid and pass a gradually increasing current, we can get values of V and i, and plot them. The result should be like that shown in Fig. 3. If we can obtain some semi-logarithmic graph paper, the result will instead be a straight line the gradient of which gives us "b" from the equation above, while the intercept is "a". The better our electrode is, the greater the value of "a" and a great deal of industrial research is now concerned with looking for novel electrode materials having a better value of "a" for key reactions

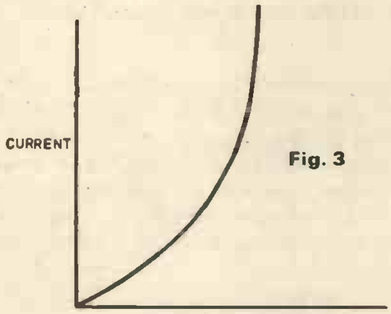


Fig. 3

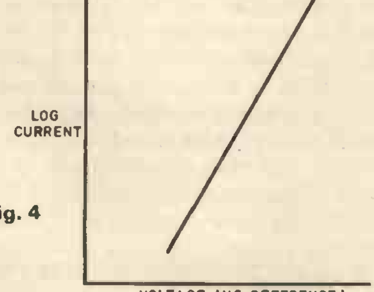


Fig. 4

such as hydrogen evolution or oxygen evolution (both involved in the "hydrogen economy") or for the chlorine evolution reaction. A more sophisticated instrument for following the relationship between current and voltage, is the potentiostat. This, unlike the constant current supply (or galvanostat) is a feedback device which measures the potential between the electrode whose behaviour we are anxious to study (working electrode) and the reference electrode, and compares this value with a pre-determined voltage which has been set up. By regulation of the current flowing in the circuit working electrode to counter electrode, that is to say variation not only of the magnitude but also the sense of this current, the desired potential is held constant. We may, in some cases, wish not so much as to hold this potential constant, but rather to vary it in a linear manner as a function of time. In such a case, we need a ramp generator, which is coupled to the sensing side of the potentiostat.

MAKING MEASUREMENTS

With these instruments, we have the essentials for doing electrochemical experiments. However a certain number of other peripherals are also desirable. The measurement of current and voltage call for some thought. Current can be measured either using a d.c. ammeter in series with the instruments, or by measurement of voltage drop across a fixed-value precision resistor. Electrochemistry is unusual as a discipline, in that currents in a single experiment may vary from a few microamperes to an ampere or more. Thus, auto-ranging current measurement devices, though not widely used at present, would be useful. A further difficulty arises because, for reasons that will be explained, the resistor across which the p.d. is measured (sometimes known as the "counting resistor") may well stand 50V off earth potential, or even more. This calls for a voltage follower with rather special properties. The same wide span of currents (expressed as voltage drop across a resistor) could also suggest a log-response amplifier.

Application of a given current with measurement of the resulting voltage, or the converse process of maintaining a defined potential in order to observe the current, are the two most basic techniques we use in electrochemistry. By changing either the applied voltage or current and observing the value of the other parameter, we can obtain a graph of current vs. voltage, and from this graph a great deal can be learned about the nature of the reaction. Is the current responsive to stirring? What is the effect of change of temperature or pH or concentration of any other species? There is nothing like a little simple automation, and application of a simple voltage ramp either to the potentiostat or the galvanostat allows us to monitor one parameter while the other is continuously changing. We can feed the input and output to an X–Y chart recorder and go away for our tea until the scan is complete. For a faster scan, we shall use an oscilloscope to record the i–V trace, though more recently this has been challenged by the transient-recorder.

SOME EXPERIMENTS

In the project series, it is intended that all the instrumentation required for the study of electrochemistry will be described. That is to say a pH or pX meter, a constant current unit, a potentiostat, a function generator and a log amplifier. If space permits current followers and voltage followers as well as coulometers will also be described. Other equipment which is useful is an oscilloscope and, or, a V–t chart recorder. What sort of experiments can we do with this equipment? All sorts of ideas come to mind. The following simple experiments are suggested:

i) Take 2 lead plates and place them in a beaker with dilute sulphuric acid. Apply a d.c. current (approximately 100mA per cm^2 for a few hours) and we have now formed a simple lead acid battery. Measure the voltage at open circuit. It should be approximately 2·01 Volts. Now connect the constant current unit across the two plates and pass current in the reverse direction. The "battery" will be discharged. Measure the voltage while this is being done and it will slowly decrease for several minutes (or longer if you have a low current or a good battery) until suddenly the voltage will plunge downwards. This is called the *knee* of the discharge curve, and if we measure the charge passed (in ampere hours) from start of discharge till the knee, we obtain the capacity of the battery—it won't be as good as an Exide!

ii) Take a clean metal electrode and plate onto it a thick layer of metallic copper from an acid copper sulphate bath. Using a constant current unit, measure the charge required. After the experiment, use a microscope to measure the thickness of the deposit. From Faraday's law and the Avogadro number, you can estimate the size of a copper atom.

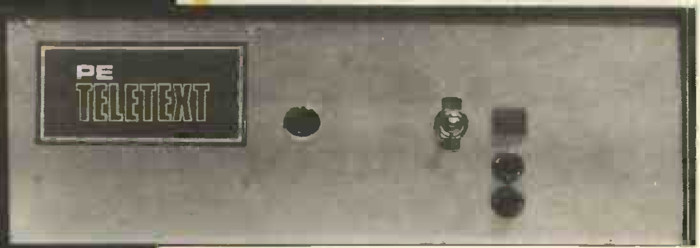
iii) Using a potentiostat and a dilute solution of sodium hydroxide (take care this does not splash!) follow the rate of hydrogen evolution at electrodes made of silver, gold, lead, iron or other metals. See how some are much better electrodes and evolve the same amount of gas at a lower voltage. Use a burette upturned to collect the hydrogen and verify Faraday's law (but do not forget to correct for water vapour pressure).

iv) Using a potentiostat as a zero-resistance ammeter, connect a piece of steel and a piece of copper through the ammeter to one another. When both are immersed in water, you will observe a current flow and after a time, evidence of the corrosion of the steel will be seen. With this instrument, which measures current without imposing any "meter resistance" even at the micro-ampere level, we can follow the corrosion process. Similar experiments can be done using stainless steel, only here the currents will rapidly decrease as the metal *passivates* and forms its protective skin. Scratch that skin and the current will shoot up again.

v) Make up a solution with small amounts of copper, iron and zinc salts in it, in dilute acid. Using a 25mV per sec. voltage ramp from the function generator connected to the potentiostat observe the current traced out. It should show three distinct plateaus corresponding to the three metals in solution and this principle forms the basis of polarographic analysis, each metal plating out as the potential becomes more negative.

The foregoing experiments are intended only as a guide to show some of the wide range that can be tackled with the equipment whose construction will be described in detail in later issues. These being scientific instruments, it follows that there is a wide range of textbooks in which electrochemistry is explained and discussed and ideas for experiments are suggested. A list of these books will be supplied by the author on request. It must be confessed that it is mainly with schools and colleges in mind that the present series has been launched, and the authors of the various articles will be happy to help interested readers in every possible way, whether in the construction of their instruments or in using them once they are built. Where possible, queries will be referred to the nearest known scientist working in the field to the address of the questioner. Happy experimenting! ★

PE TELETEXT with INFRA-RED REMOTE CONTROL



PART ONE...

David Shortland

THE PE Teletext system, which has been designed around the Mullard set of dedicated LSI chips, enables a TV set to decode and display the magazine information services transmitted by both the BBC and ITV networks (Ceefax, Orbit and Oracle).

The teletext information is transmitted in digital form along with the normal television signal using the spare lines in the field blanking interval which is usually of 25 lines duration. Some of these lines are used for test and signalling purposes and although any of them can be used for teletext transmissions, only lines 17(330) and 18(331) are used at present.

To reduce setting up and alignment problems the decoder board is available fully aligned and tested. The video summer board which has been designed by Mullards enables an excellent teletext display to be obtained via the aerial socket of a TV.

BLOCK DIAGRAM

A block diagram of the system is shown in Fig. 1.1. The aerial signal is fed to the tuner board where the video and audio information is extracted. The audio signal is then taken direct to the video summer board. The tuner board is also used for remote control channel changing. If a channel change key is pressed on the infra-red transmitter then a four-bit binary signal is sent to the tuner from the receiver to operate the changeover.

The video signal is fed to the decoder board where the teletext information is retrieved and then checked for errors. The decoder board also generates all the timng signals for the teletext display. After checking, the information is stored in two IK x 4 static RAMs ready to be displayed. When enabled the RAM outputs are converted by a character generator into a dot matrix pattern. The matrix is in a 7 x 5 dot form for each character but as the character generator also has a character rounding facility to improve character definition, this effectively increases the matrix to 14 x 10 dots. The outputs from the decoder board are then taken via an interface daughter board to the video summer board where the colour burst and audio signals are added to the

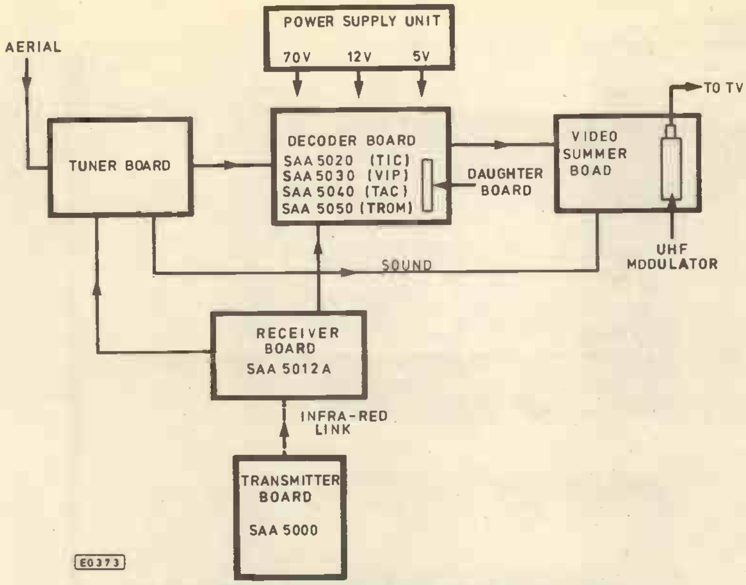


Fig. 1.1. Block diagram of the PE Teletext system

composite video signal which is then sent via a UHF modulator to the TV.

The system is connected to the TV via its aerial socket and in order to receive a good teletext display the aerial must be capable of delivering a strong signal to the set. If there are any problems with the reception then the teletext display information will be corrupted with random data and if the corruption is very bad then no text at all will be displayed.

When the system is first switched on or the reset button pressed BBC1 is automatically selected. Either of the other two channels can be chosen by pressing the appropriate button. The channel change buttons on the remote control are dual function: in the teletext mode they are the page selection numbers 1, 2, 3, etc.

REMOTE CONTROL FUNCTIONS

When the teletext mode is first selected after switch on, page 100 is automatically selected. Any other page in the magazine can be selected by pressing the appropriate page selection numbers (0 to 9) in turn. As each digit is entered the page number is built up in the left-hand corner of the screen. When the final digit, of the three digit number, has been entered the page header turns green (all except the left-hand page number) and the green page number in the header will "rotate" showing each page number as it is transmitted. When the selected page is transmitted the page number stops rotating and after the page has been captured the header reverts to white and the page is displayed.

HOLD

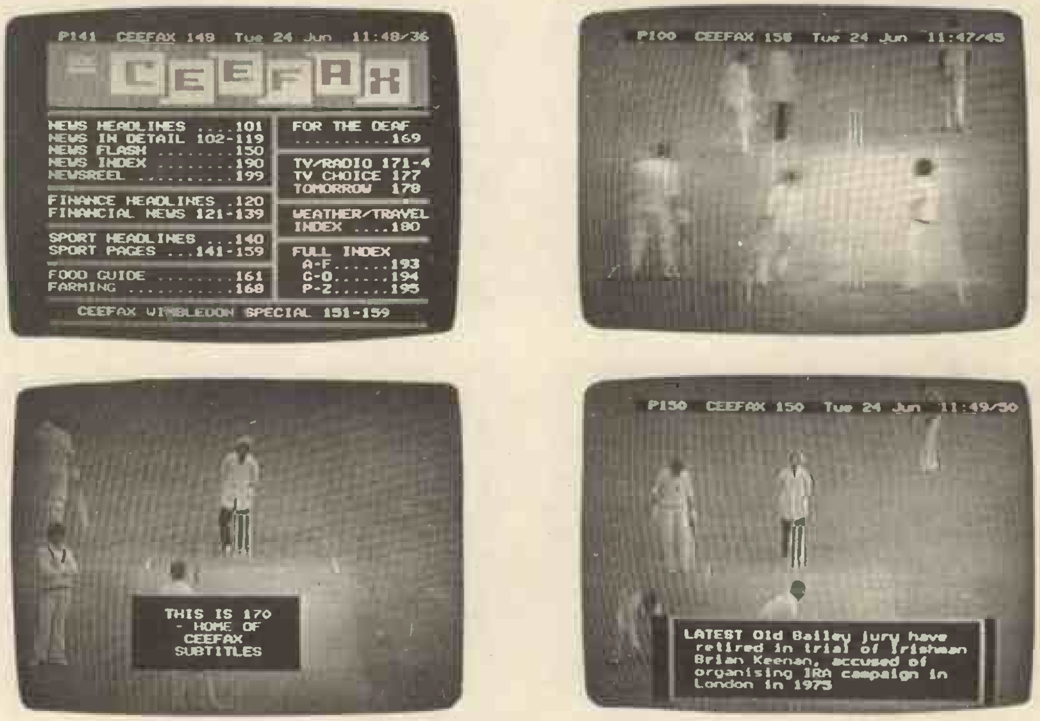
Some of the pages in the system contain more information than can be displayed on the screen at one time. To overcome this they are divided into a number of sub-pages and a different page is transmitted during each sweep of the system. As each sub-page is sent it is automatically displayed. The particular page in the series being shown is displayed in the right-hand corner of the screen, below the time (e.g. 1/4, 2/4, etc, etc). The hold key facility enables any rotating page to be held indefinitely. After pressing the hold key the word hold will appear in the top-right hand corner of the screen in place of the 24hr clock. The hold command can be cancelled by pressing the text button.

TIME

If the time button is pressed when the television picture is being viewed the 24hr clock will be inset in the video picture. The clock will disappear after 5 seconds.

TEXT

The text command switches the system into the teletext mode and page 100 (the index) of either Ceefax or Oracle is



Screen displays (Ceefax system).

Screen displays (Ceefax system)

displayed depending on which channel was selected before the text button was pressed. This does not apply to BBC2 as the Orbit index is on page 200.

TOP, BOTTOM AND NORMAL

When in the teletext mode the top and bottom buttons select the double height characters and displays one half of the page for easier viewing at a distance. The normal button changes the display back to a full page. If a new page is selected whilst the double height characters are being used the top half of the new page will appear irrespective of which half page was previously selected.

REVEAL

Pages in the system which have parts of their display concealed (i.e. quiz pages) can have these parts displayed by pressing the reveal button.

PICTURE

To switch the system back to the television picture when it is in the teletext mode, press the picture mode.

TIMED TEXT

The timed text button enables any single page in the system to be stored for viewing at a pre-determined time. To use the timed text mode, switch the system into text and select the teletext page to be stored, then press timed text. This will replace the 24hr clock with the letter 'T' followed by a flashing 00·00 display. The page selection buttons can then be used to set the time the page is to be viewed (e.g. for 8·35 pm press 2035). When this has been completed press the cancel button to return the system to the picture. When the pre-determined time is reached the page number appears in the top left-hand corner of the screen. The page can be viewed by pressing the text button. The time code can be cleared from the decoder by pressing the cancel time text key.

STATUS

The television channel being viewed can be identified at any time by pressing the status button. The channel is displayed in the left-hand corner of the screen for 5 seconds.

RESET

The reset button puts the system into the television mode and cancels all previous teletext commands.

MIX

The mix button will inset the page header into the television picture.

NEWSFLASH

If the new page is a newsflash or subtitle page then the system automatically switches back to the television video and the newsflash or subtitle information is inset into the picture. Switching back from a newsflash or subtitle page automatically turns the video off.

REMOTE CONTROL TRANSMITTER

The infra-red remote control unit which is used to control all the teletext functions is based on time-ratio discrimination and does not require any accurate timing components. The circuit diagram of the transmitter unit which is shown in Fig. 1.2 has been designed around the SAA5000 LSI chip and can transmit up to 32 commands.

To protect the system against interference of reflections the data is encoded as shown in Fig. 1.3. When a command is entered on the keypad a short pseudo-random sequence is transmitted followed by a 24-bit data stream which comprises a 7-bit start code and a 5-bit message. This 12-bit

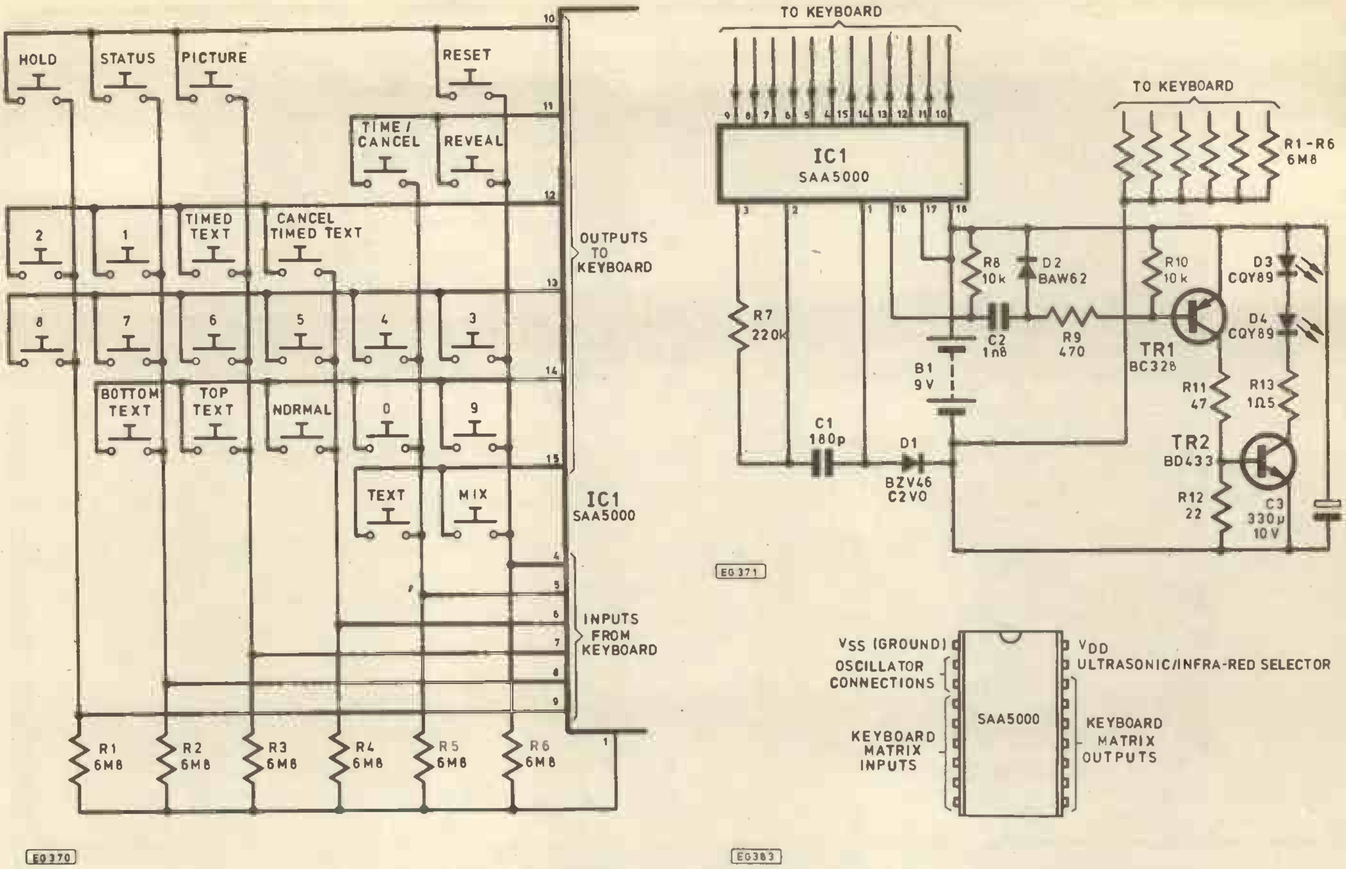


Fig. 1.2. Circuit diagram of the Transmitter unit

sequence is then inverted and transmitted again. When a key is pressed the whole data stream is automatically transmitted so the user does not have to keep the key depressed for any specific period of time. The receiver will not respond until the whole 24-bits have been received and checked.

The transmitter automatically 'powers up' when a key is pressed and will revert to standby when the transmission is completed. The push buttons are connected to 12 pins of IC1 with pins 10 to 15 being held high. When a button is pressed a high is connected to one of the input pins (4 to 9). These pins are connected to ground via resistors R1 to R6 which are pull-down resistors used to determine the input sensitivity of the chip. As the circuit 'powers up' an on chip oscillator produces a 24-bit data stream at pin 16. The oscillator is timed via resistor R7 and capacitor C1 with its frequency being used to determine the output data bit rate. The output signal is fed to TR1 which provides the base current to operate TR2. The resistor R13 defines the current for the epitaxial gallium arsenide l.e.d.s which when forward biased emit radiation in the near infra-red region. As high currents are used in the transmitter (approx 4 amps), which is supplied by C3, great care should be taken not to touch the pins of IC1 when the transmitter is being operated. This is because the time duration of the current pulses through the output diode can be greatly increased resulting in the diodes being permanently damaged.

	START	MESSAGE	$\overline{\text{START}}$	$\overline{\text{MESSAGE}}$
PSEUDO RANDOM SEQUENCE	1010011	11001	0101100	00110

EG276

Fig. 1.3. Encoding system for the transmitter data

CONSTRUCTION

The transmitter circuit is mounted on a double-sided p.c.b. which is shown in Fig. 1.4. Before any components are mounted on the board all the through board links, shown in Fig. 1.5. by the square pads, should be soldered using tinned copper wire. After soldering, check all the links for continuity with a multimeter. The components are mounted on one side of the board and the switches on the other. The push-button switches can be soldered next and as they can only be mounted one way round, carefully check the orientation before soldering. With the switches soldered, turn the board over and mount the components. Make sure the components are mounted as close as possible to the p.c.b. especially the transistor TR2. An i.c. socket should be used for IC1.

The two infra-red diodes are fitted into the end of the case using l.e.d. holders. The wiring for the diodes is shown in Fig. 1.6 along with the p.c.b. mounting details.

The p.c.b. should be mounted into the case before the i.c. is inserted. The case should be drilled to allow the 23 push-button switches to pass through. The p.c.b. should be mounted using 6BA counter sunk screws and the board spaced away from the case using either 6BA nuts or a spacer. When the board has been fitted into position check that each key operates correctly without fouling the case.

The keys can be annotated using rub-on transfers either on the key tops or on the case. If they are put on the keys then clear varnish should be used to protect them from wear. The battery can be held in place using double-sided tape.

RECEIVER CIRCUIT

The receiver circuit shown in Fig. 1.7 detects the infra-red signals from the transmitter via the photo-diode D5. A gyrator circuit designed around TR3 improves the rejection

COMPONENTS . . .

TRANSMITTER BOARD

Resistors

R1–R6	6M8 (6 off)
R7	220k
R8,R10	10k (2 off)
R9	470
R11	47
R12	22
R13	1Ω5 2·5W

All resistors ¼W 10% except where otherwise stated

Capacitors

C1	180p
C2	1n8
C3	330μ 10V elect.

Semiconductors

D1	BZV46 C2VO
D2	BAW62
D3,D4	CQY89 (2 off)
TR1	BC328
TR2	BD433
IC1	SAA5000

Miscellaneous

PP3 battery
Battery connector
Holders for l.e.d.s (2 off)
Case pac-tec type HP
P.c.b.
Switches (23 off)
Holder for i.c.

RECEIVER BOARD

Resistors

R14,R15,R20	1M (3 off)
R16	330k
R17, R23	10k (2 off)
R18	47k
R19	8k2
R21	470k
R22	4k7
R24	27k

All resistors ¼W 10% carbon

Capacitors

C4	1n
C5	470n
C6	2μ2 10V elect.
C7	22n
C8	68μ 10V elect.
C9	27p

Semiconductors

*D5	BPW34
D6,D7	BAW 62 (2 off)
TR3,TR4	BC159 (2 off)
TR5	BC148
TR6	BC149
IC2	SAA 5012A

Miscellaneous

P.c.b.
Holder for i.c.
*See Fig. 1.7.

Constructor's Note

A complete kit of parts or individual boards for the PE Teletext system will be available from *A. Marshall's (London) Ltd.*, Kingsgate House, Kingsgate Place, London NW6 4TA. The main decoder board, which is mounted on a double-sided p.c.b. with plated-through holes, will be supplied ready built, tested and aligned. The board is not suitable for home construction and its design will not be published.

of low frequencies whilst allowing the maximum response to the narrow transmitted pulses. The output from the diode (D5) is a.c. coupled to the voltage amplifier of TR4 and TR5. The response of the amplifier which is controlled by C6 and the feedback capacitance of TR5's collector has been designed to cut off low and high frequency interference. The high frequency cut off also improves the stability of the amplifier. The output of the amplifier is a.c. coupled via D6 and D7 to the base of TR6. The diodes D6 and D7 eliminate any noise which is generated in D5.

The 24-bit message code is applied to pin 22 of IC2 where it is decoded and checked for errors. The DATA output (pin 5) pin of IC2 provides a 7-bit output, 5 bits of which are identical to the input message code and the other two bits control the mode of the system (i.e. TV or teletext). The DLIM output of the chip (pin 7) is clocking pulse which is used to clock the output data from IC2. The internal functions of the circuit are controlled by an oscillator which is timed by the resistor and capacitor connected to pins 18 and 19. The 4-bit outputs from the chip (pins 2, 3, 8 and 21) are used to select the TV channel to be viewed.

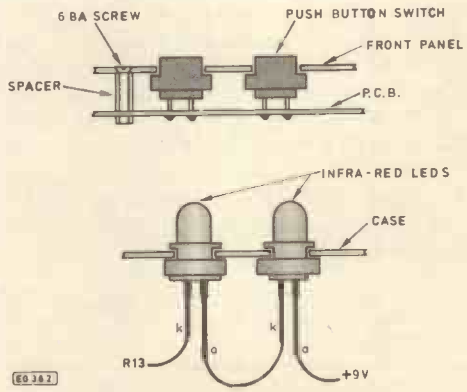


Fig. 1.6. Wiring diagram for the infra-red diodes (D3 and D4) and the mounting details for the p.c.b.

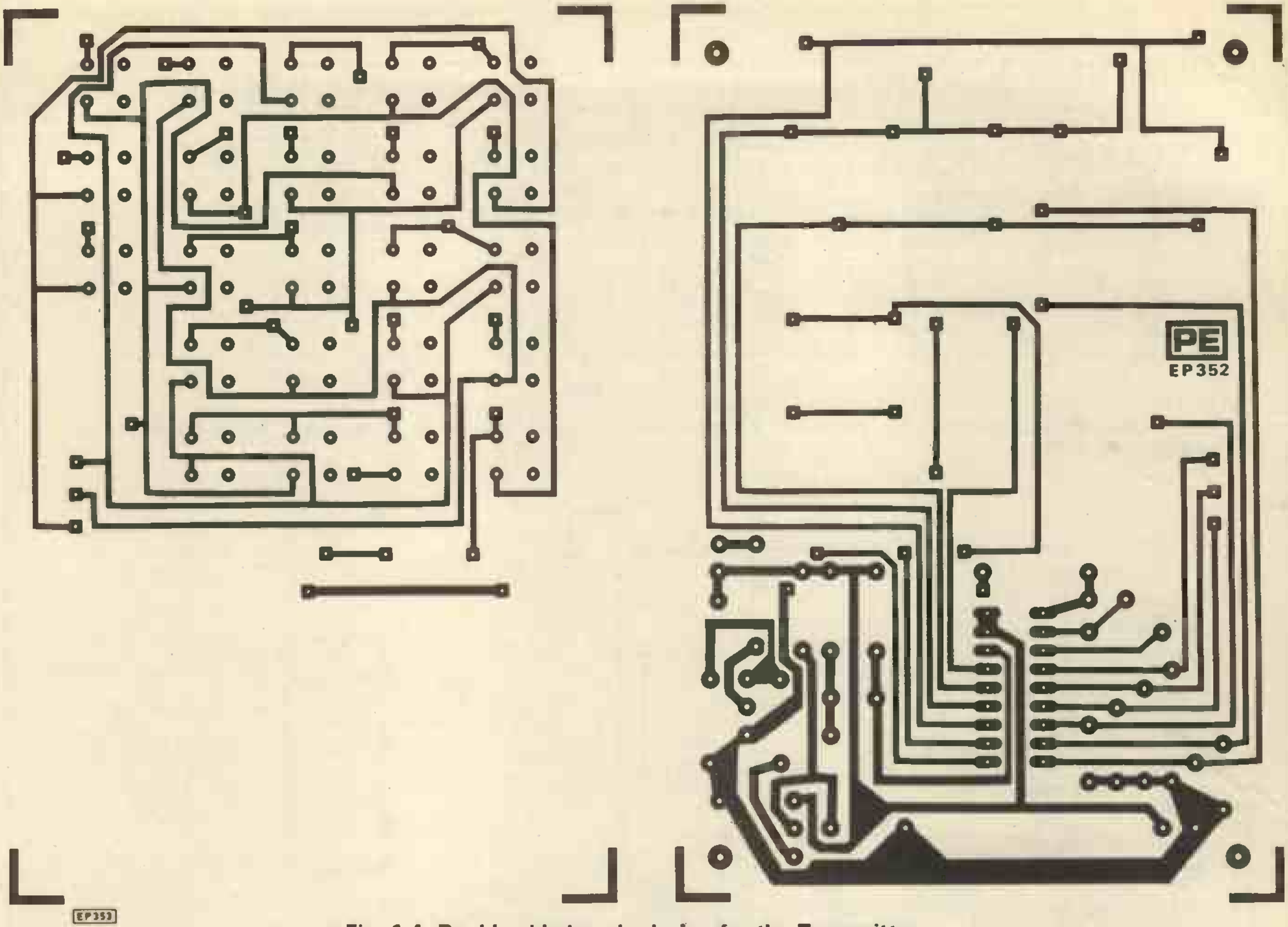


Fig. 1.4. Double-sided p.c.b. design for the Transmitter

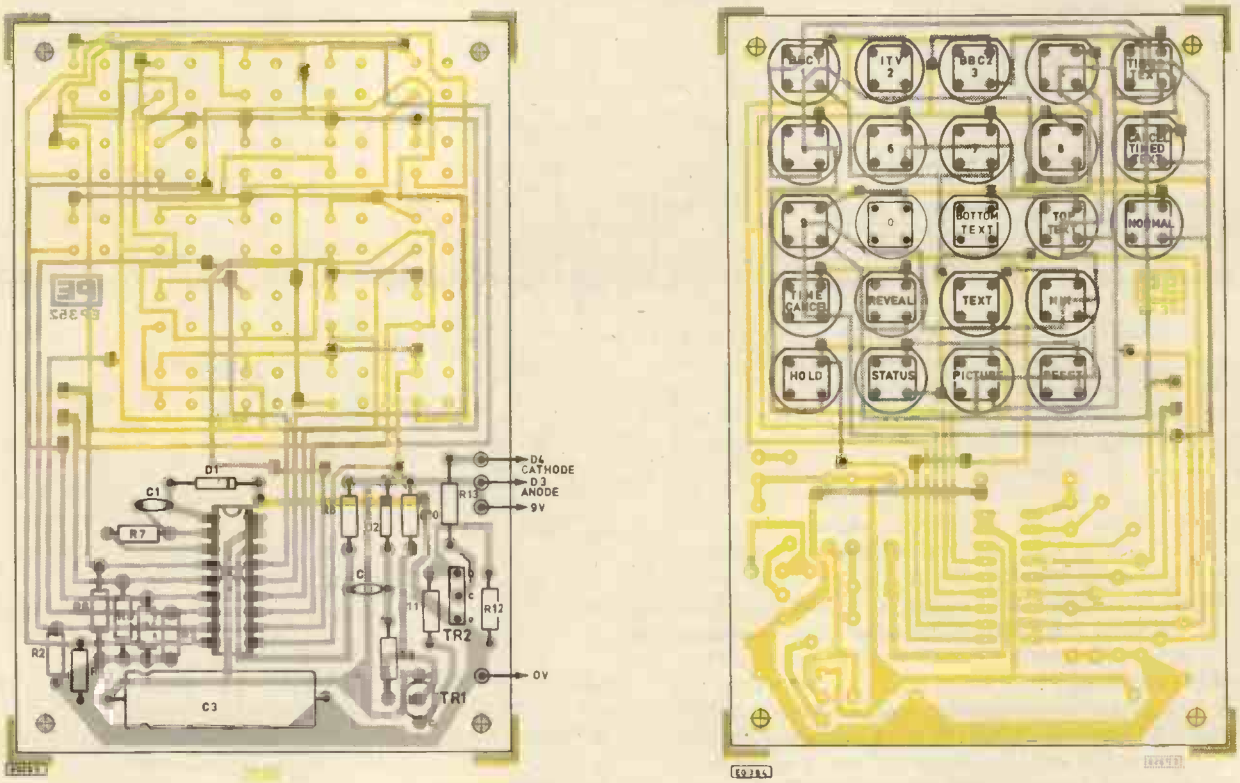


Fig. 1.5. Component layout for the transmitter board which also shows the through board links (square pads)

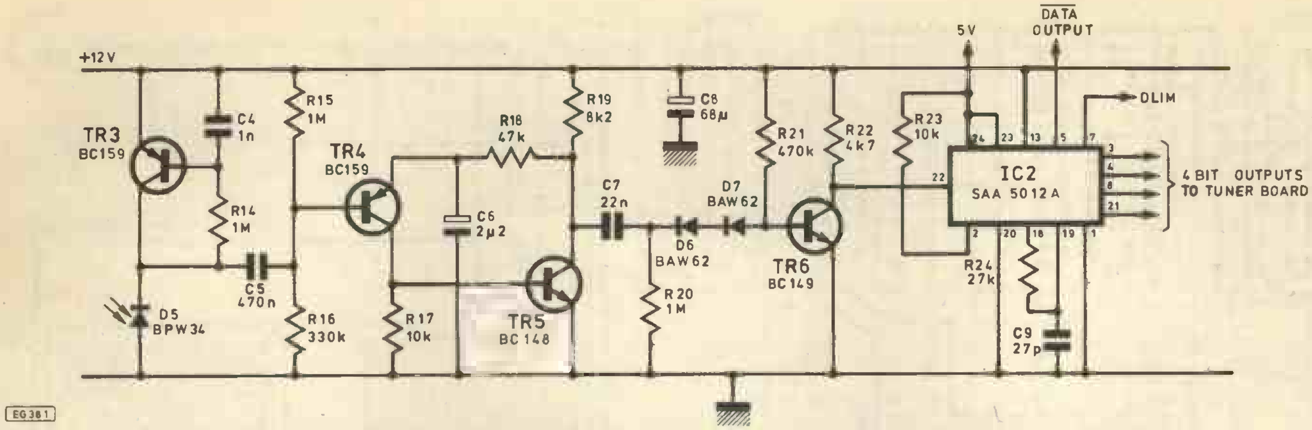


Fig. 1.7. Circuit diagram of the Receiver unit. The range of the transmitter can be increased by fitting a plastic lens in front of D5

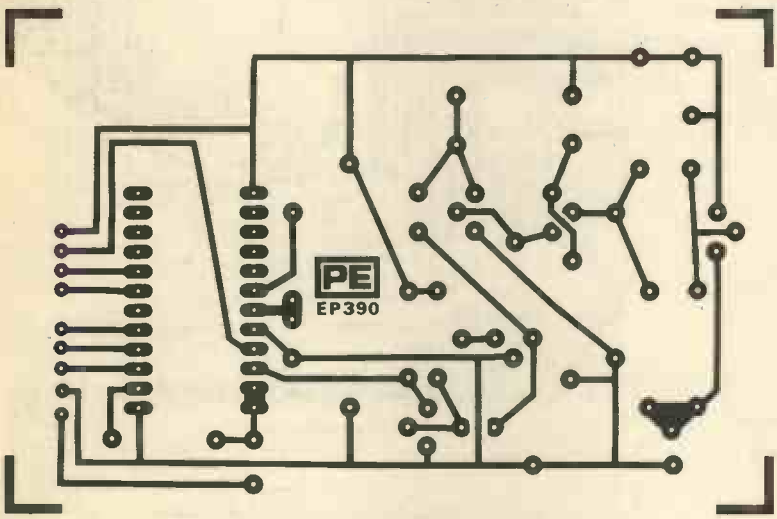
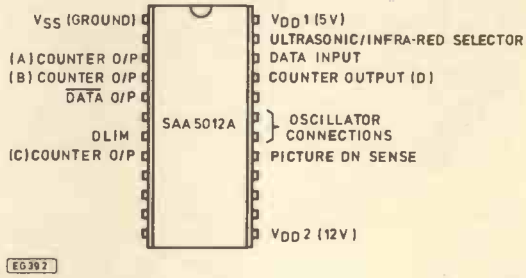


Fig. 1.8. Receiver p.c.b. design



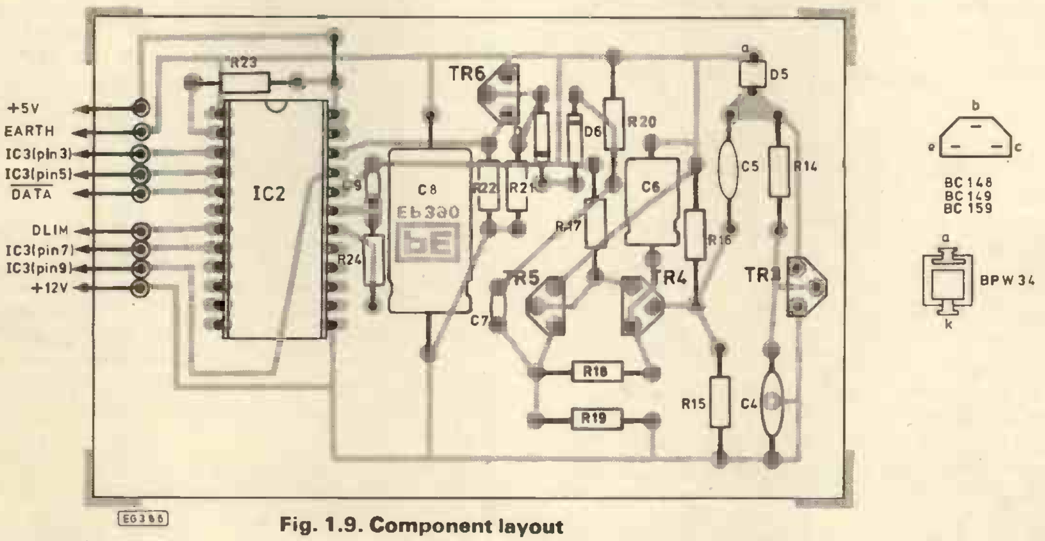


Fig. 1.9. Component layout

RECEIVER CIRCUIT

The receiver circuit is mounted on the p.c.b. shown in Fig. 1.8. All the components, except for the photo-diode D5, should be mounted on the board as shown in Fig. 1.9. A holder should be used for IC2 and after all the components have been soldered into position the p.c.b. can be turned over and the diode D5 soldered onto the track side of the board taking care that it is correctly orientated.

The inter wiring for the receiver board and the complete system will be covered after the construction of the rest of the boards.

NEXT MONTH: CONSTRUCTION CONTINUED

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To: Marshall's (PE Capacitor Offer), Kingsgate House, Kingsgate Place, London NW6 4AT. Tel. 01-624 0805.

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Tolerance—1-10pf ±0·25pF
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470p-1n ±5%
2n2-10n 10%

The pack contains 10 each of the following values: 1p, 2p2, 3p3, 4p7, 6p8, 10p, 22p, 33p, 47p, 68p, 100p, 220p, 330p, 470p, 680p, 1n, 2n2, 3n3, 4n7, 10n.

PACK 2. 130 Siemens self-healing layer capacitors with polyester dielectric, 7mm pin spacing except 1u which is 10mm.

Tolerance ±10%

250V or 400V up to 100n, 100V 220n to 1u.

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MICRO-BUS

Compiled by DJD.

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

THE five topics in this month's Micro-Bus are all totally unrelated, and include an automatic Morse-code generator, a game for the ZX80, and a program to multiply enormous numbers together.

MORSE-CODE GENERATOR

The following program was developed on an Mk14 microcomputer by *Andrew Chadwick of Hull* to produce Morse code as a teaching aid for a Scout troop. The program has other uses, such as the automatic generation of call signs and test sequences, and can easily be modified to generate Morse code from characters as they are typed in at a keyboard. The message to be transmitted is simply set up in memory and, using a look-up table, the program translates the message into Morse-code format and transmits it via the flag outputs of the microprocessor. The message is written using the simple code of 1 for A, 2 for B, etc., as shown in Fig. 1. A blank (39) must be inserted between each word, and the message must finish with the end-of-message character 37. A simple modification would enable the program to generate Morse code from a message written in ASCII.

CHARACTER	HEX CODE	MORSE CODE
A	1	·–
B	2	–···
C	3	–·–·
D	4	–··
E	5	·
F	6	··–·
G	7	––·
H	8	····
I	9	··
J	10	·–––
K	11	–·–
L	12	·–··
M	13	––
N	14	–·
O	15	–––
P	16	·––·
Q	17	––·–
R	18	·–·
S	19	···
T	20	–
U	21	··–
V	22	···–
W	23	·––
X	24	–··–
Y	25	–·––
Z	26	––··
0	27	–––––
1	28	·––––
2	29	··–––
3	30	···––
4	31	····–
5	32	·····
6	33	–····
7	34	––···
8	35	–––··
9	36	––––·
End of message	37	·–·–·
Erase/Error	38	······
Blank	39	(dot)
Long space	40	(2 dash)

Fig. 1. List of characters with their Morse codes, and the hexadecimal codes used by the program in Fig. 4.

The output can be fed directly to a high-impedance speaker by connecting the speaker between flag 0 or 1, and ground. Alternatively the output can feed a tape recorder via the simple interface shown in Fig. 2, which reduces the output to about 400 mV peak to peak, suitable for an auxiliary input.

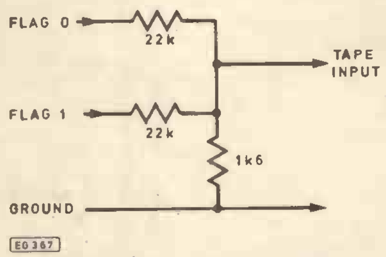


Fig. 2. Interface circuit to enable the Mk14 to drive the auxiliary input of a tape recorder.

MORSE CODE

The Morse code for the letters and numbers consists of a series of up to five dots and/or dashes, and the program uses a look-up table to convert the character to be transmitted into a single byte which specifies the Morse code; see Fig. 3. The three low-order bits of this byte, DO to D2, indicate how many dots or dashes there are in the Morse code for the character, and whether or not they will be sounded. Values of one to five imply one to five dots and dashes which will all be sounded, whereas six and seven imply one and two dots/dashes respectively which will not be sounded. This format enables spaces to be treated in a similar way to characters.

The upper five bits in the byte, D4 to D7, give the Morse code itself, a one representing a dash and a zero representing a dot. D4 corresponds to the first dot or dash.

MORSE PROGRAM

The program, shown in Fig. 4, takes up the whole of the Mk14's standard 256 bytes of RAM. It is divided into three sections: a look-up table from OF1B to OF43 containing the Morse-code bytes for the various characters, the main program from OF44 to OFC2, and a subroutine from OFC3 to OFF6. The subroutine generates either a tone or a space of length equivalent to either a dot or a dash. Which of these possible outputs is produced is determined by the two variables DDF (Dot/Dash Flag) and MSSF (Master Sound/Silence Flag) which are set up by the main program before the subroutine is called. Setting DDF to 0 gives an output of dot length whereas 1 gives an output of dash length.

CHARACTER	MORSE CODE	FORMAT IN LOOK-UP TABLE	
		Binary	Hexadecimal
A	·–	00010 010	12
1	·––––	11110 101	F5
Blank	(length = dot)	00000 110	06

Fig. 3. Examples showing how the Morse codes for the characters are stored within one byte.

Setting MSSF to 0 gives no output, whereas 1 indicates that a tone is to be produced.

PROGRAM OPERATION

Before execution of the program the speed of transmission, in words per minute, is set as a hexadecimal number in the location WPM (OF12). On running the program, pointer 1 is set to point to the location of the first character in the message; in the listing of Fig. 4 this is at address OE00, but for the extra RAM on a standard Mk14 this would be OB00. Pointer 2 is set to the beginning of the standard RAM (OF00), and pointer 3 to the start of the subroutine.

The section of program between OF56 and OF64 divides 256 by the specified speed of transmission to give the appropriate value for the subroutine's inner-loop counter. At OF65 the character code is loaded from the message, converted from base 10 to base 16, and then used as a displacement to fetch the corresponding Morse-code byte from the look-up table. The instructions from OF70 to OF9A sort out the information stored in bits D0 to D2 of the Morse-code byte, and set the appropriate variables.

The main loop, beginning at OF9B, deals with the code stored in bits D3 to D7 of the Morse-code byte, and transmits it a dot or a dash at a time by giving the two variables DDF and MSSF the necessary values, and then calling the subroutine. A dash has three times the length of a dot, and the space between each dot and dash is the same length as a dot. The space between each character is three dots long, and between each word is seven dots long. The required spaces between dots and dashes, and between letters, are inserted by the instructions between OFA9 and OFAF, and OFB4 to OFB5, respectively.

When the end-of-message character has been detected and transmitted the program returns to the monitor. The timing throughout the program is based on a system using a 4·43 MHz crystal, and will have to be altered for any other clock frequency. Note that, with the program as it stands, only the standard alphanumeric characters, whose Morse code runs to a maximum of five dots or dashes, can be produced; characters with six or more dots or dashes, such as punctuation marks, are not possible.

```
                ;       MORSE-CODE GENERATOR
                ;
     OE00  MESS    =       OE00        ;MESSAGE AREA
     OF00  RAM     =       OF00        ;RAM
     OFC2  SUBR    =       OFC2
     001F  MON     =       001F        ;MONITOR
                ;
0000               .=OF1B              ;CODE TABLES:
OF1B               .BYTE   012,00C,02C,00B,001,024
OF21               .BYTE   01B,004,002,074,02B,014
OF27               .BYTE   01A,00A,03B,034,05C,013
OF2D               .BYTE   003,009,023,044,033,04C
OF33               .BYTE   06C,01C,OFD,OF5,OE5,OC5
OF39               .BYTE   085,005,00D,01D,03D,07D
OF3F               .BYTE   055,005,006,01F,000
                ;
OF44 C40E  ENTRY:  LDI     H(MESS)     ;P1 = MESSAGE
OF46 35            XPAH    1
OF47 C400          LDI     L(MESS)
OF49 31            XPAL    1
OF4A C40F          LDI     H(RAM)      ;P2 = RAM
OF4C 36            XPAH    2
OF4D C400          LDI     L(RAM)
OF4F 32            XPAL    2
OF50 C40F          LDI     H(SUBR)     ;P3 = SUBROUTINE
OF52 37            XPAH    3
OF53 C4C2          LDI     L(SUBR)
OF55 33            XPAL    3
OF56 C400          LDI     X'00        ;INITIALIZE MILC
OF58 CA13          ST      MILC(2)     ;  AND E TO
OF5A 01            XAE                 ;  ZERO.
OF5B AA13  ADD:    ILD     MILC(2)     ;ADD SPEED
OF5D C212          LD      WPM(2)      ;  SPECIFIED IN
OF5F 02            CCL                 ;  WPM TO E
OF60 70            ADE                 ;  UNTIL CARRY
OF61 01            XAE                 ;  GENERATED.
OF62 06            CSA
OF63 94F6          JP      ADD         ;MILC=256/WPM
OF65 C501  GETL:   LD      @1(1)       ;GET LETTER
OF67 D4F0          ANI     X'F0        ;CONVERT FROM
OF69 02            CCL                 ;  BASE 10 TO
OF6A 1C            SR                  ;  BASE 16.
OF6B 01            XAE
OF6C 40            LDE
OF6D 1C            SR
OF6E 1C            SR
OF6F 70            ADE
OF70 01            XAE
OF71 C1FF          LD      -1(1)
OF73 D40F          ANI     X'0F
OF75 70            ADE
OF76 F41A          ADI     TDISP       ;ADD LOOK-UP
OF78 01            XAE                 ;  TABLE DISP.
OF79 C280          LD      -128(2)     ;GET CODE FROM
OF7B CA15          ST      CODE(2)     ;  TABLE & SAVE.
OF7D D407          ANI     X'07        ;REMOVE CODE
OF7F CA16          ST      DDC(2)      ;STORE NO. DOTS
OF81 03            SCL                 ;  OR DASHES.
OF82 FC06          CAI     X'06        ;SEE IF SOUND
OF84 9406          JP      SDDC        ;  OR SILENCE.
OF86 C401          LDI     X'01        ;SET MSSF=1
OF88 CA14          ST      MSSF(2)     ;  FOR SOUND.
OF8A 9009          JMP     ROT
OF8C 02    SDDC:   CCL                 ;SILENCE:
OF8D F401          ADI     X'01        ;SET DDC
OF8F CA16          ST      DDC(2)      ;  CORRECTLY.
OF91 C400          LDI     X'00        ;SET MSSF=0
OF93 CA14          ST      MSSF(2)     ;  FOR SILENCE.
OF95 C215  ROT:    LD      CODE(2)     ;GET CODE
OF97 1E            RR                  ;GET FIRST DOT
OF98 1E            RR                  ;  OR DASH INTO
OF99 CA15          ST      CODE(2)     ;  LOW BIT + 1
OF9B C215  SIG:    LD      CODE(2)     ;GET DOT/DASH
OF9D 1E            RR                  ;  INTO LOW BIT
OF9E CA15          ST      CODE(2)
OFA0 D401          ANI     X'01        ;TEST LOW BIT
OFA2 CA17          ST      DDF(2)      ;SET DDF
OFA4 C214          LD      MSSF(2)     ;SET SSSF FROM
OFA6 CA18          ST      SSSF(2)     ;  MSSF
OFA8 3F            XPPC    3           ;SEND FIRST ./-
OFA9 C400          LDI     X'00        ;SEND ONE DOT
OFAB CA17          ST      DDF(2)      ;  SPACE.
OFAD CA18          ST      SSSF(2)
OFAF 3F            XPPC    3
OFB0 BA16          DLD     DDC(2)      ;TEST FOR ANY
OFB2 9CE7          JNZ     SIG         ;  MORE
OFB4 3F            XPPC    3           ;SEND ONE DASH
OFB5 3F            XPPC    3           ;  SPACE.
OFB6 C215          LD      CODE(2)     ;TEST IF JUST
OFB8 E4AA          XRI     X'AA        ;  SENT END.
OFBA 9CA9          JNZ     GETL        ;NO-GET ANOTHER
OFBC C400          LDI     H(MON)      ;JUMP BACK TO
OFBE 37            XPAH    3           ;  TO MONITOR.
OFBF C41F          LDI     L(MON)
OFC1 33            XPAL    3
OFC2 3F            XPPC    3           ;RETURN.
           ;
           ; SUBROUTINE TO SEND DOT/DASH
           ;
OFC3 C217  START:  LD      DDF(2)      ;DOT OR DASH TO
OFC5 9804          JZ      DOT         ;  BE SENT?
OFC7 C406          LDI     DALE        ;DASH: GET THE
OFC9 9002          JMP     STLE        ;  LENGTH.
OFCB C402          LDI     DOLE        ;DOT: GET LENGTH
OFCD CA19  STLE:   ST      OLD(2)      ;STORE LENGTH
OFCF C213  SILC:   LD      MILC(2)     ;SET INNER COUNT
OFD1 CA1A          ST      ILC(2)      ;  FROM MASTER
OFD3 C218  TSSF:   LD      SSSF(2)     ;TEST FOR SOUND
OFD5 980E          JZ      SIL         ;  OR SILENCE.
OFD7 C403          LDI     X'03        ;SOUND: GENERATE
OFD9 07            CAS                 ;  TONE ON F0,F1
OFDA C400          LDI     X'00
OFDC 8F02          DLY     X'02
OFDE C400          LDI     X'00
OFE0 07            CAS
OFE1 8F02          DLY     X'02
OFE3 9004          JMP     DILC
OFE5 C400  SIL:    LDI     X'00        ;SILENCE: WAIT
OFE7 8F04          DLY     X'04
OFE9 BA1A  DILC:   DLD     ILC(2)      ;TEST INNER
OFEB 9CE6          JNZ     TSSF        ;  COUNT.
OFED BA19          DLD     OLC(2)      ;TEST OUTER: IF
OFEF 9CDE          JNZ     SILC        ;  ZERO STOP.
OFF1 C401          LDI     X'01        ;SO SET OUTPUT
OFF3 07            CAS                 ;  TO MEAN
OFF4 3F            XPPC    3           ;RETURN
OFF5 90CC          JMP     START       ;FOR RE-CALL
           ;
           ; CONSTANTS AND RAM OFFSETS
           ;
     0002  DOLE    =       2           ;DOT LENGTH
     0006  DALE    =       6           ;DASH LENGTH
     0012  WPM     =       012         ;WORDS/MINUTE
     0013  MILC    =       013         ;INNER LOOP COUNT
     0014  MSSF    =       014         ;SOUND/SILENCE
     0015  CODE    =       015         ;MORSE CODE
     0016  DDC     =       016         ;DOT/DASH COUNT
     0017  DDF     =       017         ;DOT/DASH FLAG
     0018  SSSF    =       018         ;SLAVE S/S FLAG
     0019  OLC     =       019         ;OUTER LOOP COUNT
     001A  ILC     =       01A         ;INNER LOOP COUNT
     001A  TDISP   =       01A         ;LOOK-UP TABLE

     0000          .END
```

Fig. 4. Program for the Mk14 generates Morse code from a message stored in memory.

BULLS AND COWS FOR ZX80

The following program to play 'Bulls and Cows', which is probably better known in the form of the plastic peg game 'Mastermind', is the first program feature in Micro-Bus to run on the Sinclair ZX80 BASIC-programmed microcomputer. It was devised by *S. Murrell of Sunderland*. The computer generates a random 4-digit 'code' which the player must try and deduce in eight or less attempts. Each digit in the code can be from 1 to 6, and each guess is entered as a string of four digits followed by a **NEWLINE**. The computer replies with a solid rectangle for each 'Bull', or correct digit in the correct position, and a shaded rectangle for each 'Cow', or correct digit in the wrong position. Each digit may only contribute towards one Bull or one Cow.

PROGRAM OPERATION

The program, shown in Fig. 5, works as follows. The computer first generates a code in the array Z(0) to Z(3). The guess string is then entered into G$, and the program converts it into an array of four numbers in G(0) to G(3).

```
 10 PRINT "MASTERMIND"
 20 PRINT
 30 PRINT
 40 PRINT "NO.OF   YOUR     MY"
 50 PRINT "TRIES   GUESS    REPLY"
 60 PRINT
 70 DIM Z(3)
 80 DIM X(3)
 90 DIM G(3)
100 FOR I=0 TO 3
110 LET Z(I)=RND(6)
120 NEXT I
130 LET A=1
140 INPUT G$
150 PRINT A,
160 PRINT G$,
170 LET B=0
180 FOR I=0 TO 3
190 LET X(I)=Z(I)
200 LET G(I)=CODE(G$)-28
210 LET G$=TL$(G$)
220 IF NOT X(I)=G(I) THEN GO TO 270
230 LET X(I)=10
240 LET G(I)=11
250 LET B=B+1
260 PRINT " *";
270 NEXT I
280 FOR J=0 TO 3
290 FOR I=0 TO 3
300 IF NOT X(I)=G(J) THEN GO TO 340
310 LET X(I)=10
320 LET G(J)=11
330 PRINT " +";
340 NEXT I
350 NEXT J
360 PRINT
370 IF B=4 THEN GO TO 410
380 IF A=8 THEN GO TO 440
390 LET A=A+1
400 GO TO 140
410 PRINT
420 PRINT "YOU WIN... WELL DONE"
430 GO TO 460
440 PRINT
450 PRINT "I WIN..THE NUMBER WAS ";Z(0);Z(1);Z(2);Z(3)
460 PRINT
470 PRINT
480 PRINT "HIT NEWLINE TO PLAY AGAIN"
490 CLEAR
500 INPUT K$
510 CLS
520 IF K$="" THEN GO TO 10
```

Fig. 5. Mastermind program for the ZX80; the task is to guess the computer's code.

The computer makes a copy of its code in X(0) to X(3), and compares this, element by element, with the guess array. If there is a match a Bull is scored, and a white block is printed. The matching numbers in X and G are converted to 10 and 11 respectively so that they will not be counted as Cows later on. Next, the number of Cows is obtained by comparing every element of the array X with every element of the array G; for every match a shaded rectangle is printed, and again the elements are set to 10 and 11 so that they will not be counted again. Finally, if the score is four Bulls the code has been correctly guessed, and the human has won; otherwise the computer will declare a victory after the eighth attempt.

In the program listing of Fig. 5 '*' is used to represent a solid rectangle, which is obtained on the ZX80 by typing SHIFT-W, and "+" represents a shaded rectangle, which is obtained by typing SHIFT-T.

64-DIGIT MULTIPLY

The following short program for the humble Mk14 can multiply two numbers together to give a result of up to 64 digits, thus amply demonstrating the superiority of the microcomputer over the pocket calculator! The program, shown in Fig. 6, was written by *Geoff Phillips* who edits the Mk14 Users Group magazine 'Complement and Add' where the program first appeared.

```
          ;        64-DIGIT MULTIPLY
          ;
     OB00 OPA      =      OB00      ;1ST OPERAND
     OB10 OPB      =      OB10      ;2ND OPERAND
          ;
          ; OFFSETS FROM OPA
     0020 ANS      =      020       ;ANSWER
     0040 DIGITB   =      040       ;DIGIT COUNTER
     0041 MULT     =      041       ;MULTIPLY COUNT
     0042 DIGITA   =      042       ;DIGIT COUNTER
     0043 TEMP     =      043
     0044 COUNT    =      044       ;COUNTER
          ;
     0000          .=OF12
OF12 C40B ENTRY:   LDI    H(OPA)    ;P2=OB00
OF14 36            XPAH   2
OF15 C400          LDI    L(OPA)
OF17 32            XPAL   2
OF18 C40B          LDI    H(OPB)    ;P1=OB10
OF1A 35            XPAH   1
OF1B C410          LDI    L(OPB)
OF1D 31            XPAL   1
OF1E C420          LDI    32        ;SET UP LOOP
OF20 CA44          ST     COUNT(2)
OF22 C21F NEXT:    LD     01F(2)    ;NEXT DIGIT OF
OF24 D40F          ANI    OF        ;  OPB.
OF26 CA41          ST     MULT(2)   ;SET LOOP
OF28 9815          JZ     DONE      ;IF O, SKIP
OF2A C410 ADD:     LDI    010       ;ADD NUMBER
OF2C CA42          ST     DIGITA(2)
OF2E 02            CCL
OF2F C5FF MULTI:   LD     @-1(1)    ;NEXT 2 DIGITS
OF31 E920          DAD    ANS(1)    ;ADD TO TOTAL
OF33 C920          ST     ANS(1)
OF35 BA42          DLD    DIGITA(2)
OF37 9CF6          JNZ    MULTI
OF39 C510          LD     @010(1)   ;RESET P1=OB10
OF3B BA41          DLD    MULT(2)   ;ADD A AGAIN
OF3D 9CEB          JNZ    ADD       ;  UNTIL DONE.
OF3F C410 DONE:    LDI    010
OF41 CA40          ST     DIGITB(2)
OF43 C400          LDI    O         ;SHIFT OPB
OF45 01            XAE              ;  RIGHT.
OF46 C501 MOVE:    LD     @1(1)     ;GET NEXT BYTE
OF48 1C            SR
OF49 1C            SR
OF4A 1C            SR               ;PUT HIGH DIGIT
OF4B 1C            SR               ;  LOW.
OF4C CA43          ST     TEMP(2)   ;KEEP IT
OF4E C1FF          LD     -1(1)     ;PICK OUT LOW
OF50 D40F          ANI    OF        ;  DIGIT.
OF52 01            XAE              ;PUT IN E
OF53 1E            RR
OF54 1E            RR
OF55 1E            RR
OF56 1E            RR
OF57 DA43          OR     TEMP(2)
OF59 C9FF          ST     -1(1)
OF5B BA40          DLD    DIGITB(2)
OF5D 9CE7          JNZ    MOVE
OF5F C420          LDI    32        ;SHIFT RESULT
OF61 CA40          ST     DIGITB(2) ;  RIGHT.
OF63 C400          LDI    O
OF65 01            XAE
OF66 C501 SHIFT:   LD     @1(1)
OF68 1C            SR
OF69 1C            SR
OF6A 1C            SR
OF6B 1C            SR
OF6C CA43          ST     TEMP(2)
OF6E C1FF          LD     -1(1)
OF70 D40F          ANI    OF
OF72 01            XAE
OF73 1E            RR
OF74 1E            RR
OF75 1E            RR
OF76 1E            RR
OF77 DA43          OR     TEMP(2)
OF79 C9FF          ST     -1(1)
OF7B BA40          DLD    DIGITB(2) ;END OF SHIFT
OF7D 9CE7          JNZ    SHIFT
OF7F C410          LDI    010
OF81 31            XPAL   1
OF82 BA44          DLD    COUNT(2)  ;END OF LOOP
OF84 9C9C          JNZ    NEXT
OF86 3F            XPPC   3         ;RETURN
          ;
     0000          .END
```

Fig. 6. Program for an Mk14 will multiply two numbers together to give an answer of up to 64 digits.

The two numbers to be multiplied are stored in BCD format, two decimal digits per byte; the first number may be up to 30 decimal digits long, and the second up to 32 decimal digits long. The result is produced as a BCD number of up to 64 digits. The program is surprisingly short, yet takes only two seconds, on average, to perform the calculation.

The numbers should be entered into memory as follows:

OB00 Highest digits of first operand
OB0F Lowest digits of first operand
OB10 Highest digits of second operand
OB1F Lowest digits of second operand

The program should then be executed from OF12, and the answer will be put into memory as follows:

OB20 Highest digits of answer
OB3F Lowest digits of answer.

INVERTED CHARACTERS ON VDU

The Mk14 VDU interface can be adapted to display reverse-video characters (black character on white background) mixed in with normal characters (white character on black background) with the addition of the simple circuit shown in Fig. 7. The circuit was submitted by *Anthony D. Love of Swansea*, and is designed so that the state of bit 6 of the character determines how the character is displayed. If the bit is zero, the character is displayed in reverse video: otherwise it is displayed normally. Thus, for example, X'41 will give an A displayed normally, and X'01 will give a reversed A.

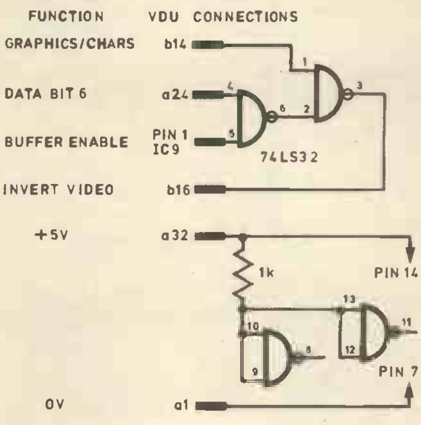


Fig. 7. Circuit to enable an Mk14 VDU to display characters in inverse video.

CIRCUIT OPERATION

The circuit checks that the byte presented on the data bus is in fact for display by checking that the tri-state address-line buffers are enabled; i.e. that pin 1 of IC9 or IC10 is low. The graphics/characters input is also checked to ensure that the VDU is in character mode and, if not, sets the invert-video input high to prevent the circuit from interfering with the graphics.

The necessary logic is contained in a 74LS32 Quad 2-input OR gate package, which should be situated as close as possible to the VDU board. All the unused inputs are connected through a 1k resistor to the positive supply rail.

DIGITAL ALARM-CLOCK

The following program will make an Acorn (System One) function as an alarm clock. The time is displayed as 'hours-minutes-seconds' on the 7-segment displays, and at the set alarm time A's replace the dashes on the displays and the output line PBO oscillates at 0·5 Hz so that a buzzer or relay can be operated; the normal display is resumed after one minute. The program, shown as a hex dump in Fig. 8, was submitted by *Peter Mayne*, whose 'Data Find Routine' was featured in the last Micro-Bus.

```
     DIGITAL ALARM CLOCK
0200 A9 01 8D 23 09 F8 A2 03
0208 20 0C FE 0A 0A 0A 0A 85
0210 60 20 0C FE 65 60 95 20
0218 CA D0 ED A9 77 85 10 A2
0220 24 20 88 FE A9 1F 85 0E
0228 A9 40 85 15 85 12 A0 06
0230 A2 01 B5 20 20 6F FE 88
0238 88 88 E8 E0 04 D0 F3 A2
0240 2C 20 0C FE CA D0 FA A2
0248 01 B5 20 18 69 01 95 20
0250 C9 60 D0 09 A9 00 95 20
0258 E8 E0 04 D0 EC A5 15 C9
0260 77 F0 12 A2 1C 20 A6 FE
0268 D0 C4 A9 77 85 15 85 12
0270 8D 18 09 D0 F3 A5 25 C5
0278 23 D0 ED 8D 08 09 4C 28
0280 02
```

Fig. 8. Hex dump of a digital alarm-clock program for the 6502-based Acorn microcomputer.

To set up the clock execute the program from 0200. You should then enter the correct time as a sequence of six digits; for example, at 7·30 and 20 seconds enter '073020'. Then enter the alarm time as a sequence of four digits; for example, if the required time is 7·31 enter '0731'. Finally type any control key to start the clock. The speed at which the clock runs is controlled by the value at 0240; since the Acorn runs from a 1 MHz crystal the clock can be extremely accurate.

ADDENDUM

The following modifications to the 'Low-Cost SC/MP System' which appeared in the April Micro-Bus are recommended by the author, *Andrew Aitken.*

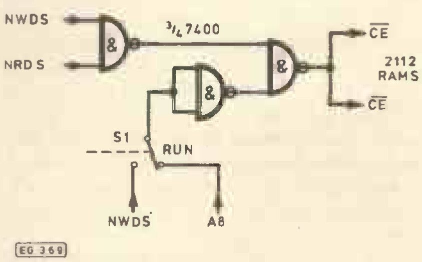


Fig. 9. Modification to the 'Low Cost SC/MP System' in the April Micro-Bus.

In the main circuit of Fig. 3 the $\overline{CE}$ signal to the RAMs should be gated with a signal which is high when NRDS or NWDS is active to prevent a conflict on the databus; see Fig. 9.

In the hex keyboard circuit of Fig. 4 the D input of the 7474 latch should be connected to the Q output, not to the $\overline{Q}$ output as shown, so that the flip/flop will toggle correctly.

FRANK W. HYDE

FOR THE YEAR 2000

The year 2000 is the present target date for the Satellite Power System. Already some five years of intensive research has shown that there are many facets to the ultimate success, some with spin-off and some showing a whole new field of technology. In this issue of *Spacewatch* a general outline of what is to be the main approach to the utilisation of Solar Energy by the United States will be reviewed. This will show not only the magnitude of the concept but also the attention to the environment and the philosophy of living in the next century. It can be seen perhaps that the thinking is not only world wide in its operation but initiates the practical possibilities and benefits for mankind.

In this project is embodied the basic dreams for a future in which man turns technology toward the concept for "The resources of the Earth for the benefit of the people of the Earth" and leads that benefit toward every man, woman and child that lives and will continue to live on Planet Earth.

THE SYSTEM

The basic principle is the collection of the energy of the Sun and its conversion into electromagnetic waves transmitted to an aerial system on Earth where it is converted to a form suitable for the existing power lines. This, the Satellite Power System, is one of the possibilities of the tapping of the power of the Sun.

THE SATELLITE

This would take the form of a flat structure 10km long and 5km wide, and to this will be attached a high power beam antenna 1km in diameter. To it would be assembled the d.c.-r.f. power amplifiers and waveguides.

At the Earth end there will be the collecting antenna, which, because it rectifies the microwave beam from the satellite, is given the name of rectenna. This will be 13·2km by 10km at a location of 35° latitude. Other locations nearer the equator could be of different design.

The frequency of operation will be 2·45GHz. This frequency is chosen because it has been established that at a power of 23mW/cm^2 it will have negligible effect on the environment and human as well as animal life.

The satellite would be put first into a low earth orbit (LEO), then later raised to the geostationary orbit (GEO).

The first impact of the magnitude of the items in the satellite and the physical extent involved, leads to some queries. It is perhaps easier to accept the receiving antenna dimensions on the ground and be less concerned with any hazards that might be involved. Each situation needs some answers. In order to get the psychological aspect in perspective and relieve anxieties of misunderstanding, the fears will be answered in advance.

The question that first arises is the safety of such large units even at the distances from the Earth when geostationary orbits are considered. Questions like: will it be stable? Can it de-orbit like Skylab? Is it likely to be a danger to people on the ground? The answer is that the density of the atmosphere at the geostationary orbit level is very low and generally satellites are considered to have a very long lifetime; indeed theoretically an indefinite lifetime. The construction of the SPS satellite is however rather different from the usual type of satellite. It will have a much smaller mass to area ratio than previous satellites and would be more subject to atmospheric drag.

The SPS satellite has been designed for a 30 year life and the orbital decay would lie between 0·25 and 2,500 metres. That is less than one part in ten thousand in the worst condition. The other associated components such as the work platforms, the normal construction facilities, the personnel and their vehicles would be less influenced since these would have higher mass to area ratios. There will be perturbations from solar radiation and from lunar and solar gravity effects. Also there are the variations like the ellipticity of the Earth. These effects would be slightly larger than the atmospheric drag but it would be a normal part of station-keeping to correct such conditions.

NO HAZARD?

Perhaps the short answer is that there is no reason to suppose that there would be any increased hazard to these large assemblies and little likelihood of danger situations. The units can be large because gravity is small.

Another question that might be raised is: How vulnerable will the units be to random events like meteor showers? This is not very likely. The large scale is such that built-in redundancy would take care of this. It must however be said that overt action military or otherwise could do damage, but when examined this is unlikely except in case of deliberate hostilities. This aspect will be considered later.

Another question might be: What is the possible danger from terrorism or the activities of rivals. The answer here is that when the system is fully operational there would be 60 satellites and a similar number of ground units (rectenna and associated facilities). Here the very nature of the organisation is such that normal security would be of such a nature as to take care of such possibilities. Therefore, short of war, the possibility is remote, since a pilot beam first is needed to *enable* the system and give the instruction to the satellite to focus the beam on the rectenna. If the transmitting antenna is pointed away from the rectenna the beam will at once de-focus. In this case there would only appear a level of background which would preclude any damage from the antenna pointed to the Earth.

One of the areas where doom thinking has taken root is the question of damage to the ozone layer and the creation of a "Greenhouse Effect".

The answer to this can be positive. Most of the ozone is between 10 and 40km in the Stratosphere. Intensive investigation of this area has continued over the past ten years. The effects from the effluents from SPS rocket launches is negligible. Above the 50km level the ozone is less than 1 per cent of the peak value in the Stratosphere. However there is the possibility that over the 70km level there may be an increase of ambient water concentrations. There are complex chemical mechanisms which control ozone at these levels, but is still not considered to be a hazard.

So far as the Greenhouse Effect is concerned, this is more difficult to deal with though there is no expectation that the situation would be aggravated by the advent of the satellites.

NEW NIGHT SKY

Some people are concerned about the aesthetic effects on the night sky. This has been considered carefully and the answer is that the satellites will be visible on clear nights. The actual brightness would be about 1/1000 of the light of the moon. In the night sky the satellites would be most noticeable at midnight and equivalent to the light of Venus. Binoculars with a magnification of seven would show them as rectangular objects and not as points of light. It could be said that they will enhance the aesthetics because of the general appearance. There would be a contrast between the random stars of the constellations and they would present an apparent straight line of objects of equal brightness. They would appear to be separated by a distance of slightly less than that of the stars in Orion's belt.

At intervals of six months, the satellites would be eclipsed and would pass through the Earth's shadow at about midnight for a number of days in succession. This would be an occurrence similar to a lunar eclipse. The satellites would first dim and then redden when reaching the edges of the shadow then darken and appear a few minutes later.

Consideration of these matters is continuing and being constantly updated. The next issue of *Spacewatch* will contain more technical details of the design and the conversion systems from the microwave transmissions to the feeding of the power lines for general distribution. After this aspect then, the possible effects on the future of meteorological conditions will be noted with the ecological and resource effects.

PE MAGNUM METAL LOCATOR

ANDY FLIND

CHEAP metal detectors are usually disappointing in use, whilst good ones tend to be very expensive. Although there is a lot of work involved in building the machine in this article, it can be completed for around £40–50, less than a quarter of the cost of most ready-made ones of similar performance. It is not strictly a design for the beginner to attempt, but a step by step construction and test procedure has been devised to make it as simple as possible. The only absolutely essential item of test equipment required is a reasonable quality test meter.

Until now, most metal detector designs for the home constructor have been BFOs. True, there have been one or two notable exceptions, but even these were relatively unsophisticated examples of their type, so readers might be interested in a brief description of the basic methods of detection and the reasons for the choice of system used in this design.

TYPES OF DETECTOR

Broadly speaking there are five main ways of detecting metal; BFO (beat frequency oscillator), induction balance, pulse induction, off resonance, and the magnetometer. The latter works by detecting small anomalies in the Earth's magnetic field strength. It's fascinating but quite useless for treasure hunting since it can detect only ferrous objects. The BFO and off resonance types both operate by detecting the small changes in the search coil inductance which occur when a metal object is present. Both suffer from a basically poor sensitivity. Some sophisticated attempts have recently been made to produce a really good off resonance machine, so far without obvious success.

Pulse induction detectors are another matter however; good ones are very sensitive indeed and some of the most expensive detectors currently available are these. They operate by exposing the gound to powerful pulses of magnetism and listening between the pulses for signals due to eddy currents set up in any metal objects present in the field. Despite their sensitivity they have a couple of important drawbacks. Their battery consumption is heavy due to the power required by the pulsed transmitter, and they are extremely sensitive to even tiny ferrous objects. Their use is thus primarily restricted to beach searching, where objects are likely to be buried at considerable depths, and where large holes can be easily and rapidly dug. On inland sites, their users can become discouraged by the frequent digging of large holes in hard ground to recover rusty nails, etc.

This leaves the induction balance types which have become more or less the standard general purpose detector for both serious treasure hunters and detecting hobbyists alike. It has two coils in its search head, one of which is fed with a signal which sets up an alternating field around it. The other coil is placed so that normally the field around it balances and it has no electrical output. A metal object approaching the coils will distort the field, resulting in an imbalance so the the pickup coil will produce an output. This can be amplified and used to inform the operator of a "find" in a variety of ways. Frequently in simple detectors an audio modulated transmitted signal is used, the output from the pickup coil then being amplified and demodulated like an AM radio signal. There are many possible coil arrangements, but most detectors available today use one of the two shown in Fig. 1. Fig. 1(a) shows a "widescan" coil, so called because its most sensitive area (shaded) extends right across the coils Fig. 1(b) shows a "pinpoint" type, also known as a "4B". In the author's experience the pinpoint is by far the better coil in use, as widescans have poor pinpointing ability and tend to give false signals for ferrous objects off centre, coins on edge and the like. It's noticeable that many of the best imported American machines use pinpoint coils.

DISCRIMINATION

All of this is fine, but there are a couple of extra refinements necessary in a really good metal detector. One of these is the ability to discriminate between unwanted junk such as silver paper, scraps of iron etc, and desired objects. The other is some means of eliminating false signals due to "ground effect". Ground capacitance effects can easily be prevented by Faraday shielding around the coils, but most inland soils contain a proportion of iron oxide which gives a signal similar to a piece of ferrite. Beaches wet with seawater on the other hand are slightly conductive, and this too causes false signals to be produced in the pickup coil. Obviously some means of "tuning out" these effects will improve the detector considerably.

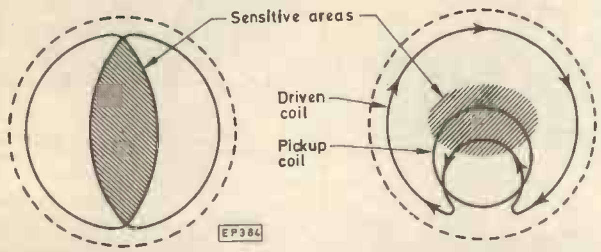


Fig. 1 (left). 'Widescan' coil layout; (right) 'Pinpoint' coil layout

Fortunately the signals from the search coil consist of more than just amplitude variations; they also contain information in the form of phase shifts which differ markedly according to the type of object causing the signal. With a relatively simple phase sensitive detector therefore, a machine can be designed which will totally reject ground effects and can also, with practice on the part of the user, eliminate the majority of the rubbish detected without the necessity of having to dig it up!

NOMENCLATURE

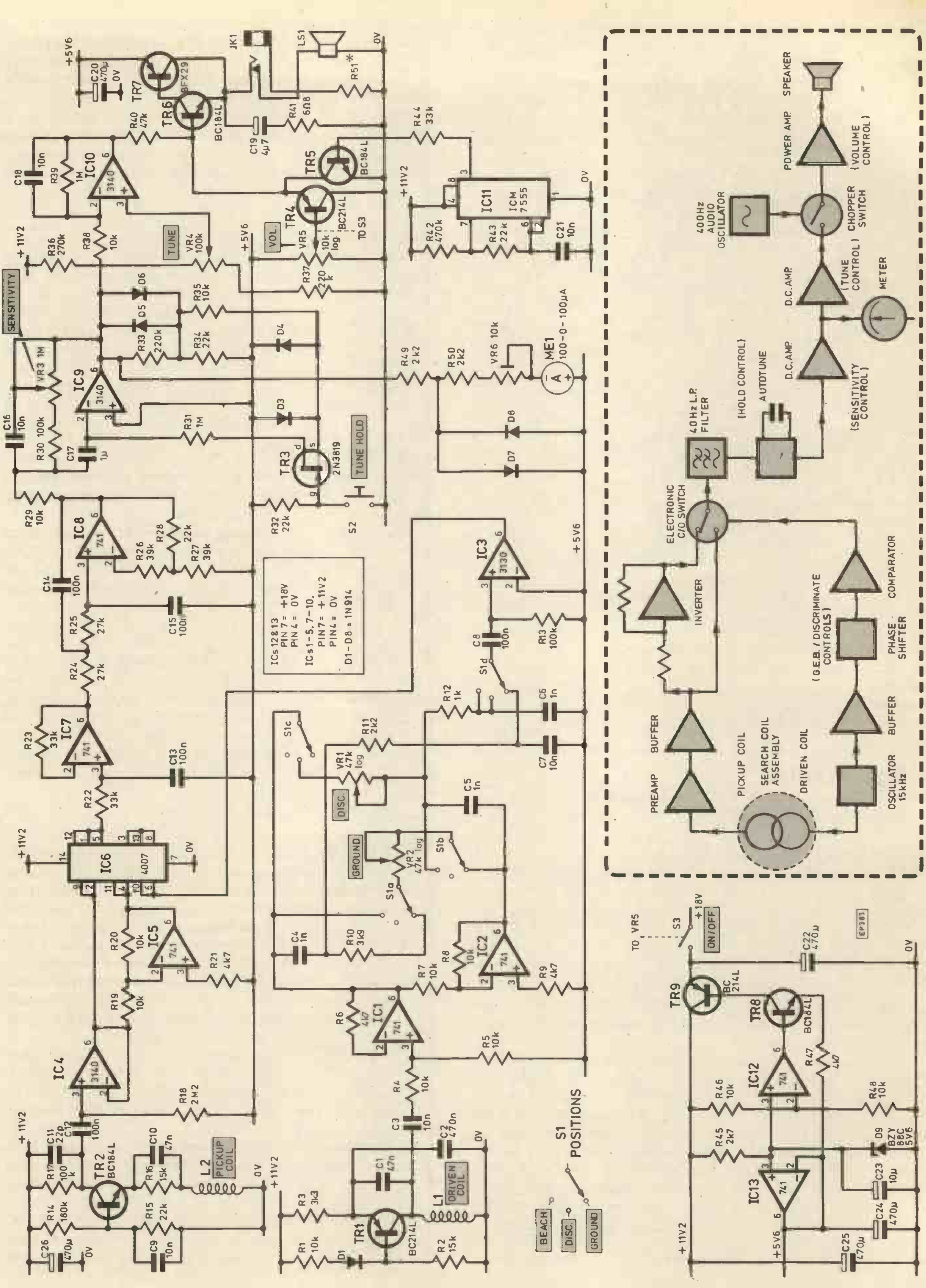
Some of the terms used by manufacturers to describe their machines in recent years have been somewhat confusing so, before we proceed, a note on these may not be amiss. 'VLF' stands for "very low frequency". The ability to discriminate from phase information against thin section objects like foil depends on frequency. At higher frequencies, 'Skin effect' eddy current conduction makes such discrimination ineffective. Therefore manufacturers began using lower and lower frequencies, at least one machine actually worked at less than 2kHz. This created problems of its own, as at such low frequencies sensitivity to cupro-nickel coins is not so good and "Q" problems arise in the coil design. Most detectors nowadays operate somewhere between 10 and 20kHz, where discrimination is still excellent but sensitivity and coil design problems do not arise.

"GEB" means "ground exclusion balance" and refers to the phase sensitive means of excluding ground effect. "TR" means "transmit-receive", and is often used to describe the discriminate mode, suggesting that the machines operate with different frequencies or coil configurations in the different modes—they don't; the only thing that is changed between modes is the phase reference point. It is not possible to avoid ground effect and discriminate at the same time, so one normally searches in GEB mode, and on finding an object, checks it with the discriminate mode before digging. Beer can pull rings can be rejected by the way, but machines capable of doing this will also reject any cupro-nickel coin smaller than a 10p when set to do so. It is probably better to tolerate the rings—many charities now collect these anyway.

BLOCK

Fig, 2 (dotted) shows a schematic of the Magnum detector. The drive oscillator sets up a field around the search coil, and the pickup coil is positioned so that it only gives an electrical output when a metal object distorts this field. The operating frequency of these stages is approximately 15kHz. Signals from the pickup coil are amplified, buffered and then inverted so that non-inverted and inverted versions of it are simultaneously available. These are fed to the two inputs of an electronic changeover switch, operated by a reference signal derived from the drive oscillator. This reference signal has first been passed through a phase shifting network which can be adjusted as required by the user. The output from the switch is passed through a 3rd order low-pass active filter with a cut-off point set at 40Hz, which removes practically all of the 15kHz signal, leaving only the average d.c. level.

Any given signal producing object causes changes in both magnitude and phase of the received signal, so by adjusting the phase shift network correctly a point can be found where these changes either cancel out or cause a net fall in the d.c. level, enabling unwanted signals from ground, foil, iron etc, to be eliminated. Incidentally, most similar designs to date have used either pulse sampling phase detectors, or have selected only half-cycles of the input signal. The use of the



ICs 1,2 & 13 PIN 7 = +18V PIN 4 = 0V
ICs 1-5, 7-10, PIN 7 = +11V2 PIN 4 = 0V
D1-D8 = 1N914
SENSITIVITY
TUNE
VOL.
TUNE HOLD
DISC.
GROUND
BEACH
S1 POSITIONS
PICKUP COIL
DRIVEN COIL
ON/OFF
TO VR5
EP383
OSCILLATOR 15kHz
DRIVEN COIL
SEARCH COIL ASSEMBLY
PICKUP COIL
PREAMP
BUFFER
INVERTER
ELECTRONIC C/O SWITCH
40Hz L.P. FILTER
(HOLD CONTROL)
AUTOTUNE
D.C.AMP
(SENSITIVITY CONTROL)
(TUNE CONTROL)
METER
400Hz AUDIO OSCILLATOR
CHOPPER SWITCH
POWER AMP
(VOLUME CONTROL)
SPEAKER
PHASE SHIFTER
(G.E.B./DISCRIMINATE CONTROLS)
COMPARATOR

inverter and changeover switch requires very few extra components and greatly improves the signal-to-noise ratio, ultimately resulting in more sensitivity.

After the filter, the d.c. signal is amplified. It is only changes in the signal that are of interest, so a means of "tuning out" the initial standing d.c. level is required. In simple machines this is a manual control, but the need for readjustment after each operation of the phase controls—say switching from "ground" to "discriminate"—makes some form of automatic tuning desirable. On most commercial machines a "tune" button resets the output to zero every time it is pressed, but these are notoriously prone to drift. Attempts to use continuously resetting systems have been made, but this tends to lower the overall sensitivity as most manufacturers use rather crude filtering, resulting in considerable delay in the response to a detected object. In effect the autotune tries to reset the output to zero at the same time as the detected object is trying to cause it to rise! The highly efficient filtering used in this design ensures an instant response to a signal, so a continously resetting tuning system can be used. This does away with all the drift problems, and allows the machine to be used continuously at maximum sensitivity if required. A "freeze" button is provided to stop the tuning action whilst pinpointing the exact position of finds or discriminating.

After the autotune and amplifier stage the signal is fed to a centre-zero meter; in "discriminate" this indicates positive for "good" finds and negative for "bad" ones. Then it goes to a further amplifier with a control which sets the point at which the audio output is to start. The output from this is of course still d.c., so it is chopped up by an audio oscillator, providing a signal which only needs a power output stage to drive the loudspeaker.

CIRCUIT

Fig. 2 shows the complete circuit of the machine. TR1 and associated components form the drive oscillator, which provides a very pure 15kHz sinewave output. IC1 buffers part of this signal and the circuitry around IC2 introduces the phase shift as required. In "ground" the available shift is about −10 to +40 degrees, whilst in "discriminate" and "beach" it is about 0 to −170 degrees. IC3 is a comparator; the 3130 was chosen for its high slew rate and good output drive signal for the CMOS switch IC6. TR2 is the received signal preamp and is connected as a common base amplifier. This and oscillator TR1 are both based on designs which have been used in several manufactured machines because they are simple and work well. The receive coil L2 is untuned; this, coupled with the low impedance input load of TR2 ensures the predictable phase response required for reliable discrimination. The output of TR2 is at high impedance so IC4 acts as a buffer, whilst IC5 is a unity gain inverter. IC6 is connected as a CMOS electronic changeover analogue signal switch. IC7 and IC8 together are the 3rd order low-phase active filter.

IC9 is a d.c. amplifier and also the auto-tune stage. The action of this is probably easier to understand if one first considers an ordinary op-amp inverting amplifier, as shown in Fig. 3. If the +input is at 0 volts, the −input must also be at 0 volts, so if a voltage is applied to the input resistor R_{in} the output will change until it restores the 0 volts at the −input via R_f. Now consider the effect of placing a capacitor at point "x". If the output is connected directly to the −input, it will go to 0 volts. If at the same time a voltage is applied to R_{in}, the capacitor will acquire a charge. If the output is now disconnected from the −input it will remain at 0 volts because the capacitor will retain the charge necessary to

COMPONENTS

Resistors
R1, 4, 5, 7, 8, 19, 20, 29, 35, 38, 46, 48,—10k.
R2, 16,—15k
R3,—3k3
R6, 9, 21, 47,—4k7
R10,—3k9
R11, 49, 50,—2k2
R12,—1k
R13, 17, 30,—100k
R14,—180k
R15, 28, 32, 34, 43,—22k
R18,—2M2.
R22, 23, 44.—33k
R24, 25—27k
R26, 27,—39k
R31, 39,—1M.
R33, 37,—220k
R36,—270k
R40,—47k
R41,—6R8
R42,—470k
R45,—2k7.

Potentiometers
VR1, 2,—47k log carbon.
VR3—1M lin. carbon.
VR4,—100k lin. carbon.
VR5,—10k log. with switch.
VR6,—10k preset, sub min horizontal.

Capacitors
C1, 10,—47n polyester
C2,—470n polyester
C3, 7, 9, 16, 18, 21,—10n polyester
C4, 5, 6,—1n polystyrene
C8, 12, 13, 14, 15,—100n polyester
C11,—22p polystyrene
C17,—1μ polycarbonate
C19,—4·7μ 63V electrolytic
C20, 24, 25, 26—470μ 16V electrolytic
C22,—470μ 25V electrolytic
C23,—10μ 25V electrolytic

Diodes
D1 to 8,—1N914.
D9—BZY88C 5V6, 5·6 volt Zener.

Transistors
TR1, 4, 9,—BC214L
TR2, 5, 6, 8,—BC184L.
TR3—2N3819.
TR7—BFX29.

Integrated Circuits
IC1, 2, 5, 7, 8, 12, 13,—741 8-pin d.i.l.
IC3,—CA3130 8-pin d.i.l. or T079.
IC4, 9, 10,—CA3140 8-pin d.i.l. or T079.
IC6,—4007UBE (CMOS).
IC11,—ICM7555—low power 555 timer 8-pin d.i.l.

Miscellaneous
S1, 4-pole 3-way rotary switch, S2, pushbutton, miniature, press to make, Meter, 100-0-100 microamp centre zero, LS1—2½in. 8ohm Loudspeaker, 12 off 8-pin d.i.l. i.c. holders, 1 off 14-pin d.i.l. i.c. holder, 5-pin DIN plug and socket, Headphone socket, 3 PP3 battery clips, 32 and 36 SWG enamelled copper wire, 5A bare tinned copper fuse wire, 2 metres of 4-core individually screened cable, Case, Vero type 75-1411-D, 6 control knobs, approx 25mm skirt, Plus plastic plumbing components, "Melaware" plate, glassfibre repair kit etc. to make coil, stem and handle —see text.

Kits available from **Maplin Electronic Supplies Ltd.**

offset the input voltage. A change in the input voltage will now be reflected in a change in the ouput voltage, the gain being given by R_f/R_{in}. In this way an amplifier can be constructed using only one op-amp which will offset large d.c. input voltages and yet provide high d.c. amplification of very small input voltage changes.

In the main circuit TR3 provides a means of connecting the output to the —input. The output is divided by R33 and R34 and fed through R31, so that the reset rate is relatively slow but continuous, as TR3 is normally conducting. If the tuning error is very large however, as it would be after switching on or operating the discriminating controls, D5 or D6 will conduct and greatly accelerate the tuning rate. D3 and D4 prevent the gate junction of TR3 from becoming forward biased at any time.

VR4 sets the threshold of IC10 and is normally adjusted to that it's output is at negative rail voltage. On receipt of a signal it rises towards positive. IC11 is a low-power 555 timer connected as an astable oscillator, giving very short (about 100 microsecond) negaative pulses at about 400Hz. Thus TR5 is normally on and turns off only during these pulses so after R40 any output from IC10 is chopped into short positive going pulses. This is the ideal waveform to create lots of noise with an economic power consumption. The volume control in a design such as this is normally only required to limit the maximum noise level, so in this design VR5 and TR4 act as an adjustable clamp. In this way the sensitivity is not reduced if the volume has to be kept turned down. TR6 and TR7 are a complementary Darlington pair, their current gain enabling the signal to drive the loudspeaker or headphones.

SUPPLIES

Two separate power supplies are used in this machine. The bulk of the circuitry is supplied with 18 volts from two PP3 batteries in series, regulated by the circuit around IC12 and IC13. With so many op-amps its far easier to arrange the design around a centre-tapped supply, so the reference generated by the Zener is buffered by IC13. It is then doubled by IC12, TR8 and TR9, to give a regulated positive rail of twice the Zener voltage, nominally +11·2 volts. This arrangement has been used in preference to an integrated regulator since it will operate until the battery voltage has fallen to only 0·1 volt above the regulator output. Most integrated regulators require a differential of at least 2 volts, which in practice means that the batteries have to be replaced rather more frequently. The total power consumption of all this circuitry is about 20mA, less than many radios at normal volume.

Power for the loudspeaker output stage comes from a separate 9 volt battery, as this is the simplest way of avoiding decoupling difficulties in this very sensitive circuit. An extra PP3 is far smaller than the decoupling capacitors which would otherwise be required! Only the one power supply switch is required as the output draws no current unless an input signal is present.

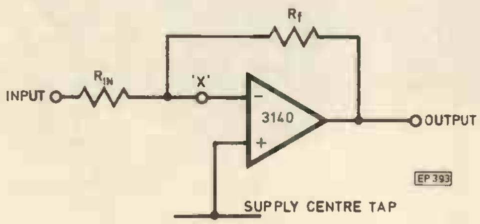


Fig. 3. Op-amp inverter

CONSTRUCTION

Construction is on two printed circuit boards and should be adhered to as this is a very sensitive circuit indeed; the result of any changes may well prove to be severe instability!

The two boards are stacked vertically in the final assembly resulting in a control box which is smaller and neater than many very expensive manufactured products.

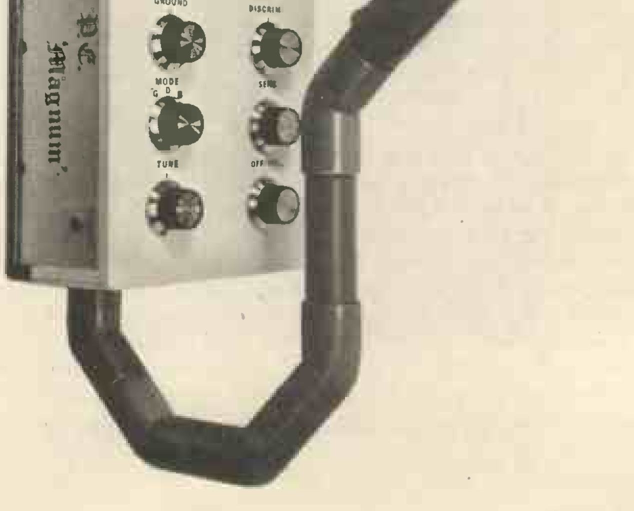
The board containing the power supply, autotune and output should be built first as the power supply will be required for testing the "front end" board (Fig. 5).

ASSEMBLY DETAILS

Start construction by fitting the six links. The fit R45 to R48, C22 to C25, ZD1, TR8, TR9, IC12 and IC13. Apply the 18 volt battery via a 100mA meter and a 220 ohm series resistor, which will limit the current if any faults are present. It's as well to use this resistor throughout the testing of both boards. After a brief surge as the eletrolytics charge the current should settle to about 5mA. Check that about 11 volts appears across C25, and about 5·5 volts across C24. This completes the power supply section.

Continue by fitting R40 and R41, C19 and C20, TR6 and TR7. Hook up the speaker, apply the 9 volt power supply via the 100mA meter and a 100 ohm resistor, again in case a fault is present. After a brief surge the current drawn should drop to zero. A finger on R40 and the battery positive at the same time should cause a crackle and an indicated current flow. Fit R42 to R44, C21, TR5 and IC11. IC11 is the low-power 555 timer; despite the manufacturers' notes to the contrary these are a little sensitive to handling so treat it with care and use a holder. I.c. holders are advisable throughout in fact; there is ample room for them. Apply both power supplies. A finger on 9 volts positive and on R40 should now produce the 400Hz output tone, albeit possibly at rather low volume. After this the 100R resistor can be left out of the 9 volt supply during testing, although the 220R in the 18 volt supply should be retained. Fit TR4 and hook up VR5. Apply power supplies, place fingers on R40 and 9 volts positive, and check that the volume can be controlled with VR5. This is one of those many jobs in electronics for which one requires three hands!

Fit R33, R34, R36 to R39, C18, and IC10. IC10 may be in



Control fascia of P.E. Magnum detector. Note 'Tune Hold' switch on handle.

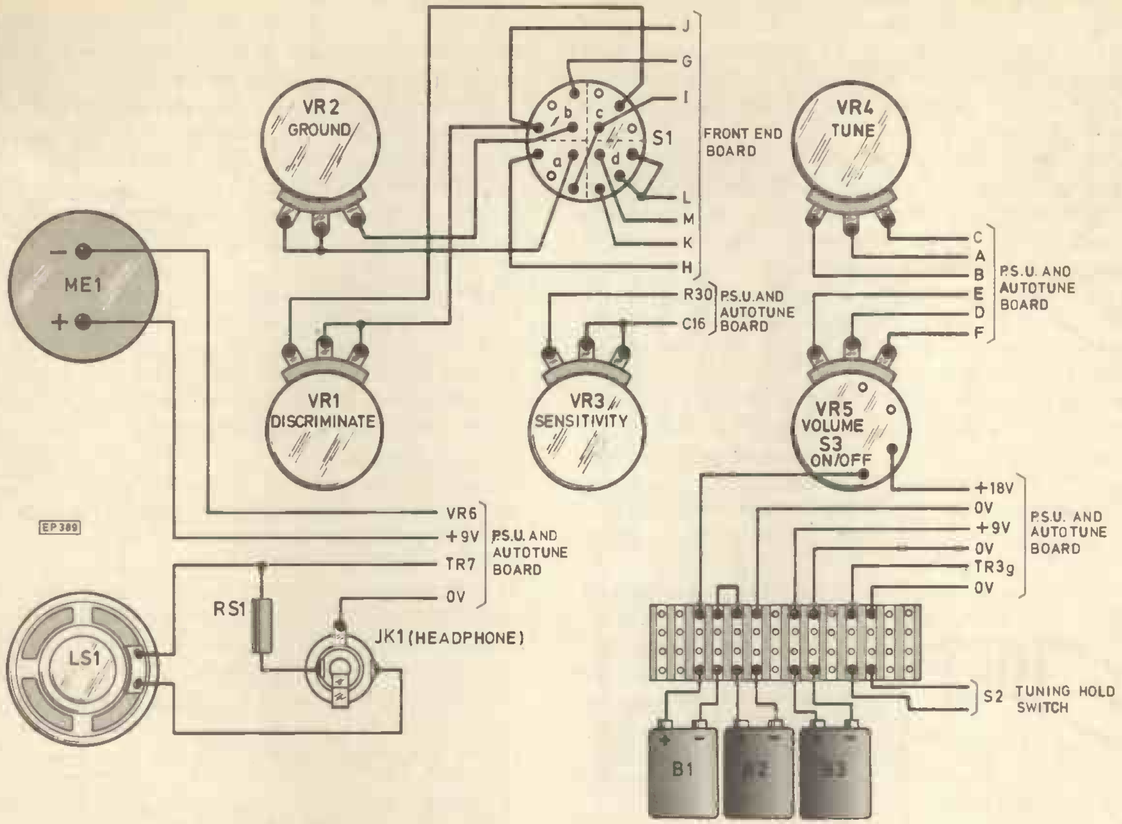
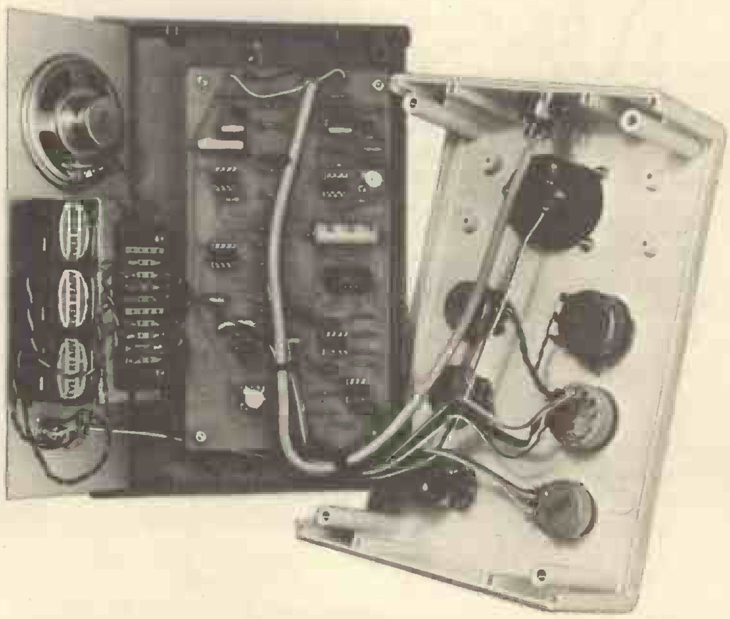


Fig. 4. Connections to controls and headphone jack socket. Other connections as marked on p.c.b. overlays

BOARD ASSEMBLIES

Power supply, autotune and output board



Front-end board in position

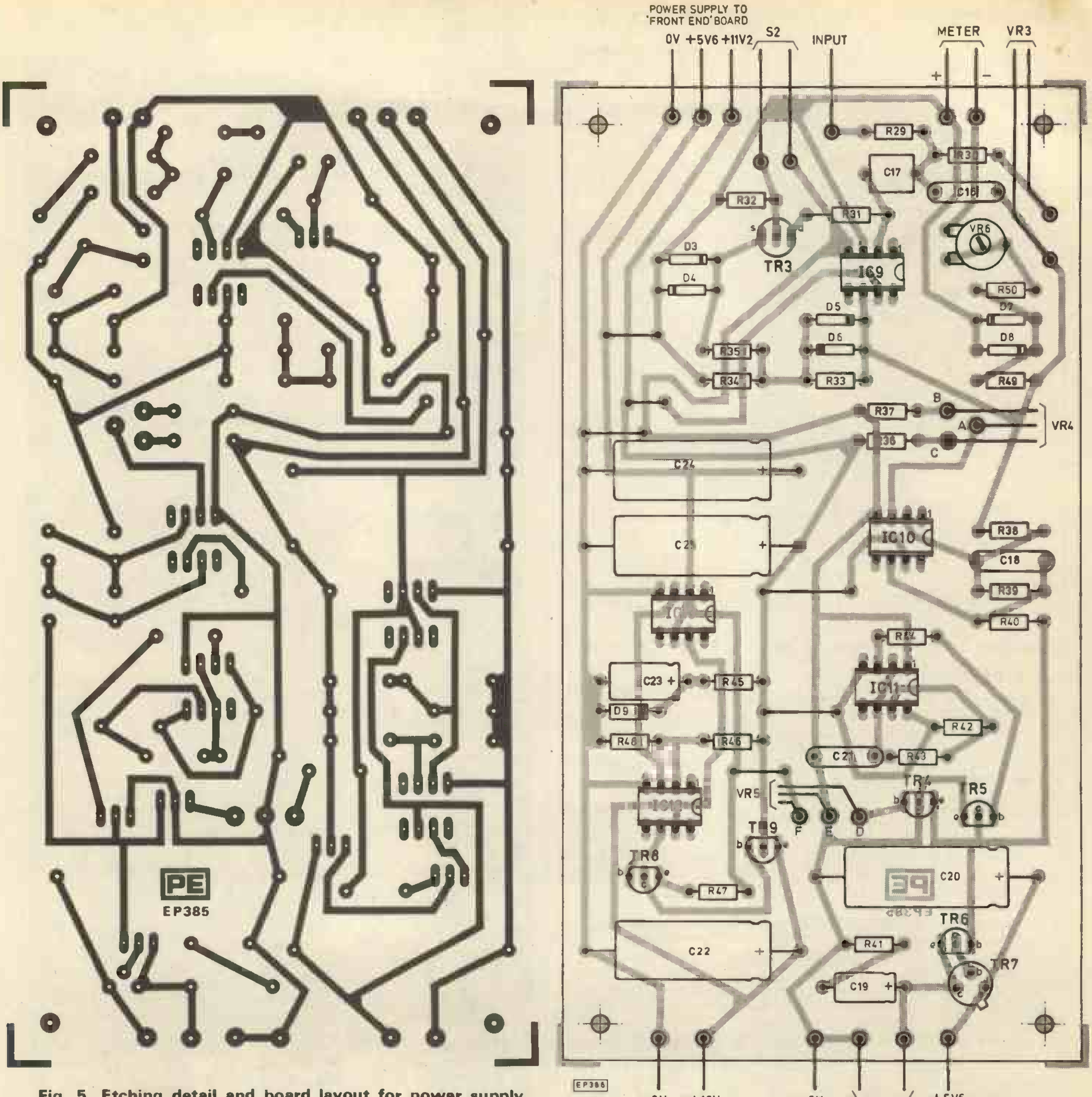


Fig. 5. Etching detail and board layout for power supply, autotune and output

either an 8-pin d.i.l. package, or the round metal T079 version. You can now hook up VR4 and apply power. It should be possible to turn the output tone on and off with VR4—gradually, since the input of IC10 at this stage is effectively taken to the supply centre-tap via R33 and R34 which reduces its gain somewhat. If there is no output tone check that the volume isn't turned right down.

FINAL TEST

Fit all the remaining components to this board. Hook up S2, VR3 and the meter. Short the input point to the battery centre-tap. Apply power; the meter should return to zero within a couple of seconds due to the autotune action. Adjust VR4 to just below the tone threshold point. Touch the 18 volt battery positive with one hand, and, taking a 10M resistor in the other, touch the top end of R29 via the resistor. This should produce a brief burst of tone and a positive jump on the meter, which will then return to zero. Repeat this procedure whilst pressing S2—the sound and meter deflection produced should then be continuous. Press the button, and touch either of the 18 volt battery leads and the bottom of C17. This should cause the meter to drive fully up or down, and its full scale deflection can then be adjusted with VR6.

Next month: details will be given of the remainder of the construction and using the detector.

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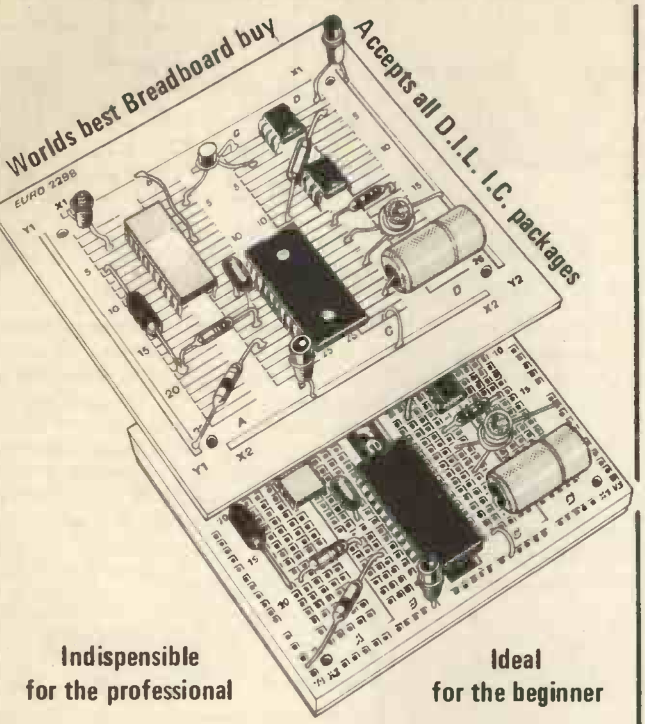

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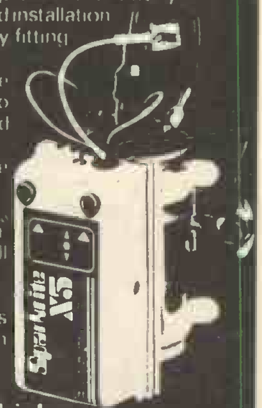

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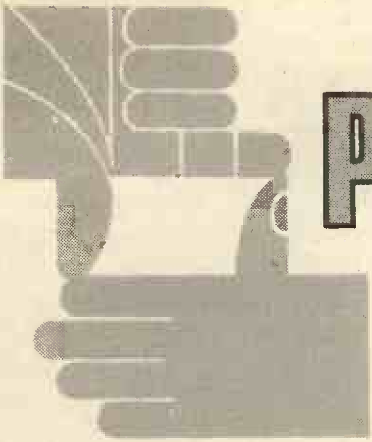


PATENTS REVIEW...

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

LOW-LIGHT VIEWFINDER

English Electric Valve Company Ltd. patents (BP 1 559 586, filed in 1976 under the old laws) a greatly simplified low-light tv system. Such a system can, for example, be used as the viewfinder for a camera operating in the invisible infra red (or ultra-violet) regions. Normally an infra-red camera, with a vidicon tube of the thermal-imaging or pyro-electric type, requires a separate monitor as a viewfinder which in turn requires external synchronization. This is expensive and the aim is to provide an inexpensive viewfinder built into the camera.

In many respects the new invention borrows from ideas as old as television—i.e. mechanical scanning by synchronously locked discs in the Baird system. A pyro-electric tube produces an output signal only when its target area is either heating up or cooling down under the influence of infra-red. No output is produced in a steady state condition so the tube must be associated with a shutter which regularly interrupts the infra-red image. Normally, the tube target gives a positive signal from areas that are warming up and a negative signal from areas that are cooling down. The negative signals are then all inverted electronically so that a constant polarity output is fed to a display tube viewfinder. But clearly synchronization between the tubes is all important.

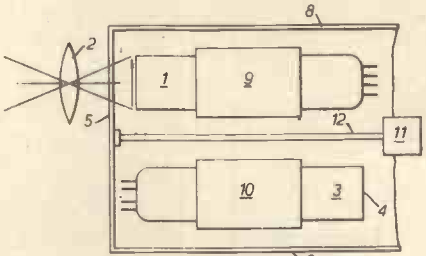


FIG. 1.

Figure 1 shows a camera with a pyro-electric pick-up tube 1 and an imaging lens 2. Monitor display tube 3 provides the reconstituted image on phosphor screen 4. The image from lens 2 is chopped by cylindrical shutter 5 which rotates with a cylinder 8 on axis 12 around both the pick-up and display tubes. The shutter can provide one cut-off per revolution (Figure 2) or two cut-offs per revolution (Figure 3). The crux of the invention is the provision of deflection coils on the body of the cylinder 8. These thus rotate in mechanically locked synchronism with the shutter; so both the tv tubes display a deflection pattern which is synchronously locked irrespective of the speed at which the cylinder rotates.

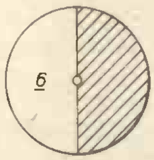


FIG. 2.

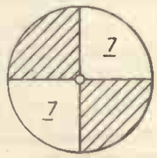


FIG. 3.

An AC scanning field is fed to the deflector coils and the reproduced picture is superimposed on a tv raster pattern. Although, as shown in Figure 5, this may well be non linear, i.e. the raster lines may be non parallel, this is of no consequence. Both the camera tube and the diplay tube are mechanically locked to exactly the same scan pattern, so the displayed picture shows no distortion of shape.

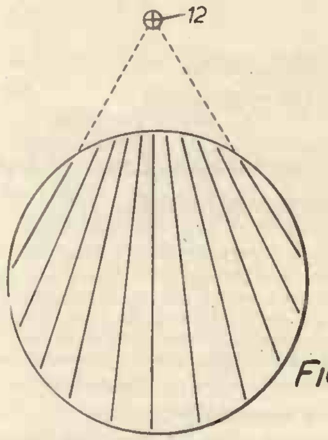


FIG. 5.

News Briefs

THIRD MADLEY AERIAL

WORK HAS started on a new space communications aerial for the PO at Madley in Herts. This erection is necessary to keep pace with the enormous volume of overseas telephone calls from the UK, currently ten million a month, and doubling every four years. With telex and computer data increasing as fast, the £7·5m project will add to the satellite earth station's £17m worth of existing hardware. The PO is spending an overall £1000m annually on new plant to constantly update Britain's communications with the rest of the world.

A £3m contract goes to Marconi Communications Systems, who will supply everything except the dish itself, and its control electronics and receivers. The remainder of the aerial and its electronics will be supplied by the Mitsubishi Electric Corporation. To be completed in 1981, the aerial will work with a satellite in a geostationary orbit 23,000 miles above the Indian Ocean, one of the eight satellites now operating the Intelsat (International Telecomms Satellite Organisation) global system. "Madley Three" will be a 32m diameter dish capable of transmitting 2000 telephone calls and two TV programmes simultaneously. Its satellite is capable of handling up to 12,000 calls at once.

TI 58/59 CLUB

A NATIONAL TI 58/59 calculator club has been started by Mr. R. M. Murphy of the Dept. Electronics Engineering, University College Swansea, Singleton Park, Swansea.

The basis of the club will be direct exchanging of programs, or purchase of programs at 50 pence each. There will be a newsletter every two months, and since a PDP 11/32 computer is to be used for administration, the club should be very efficient. Guide books on conversion, upgrading and such things as a cheap cassette interface, will be available.

Work is taking place to interface a SC/MP micro' to the calculator to drive a 10-digit, 16-segment alphanumeric display.

Membership will cost £5, or £3 to those who include a program plus flow diagram and instructions.

Constant Current Sources

I. MILLAR

WHEN dealing with purely electronic circuits, whose resistance changes little with time, it matters little whether one uses a constant current or constant voltage source, and indeed most electronic engineers are quite content to use the latter. However as soon as we move either to heavier current loads—where resistive heating becomes significant—or to more complex systems such as electrolyses, where total cell impedance depends on the sum of resistance through the electrolyte and *reaction impedance*, a constant current source becomes mandatory for any quantitative measurements. Briefly to elaborate on the foregoing terms, it will be obvious that passage of any significant current through the electrolyte will cause resistive heating and thus lower the solution resistance. In this, its behaviour differs from the resistance coefficient of a metal, which is of opposite sign. It will be noted that the sign of the solution temperature coefficient, like that of an electric arc or a fluorescent tube, could induce a runaway condition. The second component is the so-called reaction impedance, that is to say, the resistance to passage of current at the electrodes themselves. This is a function of electrode materials, their size and not least, the type of electrolysis taking place. In short, the simplest electrolysis can in practice require a voltage increase of 50% or more in order to maintain a given current. Nothing could better demonstrate the need for the type of equipment to be described here. Knowing that current remains invariant with time, enables us to perform experiments such as the experimental verification of Faraday's Laws, where total charge passed is current x time. Then too, using the same principle, we can pass a known charge and thereby generate a given quantity of a chemical or a metal ion. Such techniques are widely used in analysis where they correspond to an electrochemical means of "weighing out" from a bottle, but are far more accurate in most cases. Used with an oscilloscope the constant current source can tell us about species adsorbed on an electrode surface, for as long as many species exist, the potential will change only slowly, if at all. Once they are all gone, it will rise sharply. Last but not least, by passing a constant current, and measuring the rate of potential change of an electrode, we can determine the effective capacitance, from the simple equation:

$$i = C \cdot dV/dt$$

That capacitance is directly related to surface roughness, or the presence of foreign species adsorbed on its surface. In short, this is a most useful tool.

Early constant current sources consisted simply of a high voltage—up to 100V DC connected across the electrolysis cell through a substantial resistance (which of course was required to dissipate a substantial wattage without too much temperature rise). But some years ago, solid state power sources began to find favour.

DESIGN AND SPECIFICATION

Our specification will depend on the purposes for which we use the constant current source, or galvanostat, as it is often known. The prime question relates to the current output. For such work, an output of 20mA will suffice, especially when electro-analysis is the major interest. But for much other work, such as studies in electrolysis of brine, or battery research, a higher output, such as 1–2A is more useful, in that it enables us to do what we wish on electrodes of reasonable size, say 1–5cm^2 in area. The second feature must of course be current stability, and this is defined both with respect to time, into a constant load, and also with respect to load variation, over a short space of time. A one per cent constancy would be the lowest acceptable value, while a figure such as 0·3 per cent would be better. Again, the effect of ambient temperature on output current should not be neglected here, and can be lumped into the above figures.

Finally we have two further specifications to meet. Ripple content should be less than 0·1 per cent and then there is the question of rise-time which depends very much on the proposed duty. But in some applications the device is switched onto load extremely fast, using a mercury-wetted reed relay or a CMOS and VMOS switch. Into a purely resistive load, the rise time shoud be fast—of the order of 1 microsecond.

Various circuits have been published, from time to time, which fulfil these specifications.

We shall show here the construction of two units. The simpler one, based on a design of Dr. Colin Vincent, of the University of St. Andrews, is a single transistor galvanostat.

It will deliver up to 22mA. The more sophisticated instrument is based on a design that was evolved at Salford University. It will deliver from 5 microamperes to 3 Amperes in 6 switched ranges. To extend the utility of the latter instrument, we have included a switch to convert it from constant current to constant voltage mode. The range switch and ten-turn potentiometer then provide a voltage range from 0V to 30V.

A further feature incorporated in this instrument is an input socket which allows an applied voltage function to control the current output as a function of time. Thus by application of a square wave voltage function, the corresponding current output will be produced. Suitable function generators are readily available commercially, though their construction will form the basis of a future article in this series.

20mA GALVANOSTAT

a) Circuit

The circuit consists of a full wave rectified power supply comprising:—T1, D1, D2, C1, C2 and R1 which delivers approximately 30V D.C. Transistor TR1 operates in the common base mode giving a very high impedance collector circuit. The current flowing in the load R_L (collector current) is determined by the voltage applied to the transistor base V_P and the value of R_3, and is approximately equal to:

$$\frac{V_P - V_{BE}}{R_3}$$

where V_{BE} is the potential drop across the base emitter junction; this being about 0·6V for a silicon transistor.

Therefore the maximum load current for the circuit is

$$\frac{6{\cdot}2 - 0{\cdot}6}{270} = \text{approx. 20mA}$$

By varifying the base voltage using VR1 the output current can be varied between 1 and 20mA. The circuit will keep the current constant to 0·1 per cent for 1 hour after reaching working temperature. In order to keep the circuit under load and at working temperature when not in use, a standby clearing load has been incorporated consisting of S2 and R4. The ability to supply maximum output current into high resistance loads is restricted by the available output voltage of 30V.

CONSTRUCTION

The circuit is constructed on a small printed circuit board no particular problems being envisaged.

The original circuit was constructed in a small metal box measuring 135 x 80 x 55mm.

CALIBRATION

The circuit was loaded with a 100 ohm 0·5 watt resistor and allowed to warm up for one hour.

The scale was then marked by adjusting VR1 and measuring the output current with a meter.

Fig. 1. Circuit diagram of 20mA Galvanostat

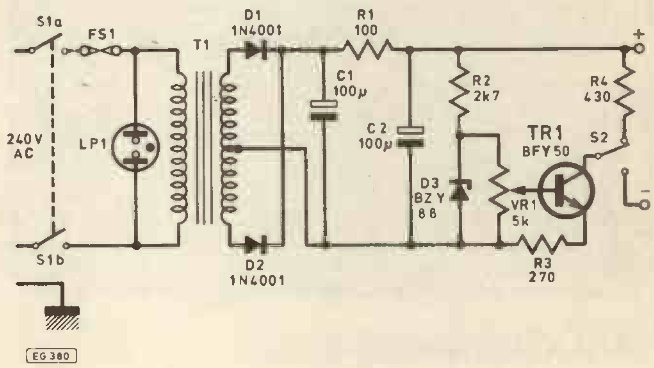


Fig. 2. Printed circuit (actual size)

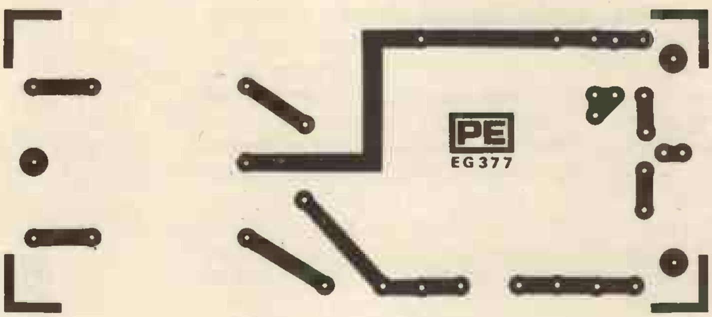
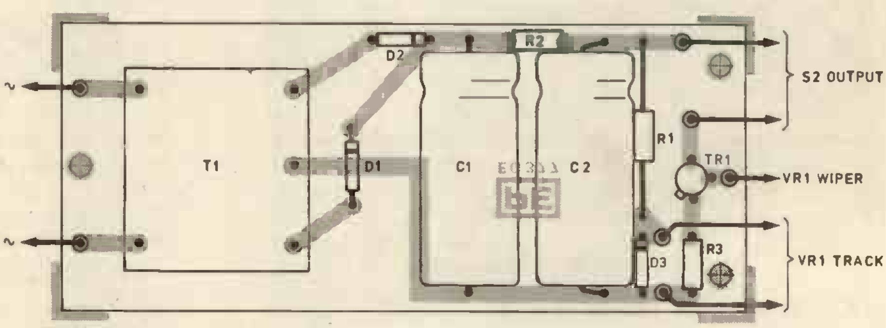


Fig. 3. Component overlay



COMPONENTS . . .

Resistors

R1	100
R2	2k7
R3	270
R4	430

All 0·5W 2% Thick Film

Potentiometers

VR1	5k lin	1 watt wirewound

Capacitors

C1, C2	100μ	63V Electrolytic (2 off)

Semiconductors

D1, D2	1N4001 (2 off)
D3	BZY88 6·2V 400mW
TR1	BFY50 (2N3053)

Transformer

T1 — 240V primary
20–0–20 V r.m.s. Secondary 1·2VA
printed circuit mounting
R.S. Components 207–908

Miscellaneous

S1	DPDT Min. toggle
S2	SPDT Min. toggle

Fuseholder + 1A Fuse
240V Neon
P.c.b.
Output socket

3A GALVANOSTAT

CIRCUIT

The circuit provides an output voltage of up to 30V d.c. at currents up to 3A.

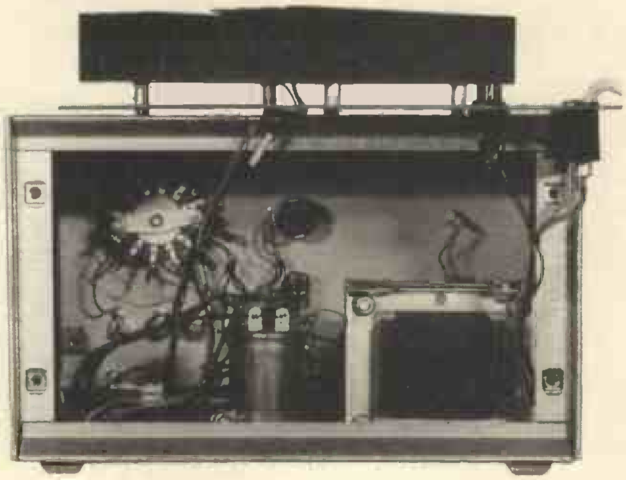
The circuit functions as either a constant voltage or constant current power supply, depending on the position of function switch S3.

The output voltage or current is dependent on how much output transistors TR2 and TR3 are turned on by operational amplifier IC1, and TR1.

Initial setting of voltage or current is achieved by adjusting the voltage at the non-inverting input of IC1 using VR1 to vary the reference voltage derived from the Zener diode stabilising network R1, D9, R2, D10 and C2. Resistors R3 and R4 determine the limits within which VR1 operates.

The circuit can be controlled externally, e.g. from a sweep generator via the external input socket SK1. For full output a control voltage of one volt d.c. is then required.

In the constant current mode, one of the resistors R8–R13, selected by range switch S4, is connected in series with the load. Voltage developed across this resistor is fed back to the inverting input of IC1 so that if the output current increases the voltage across R8–R13 will increase thus causing the output voltage of the circuit to decrease holding the output current constant. The reverse occurs should the output current drop.



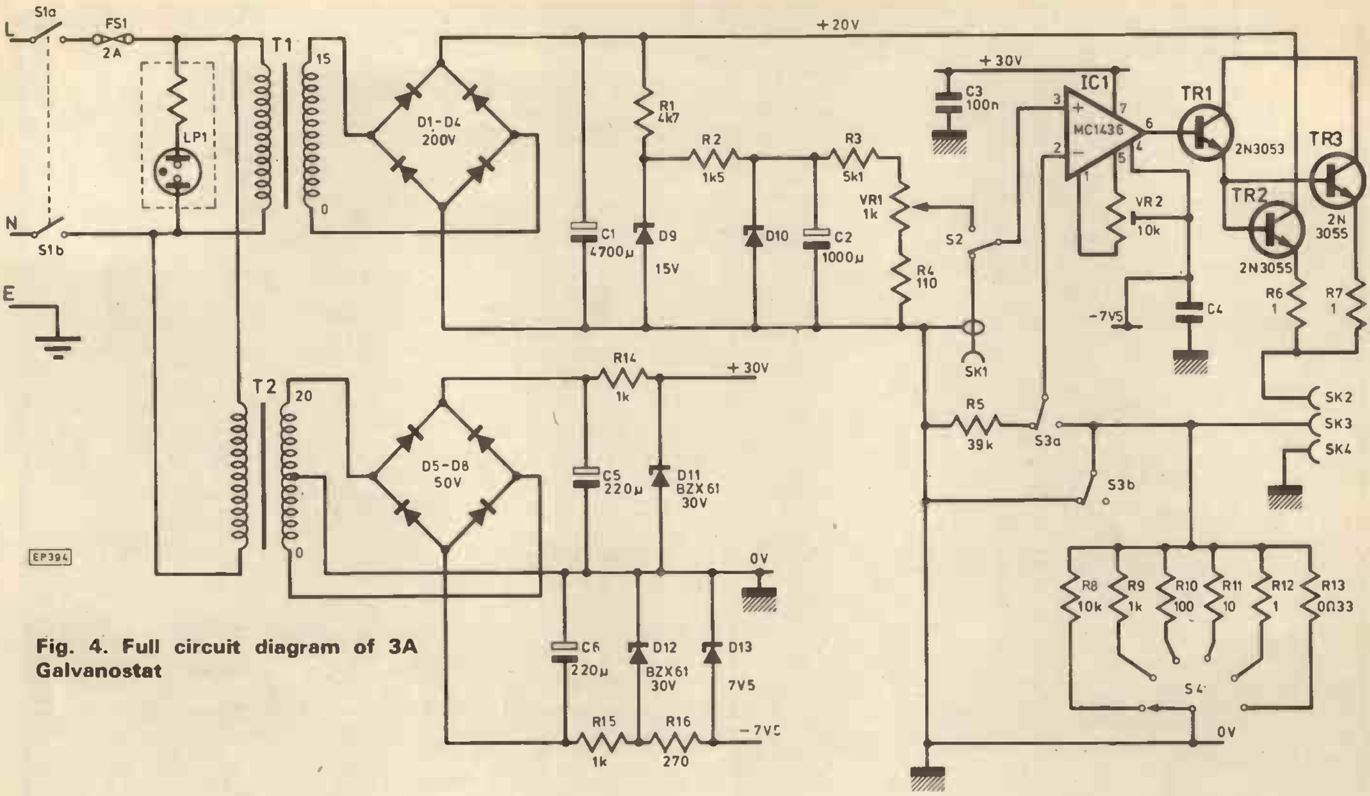


Fig. 4. Full circuit diagram of 3A Galvanostat

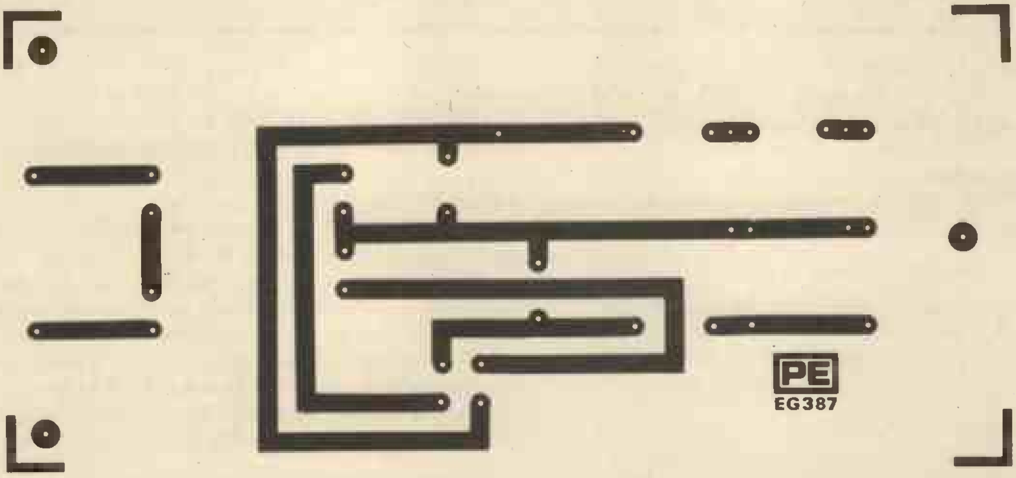


Fig. 5. Printed circuit for op. amp. power supply board (actual size)

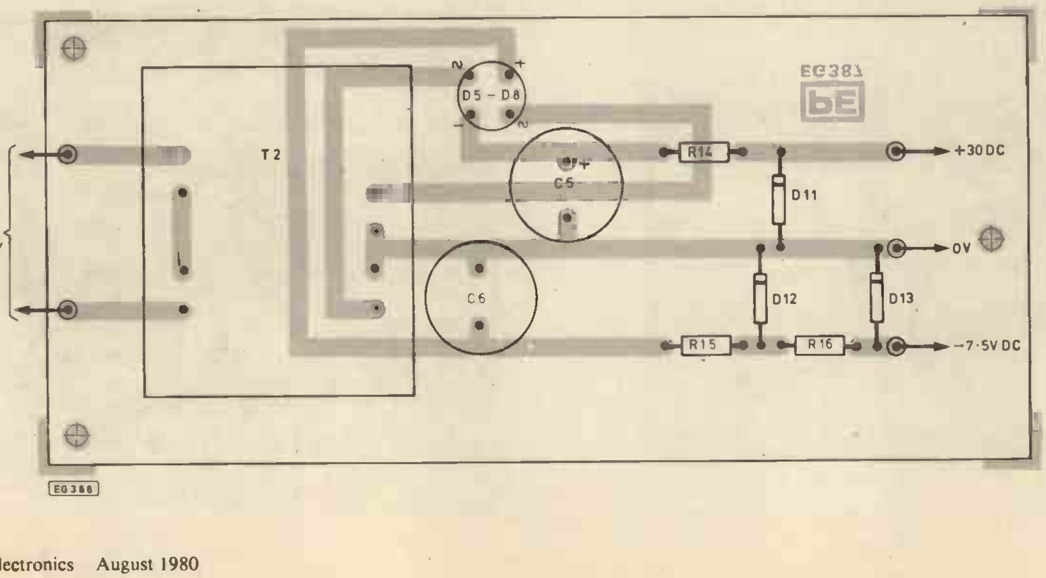


Fig. 6. Component overlay for above

COMPONENTS . . .

Resistors

R1	4k7	Thick Film
R2	1k5	Thick Film
R3	5k1	Metal Oxide
R4	110	Metal Oxide
R5	39k	Thick Film
R6, R7, R12	1R	2·5W Wirewound (3 off)
R8	10k	Thick Film
R9	1k	Thick Film
R10	100R	Thick Film
R11	10R	Thick Film
R13	0·33	2·5W Wirewound
R14, R15	1k	Thick Film (2 off)
R16	270	Thick Film

All resistors $\frac{1}{2}$W 2% unless otherwise stated.

Potentiometers

VR1	1k	3W 10 turn linear
VR2	10k	Enclosed cermet preset linear

Capacitors

C1	4700µ	63V	Can electrolytic
C2	1000µ	25V	Wire ended electrolytic
C3, C4	100n	Disc	Ceramic (2 off)
C5, C6	220µ	63V	Wire ended electrolytic

Semiconductors

D1–D4	4A	200V	Bridge rectifier
D5–D8	1A	50V	Bridge rectifier
D9	BZY88	15V	400mW Zener diode
D10	BZY88	5·1V	400mW Zener diode
D11, D12	BZX61	30V	1·3W Zener diode (2 off)
D13	BZY88	7·5V	400mW Zener diode
TR1	2N3053		
TR2	2N3055		
TR3	2N3055		
IC1	MC1436 CG. (Motorola)		

Transformers

T1	240V Primary 0–15V, 0–15V 100VA Secondary
T2	240V Primary 0–20, 0–20 6VA Secondary (R.S. Components) printed circuit mounting

Switches

S1, S2	DPDT Miniature toggle: 250V AC 1A (2 off)
S3	DPDT Miniature toggle
S4	1P 6W Rotary 6A 30V DC

Miscellaneous

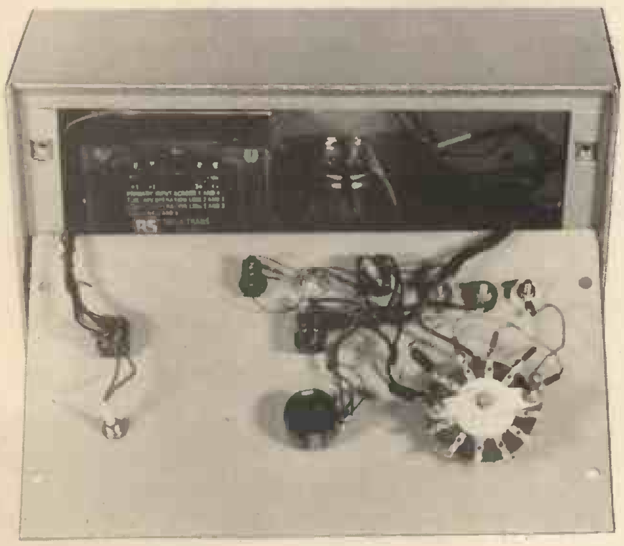
Fuseholder and fuse
Neon
Sockets
Printed circuit board
Heatsinks
Case

In the constant voltage mode R8–R13 are shorted by S3B and IC1 inverting input is grounded via R5 by S3A. Capacitors C3 and C4 provide supply decoupling for IC1.

The output voltage is provided by T1, D1–D4 and C1, and IC1 has a separate power supply providing +30V and −7·5V. Switch S5 was also incorporated to reverse the polarity of the output.

CONSTRUCTION

The prototype circuit was constructed on two printed circuit boards, one for the main circuit and one for the operational amplifier power supply. C1 was mounted separately and resistors R8–R13 were mounted directly on S4.



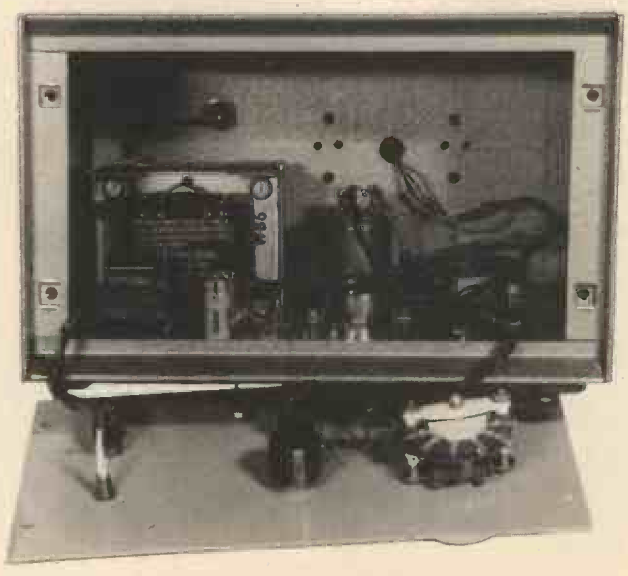
TR2 and TR3 were mounted on a heatsink with a thermal capacity of 1·1°C per watt, which was mounted away from the case on 10mm spacers to give improved ventilation. A small clip-on heatsink was also fitted to TR1.

SETTING UP AND USE

Firstly the offset null is adjusted. With both inputs of IC1 grounded, adjust VR2 to give 0V at IC1 output.

The circuit will supply between 10µA and 3A in six overlapping ranges, although when using the 1A and 3A ranges, the output transistors will become quite hot (up to 65°C), and load resistances of not less than 1Ω should be used on the 1A range and 8Ω on the 3A range.

When used as a constant voltage power supply the output current should be restricted to 1A. ★



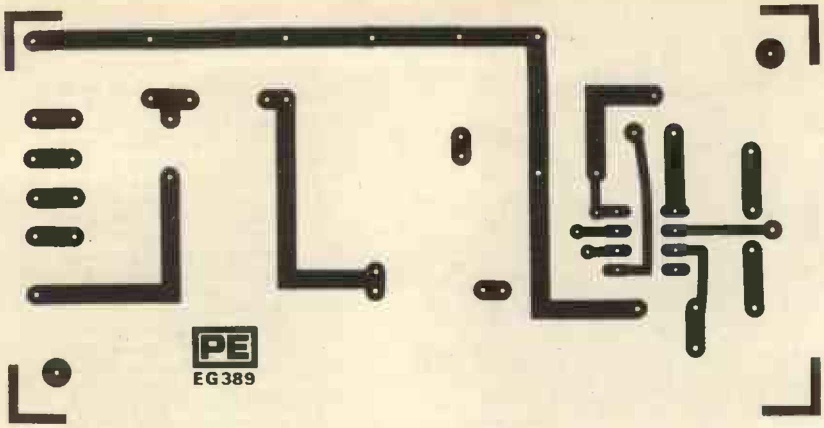


Fig. 7. Main board p.c.b. (actual size)

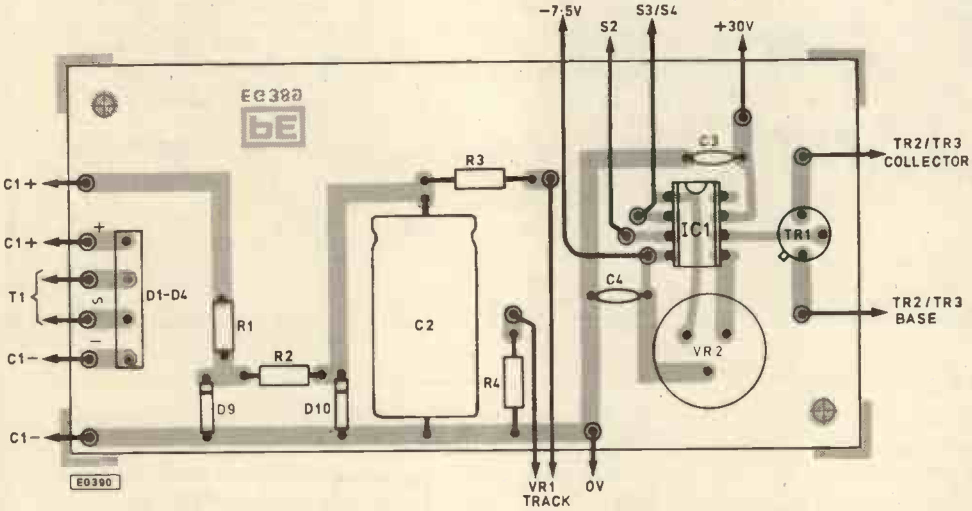
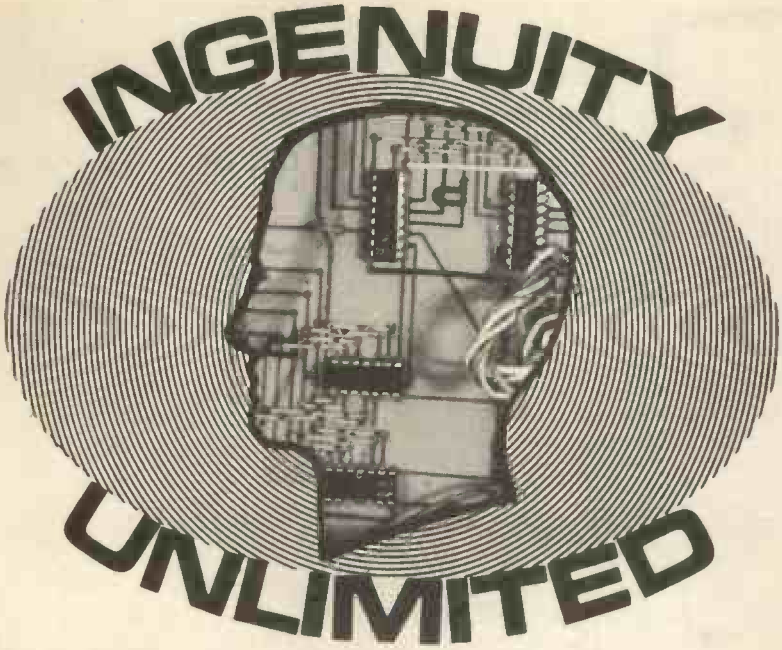


Fig. 8. Component overlay for above

Countdown

Computer Graphics (exhibition & conference) Aug. 12–14. Metropole, Birmingham. **O**
Harrogate International Festival of Sound Aug. 16–19 (18 & 19 trade). The Exhibition Centre + hotels. **X**
Edtech Aug. 19–21. Holland Park School, London. **C1**
Personal Computer World Show Sept. 4–6. Cunard Hotel, Hammersmith, London. **M**
Laboratory Sept. 9–11. Grosvenor Ho., Park Lane, London. **E**
Intron 80 Sept. 9–11. RDS, Simmonscourt Pavilion, Dublin, **V**
West of England Electronics Exhibition Sept. 9–11. Bristol Exhibition Centre. **Q**
Electrathon (Lucas battery vehicle race) Sept. 13, 1980. Fashioned on last year's event, this "whispering Grand Prix" is a contest for *home made* electric vehicles. It will again be held at Donington Park Race Circuit, nr. Derby. Details: ✆ 021-554 5252.
Avionics (symposium) Sept. University of Surrey. **S1**
Emix (Electronic Measuring Instruments Exhibition) Sept. 30, Oct. 1–2. Post House Hotel, Southampton. **I**
BEX (Business Equipment Exhibition) Oct. 1–2. The Guildhall, Plymouth. **K**
Emix Oct. 7–8. Centre hotel, Newcastle. **I**
Emix Oct. 14–15. Guildhall, Cambridge. **I**
Drive Electric October 14–17. Wembley Conf. Centre, London. Organiser: ✆ 01-834 2333.
BEX Oct. 15–16. Assembly Rooms, Edinburgh. **K**
Engineering Ireland Oct. 15–18. Leopardstown Exhibition Centre. **V**
Testmex (exhibition and conference) Oct. 28–30. Wembley Conference Centre. **T**
Viewdata Exhibition for Professional & Business People Oct. 29–31. West Centre Hotel, London. **Z1**
Compec Nov. 4–6. Olympia. **Z1**
BEX Nov. 5–6. Sophia Gardens, Cardiff. **K**
Semiconductor International 80 Nov. 25–27. Metropole Convention Centre. **T1**
Breadboard Nov. 26–30. Royal Horticultural Halls, Westminster. **T**
Solar Energy Exhibition Aug. 23–28, 1981. Brighton. **M**

E	Evan Steadman. ✆ 0799 22612
I	ITF. ✆ 021-705 6707
K	Douglas Temple Studios, 1046 Old Christchurch Rd., Bournemouth.
M	Montbuild. ✆ 01-486 1951
O	Online Conferences. ✆ 0895 39262
Q	Exhibitions For Industry Ltd. ✆ 08833-4371
T	Trident International Exhibitions. ✆ 0822 4671
V	SDL Exhibitions, 68 Fitzwilliam Square, Dublin, Ireland.
X	Exhibition & Conference Services, Claremont Ho., Victoria Ave., Harrogate, Yorks. ✆ 0423 62677
C1	Stereoscopic Television Ltd., 41/43 Charlbert St., St. John's Wood, London NW8 6JN. ✆ 01-722 4139
S1	Society of Electronics & Radio Technicians, 57–61 Newington Causeway, London SE1 6BL. ✆ 01-403 2351
T1	Kiver Communications U.K., Millbank House, 171/185 Ewell Road, Surbiton, Surrey KT6 6AX
Z1	IPC Exhibitions Ltd., 40 Bowling Green Lane, London EC1R 0NE. ✆ 01-837 3636



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

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

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

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

A HEX KEYPAD

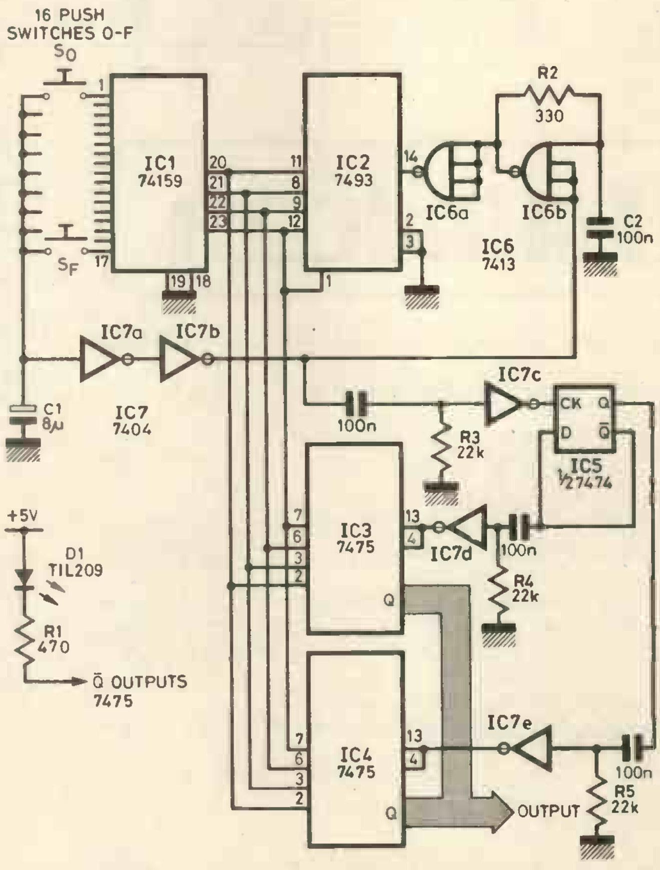
THE accompanying circuit shows a hexadecimal keyboard interface which can be used as both a peripheral to a microprocessor or for inserting data under DMA. It gives visual indication of the output on a bank of eight leds.

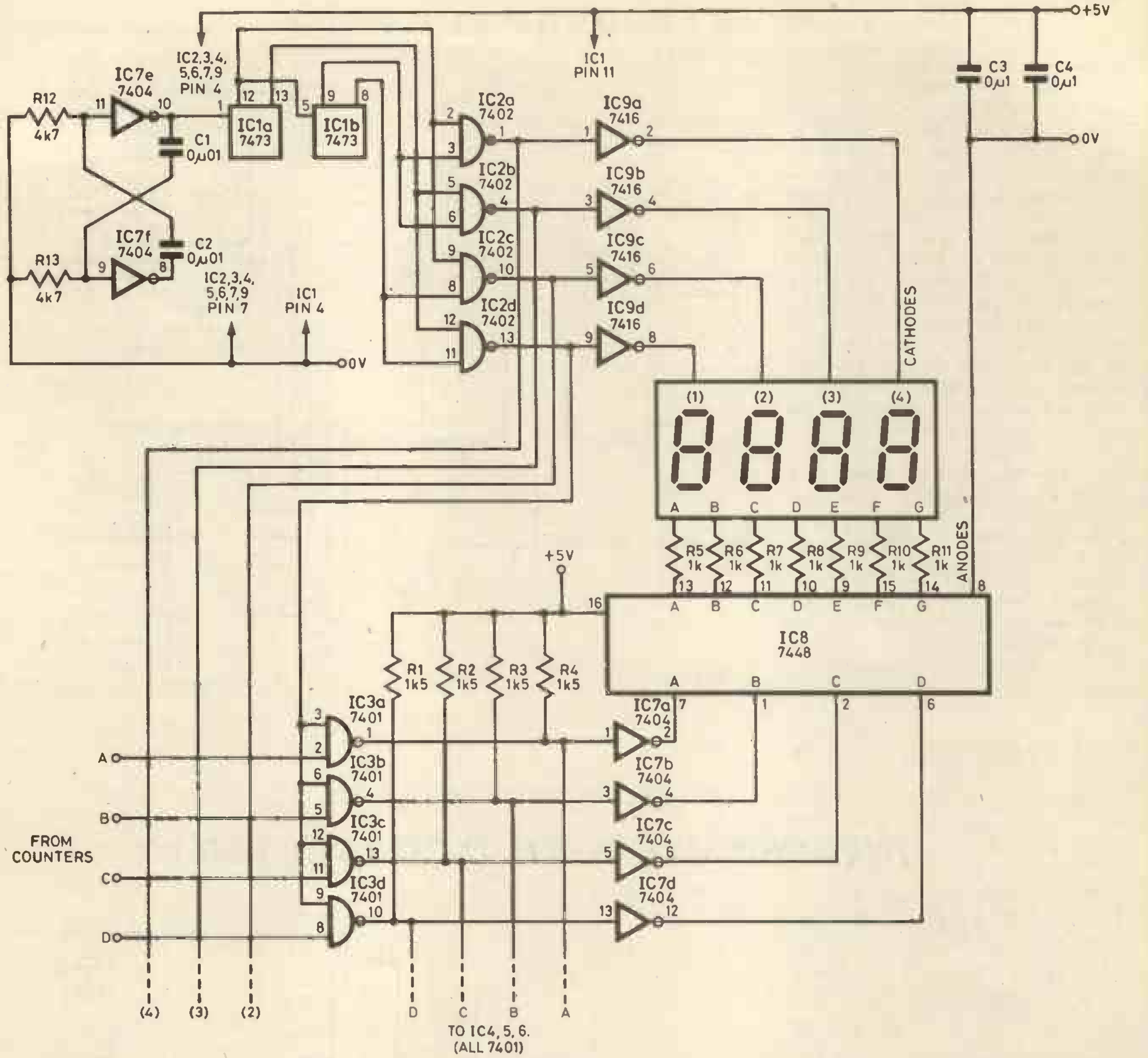
Each key is strobed low in turn by the configuration of IC1 and IC2. When a closed key is found, C1 is discharged and the clock IC6b stopped. IC2 clocks on the up-stroke, so IC6a is included to stop extra pulses reaching the counter. As the voltage on C1 falls, it produces a clock pulse for IC5, which is wired as a divide by two counter. Falling edges on IC5's output, latch the four bit number on IC2 (representing the button pressed) alternately into IC3 and IC4. C1 debounces the keys.

If the circuit is used for DMA, the output can be connected to the data bus. The two hex digit byte is entered and the Chip Enable pin of the memory strobed low to insert the byte. If a wrong number is entered, it can be re-entered before the $\overline{CE}$ line is strobed.

If the circuit is used as a peripheral, then it must be interfaced through a tri-state buffer like the 74125, in which case it would have to be polled. A cheaper method of interface is via a 7401 NAND gate with open collector outputs. Because this performs an inversion, the data should be taken from the $\overline{Q}$ outputs of the 7475.

D. Greaves,
Romsey,
Hants.





MULTIPLEXER

THE circuit is of a four digit multiplexer, which was designed to facilitate the use of a multiplex connected type of l.e.d. display. The circuit can also be used to advantage with unmultiplexed l.e.d. displays, but the total current which may be drawn from each digit driver is limited to 40 mA. Alternatively discrete transistor drivers could be used. The type of display for which this circuit was intended is the miniature calculator displays now available at low cost. With the values of R5–R11 the current per segment is just over 3 mA, which will give adequate brightness in most applications. The circuit is for common cathode l.e.d. displays.

The circuit functions as follows: IC1 and IC2 form a divide by four counter with decimal outputs, which is used to scan the digits and multiplexer gates, simultaneously.

IC9 is an inverting buffer with 40 mA open collector outputs. These are wire-O Red together to enable the BCD outputs of the counters to be connected to the inverters of IC7 and so to the decoder driver i.c., one after the other in sequence. With their respective digits. IC7 reinverts the BCD information because it becomes inverted by the NAND gates. R1–R4 pull up the open collector outputs of the NAND gates.

IC8 is the BCD to decimal decoder driver IC and is for common cathode type displays. R5–R11 are the current limiting resistors for the digits. The remaining two inverters of IC7 are used to form a multivibrator which is used to clock the divide by four decimal counter. C3 and C4 are supply decoupling capacitors and should be spaced approximately 4 IC's apart. Common anode type displays could be used with a 7447 for IC8. Discrete digit drivers must be used. More than four digits could be displayed by the use of more 7401s and a suitable decimal decoded counter.

C. F. Shorto,
Weymouth,
Dorset.

KEYBOARD SCANNER

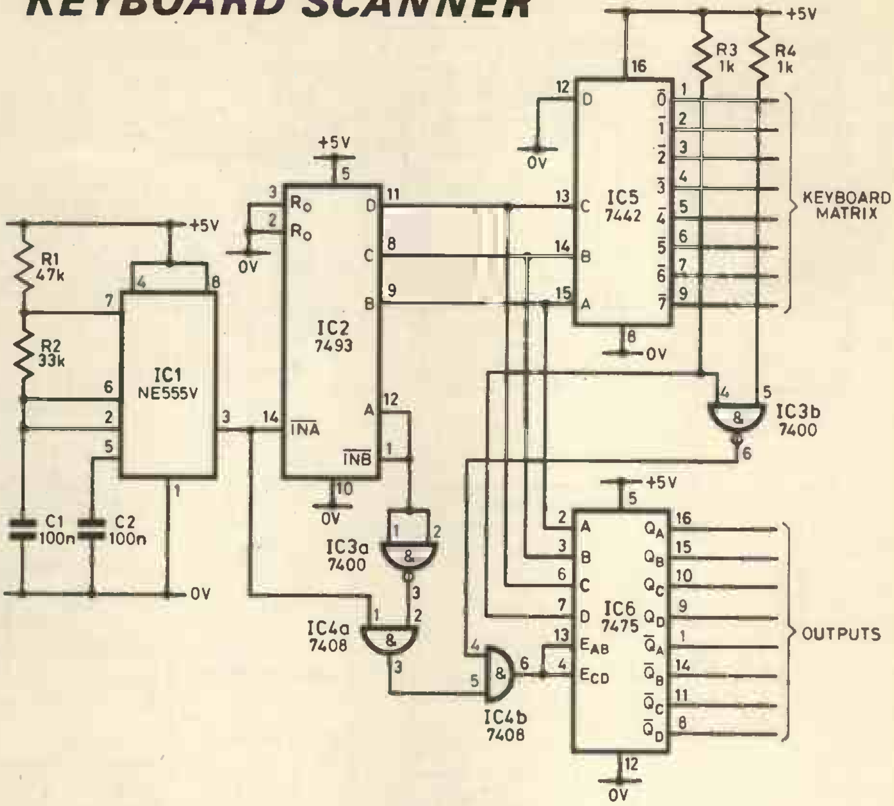
THIS circuit produces a 4 bit binary word for a key pressed on a keyboard.

IC1 is wired in its astable mode. Pulses produced at pin 3 are taken to IC2, a 4 bit binary counter. The three most significant digits are taken to IC5, a BCD to decimal decoder. The outputs of this are low on select. As IC2 counts, one row of the keyboard matrix is low, followed by the next in sequence, thus the scanning action is produced. If a key is pressed then that row becomes low when IC5's "scan" reaches it. One of IC3b's inputs also becomes low at this moment, the output going high. ICs 3a and 4a detect when the clock is high and the output "A" of IC2 is low. IC4b detects when IC3b and IC4a are high and enables the latch, IC6. The "D" input to IC6 is derived from a column which contains the lower eight keys of the keyboard. A correct four bit binary code will then be obtained

If a new key is pressed, its binary code will be accepted regardless of the code already present. Both true and complementary outputs are obtainable.

The whole circuit was constructed on stripboard, with ribbon wire interfacing the keyboard. Outputs were accessible via solder con pins for easy connection to a breadboard. Two 100n ceramic capacitors are also necessary for decoupling especially near IC1.

A. Piper
Newport Pagnell,
Bucks



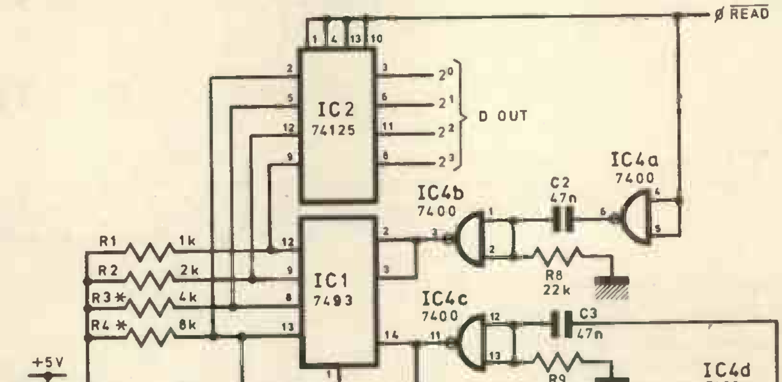
INEXPENSIVE A-TO-D CONVERTER

THE circuit shown converts the input voltage from VR2 into a four bit binary number suitable for many computer games (e.g. lunar landing). More bits can easily be added, however this method of conversion will not be sufficiently accurate for more than eight bits. Four i.c. packages are used.

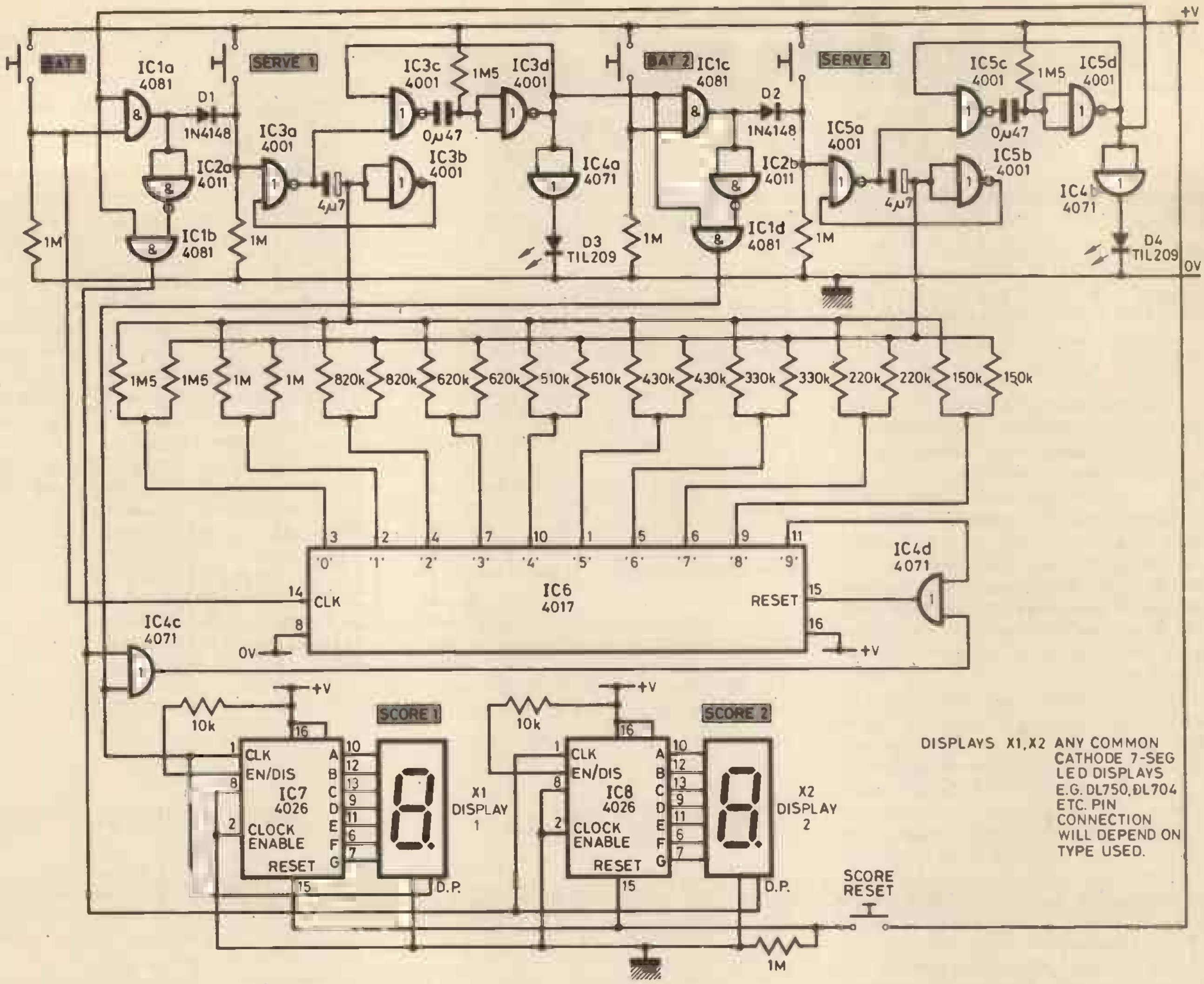
Initially counter IC1 is set at zero; however it is quickly clocked by the astable configuration IC4c and IC4d. As it counts, the four resistors R1 to R4 produce an increasing voltage proportional to the count. When this voltage is higher than the voltage at the wiper of VR2, IC3's output swings to +5V which saturates transistor TR1 and stops the clock. Now the count on IC1 points to the input voltage and it can be read via the buffer IC2. IC4a and IC4b detect the end of the reading and reset the counter so the cycle re-starts.

Although during the counting period the reading on IC1 is incorrect, this will never be noticed because it is pointless reading the converter more than twice a second, as the user will not have appreciably moved VR2. VR1 is set to give a full scale setting of VR2 of all ones (1111).

D. Greaves,
Romsey,
Hants.



EG 343



PORTABLE TENNIS

THE circuit diagram is shown up above and if the logic is followed through, the circuit operation should be fairly self explanatory.

To start a game the "Reset" button is pressed to clear any scores on the counters. A player then serves by pressing his "Serve" button. After a period of time the 'ball' reaches the other player. This is signified by his l.e.d. lighting up. While this is lit he must press his "Bat" button to return the ball. If he fails to press the button at the right time, this is a miss and registers a point on his opponent's score counter. If he hits it then, after a period of time, it reaches the first player lighting up his l.e.d., he tries to hit it and so on. Each miss is counted as a point on the other player's counter.

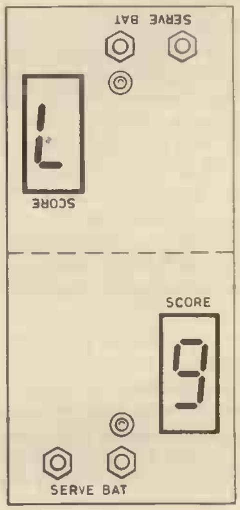
Some skill is required in playing this game since the time taken for the "ball" to cross the "court" does not remain constant. Rather the time taken decreases during play until either a player misses a ball or the counter has gone through the eight speeds. At this time it reverts to the slowest speed and gets faster again.

Serving triggers the monostable IC3a and b or IC5a and b. At the completion of its cycle it sends a pulse, which is generated by IC3c and d or IC5c and d, to the other player's circuitry. The period of monostables IC3a and b and IC5a and b is determined by the resistor selected by the counter IC6. Each second hit advances the counter until it is reset.

A suggested top-panel layout is shown right.

Incidentally, a sort of doubles game can be produced by inserting another push switch across each of the "Bat" switches. Thus if one player missed the "ball", the other would have a good chance of hitting it.

P. Bailey,
Rutherglen,
Glasgow.



Readout...

A selection from our Postbag

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

Velikovsky: Pure Myths

Sir—While leafing through my father's copy of *PE* (June 1980) I was rather surprised to find a serious letter supporting the ridiculous theories of Immanuel Velikovsky. In the letter, Mr. Austin "looks forward to reasoned argument" on the subject. For those readers interested in such, I should like to recommend the book *'The Stars in Their Courses'* by Dr. Isaac Asimov which contains, among other fascinating essays, a chapter entitled 'Worlds in confusion', from which I shall draw a few comments to the attention of your readers.

Velikovsky's book was claimed to be the work of a scientist (which Velikovsky is not) who had proved the Bible to be true. The basis of his theory is that Jupiter spewed out a huge comet, leaving behind the Red Spot, which careered about the solar system causing no end of interesting effects, before settling down to become Venus. The book is full of nonsense physics and ludicrous assumptions. For example, Velikovsky states that the laws of astronomy predict that a satellite will rotate slower than its planet and then points out that this is not so for the inner planet of Mars, thus demonstrating that all astronomic laws are wrong. It looks very nice but is nothing but transparent twaddle. There is nothing any astronomic law predicts about the speeds of rotation, which depend only on the primary and satellite distance and mass. In fact, the inner satellite of Mars has a rotational period of exactly that predicted by physics.

Velikovsky also makes heavy use of medieval Jewish legends and the writings of the ancients, taking metaphor and legend as fact, and constructs his own chronology to fit his "facts". His theory contains glaring errors of chemistry and physics that could be spotted by an A-level student (in one part he transforms hydrocarbons into carbohydrates in the space of a paragraph although the two classes of compound are completely different), and mis-interpretation of scientific observation. He uses scientific results when they agree with his theory and throws them away when they do not. He draws heavily on the spectroscopic analysis of comets tails without explaining why scientists who cannot handle the simple calculations of celestial mechanics should be trusted with such complex analysis!

When he needs a rain of fire to explain certain biblical tales he hits on the theory that the hydrocarbons in comets' tails will burst into flame when passing through the Earth's atmosphere. Is this plausible? No sir, not a chance. Gas does not come much thinner that that in comets' tails and it certainly would not burn in the atmosphere. You may say how do we know? Well, in 1910 we passed through the tail of Halley's comet and absolutely nothing happened! (as predicted by the scientists and completely opposite to the phrophets of doom).

I could go on, but do not think it necessary. In short, Velikovsky's work is nonsense and demonstrates nothing except the gullibility of the non-scientific public. It has more in common with crank mail (Dear Sir, I have recently disproved the theory of relativity, etc., etc.) than a serious work. Copernicus developed his Sun-centred theory only because he was a thorough student of the Earth centred theories; Einstein developed relativity while a thorough student of Newtonian mechanics. Point taken?

David G. W. Birch, B.Sc.,
Swindon.

The AY-3 Saga

Sir—Last year I wanted a GIM integrated TOG, the AY-3-0214, to make a copy of the Wersi master oscillator for my Maplin organ. Recent comment in your magazine reminds me of this.

GIM very promptly sent me their product guide, and the data sheet on their music i.c.s. In the back of the product guide are listed their distributors so I set out to contact them. (I had already tried about 10 of the retailers who advertise the AY-1-0212 and other GIM ICs in the various hobby magazines and they were all useless, so I suggest that Mr. Partridge's solution does not work!) *(Readout May 1980)*. Of the distributors, one was down-right rude, two just did not want to know. Crellon Electronics were helpful but said that they had to order a minimum of 25, and did not wish to be left with 24. They could only supply if I would have 25, at £13·50 each!—fair enough.

I then wrote to GIM again and thanked them for the information but suggested that it was a pity that their excellent i.c.s were not available, and told them why. Within a week or so I received a letter from them, stating that if I wrote to Semiconductor Specialists at West Drayton, they would now be able to supply me, which indeed they did for the sum of £13·80. Previously they had "not got it in stock." and "had never had it" and "didn't want to know about getting it".

So if your readers are trying without success to obtain GIM i.c.s then I suggest they write to: General Instruments MicroElectronics Ltd., Regency House, 1/4 Warwick Street, London W1R 5WB. They won't supply directly, but they do seem to be quite good at waking their distributors up!

Lastly, since buying that i.c. I have seen that it is on the "Doram" list at £10·10. Oh well, you can't win them all.

A. Jaques,
Urmston, Manchester.

CPUs: The Last Word

Sir—Re the letter by C. R. Harris in your June issue, I would like to point out that the article was originally credited to Roy Featherstone, now at Edinburgh researching into artificial intelligence, and secondly, that the ultimate CPU described has the advantage over its silicon rivals of being mass produced by unskilled labour!

Tim Sutherns,
President, S.U. Computer Club,
Southampton.

SALE SAVE-SAVE-SALE SA

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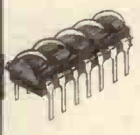

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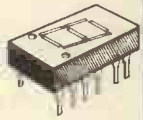

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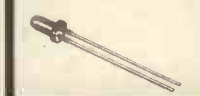

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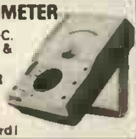

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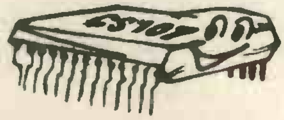

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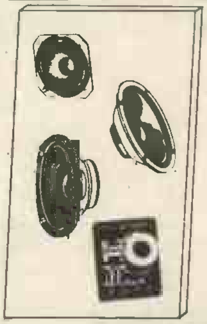

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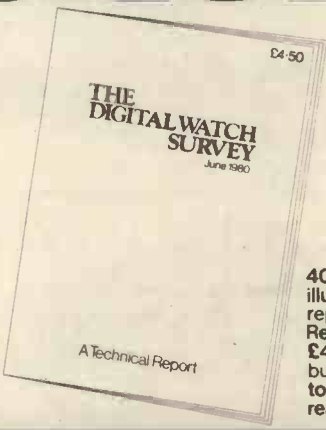

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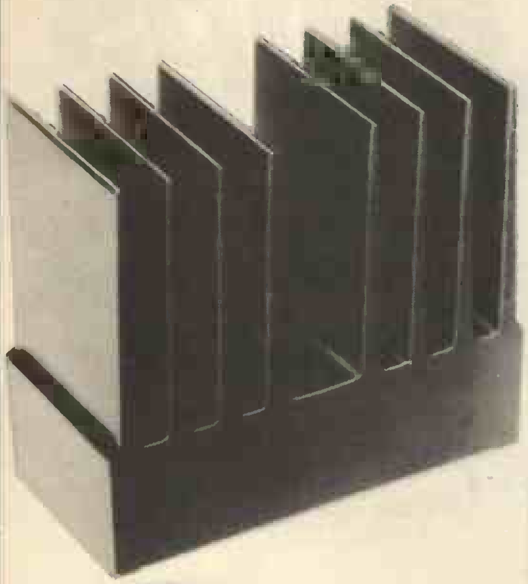

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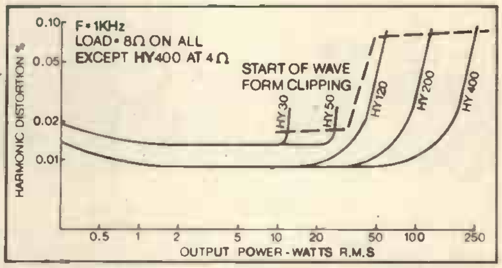

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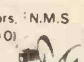

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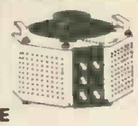

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Range available from stock S.A.E. for details

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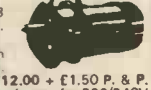

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24V. D.C. 200 rpm 10lbs/ins. continuously rated geared Motor mfg. by either Parvalux or Carter. Easily removable from heavy ali. chassis containing 9×24V. D.C. Solenoids, microswitches, friction clutch, precision gearing etc. etc. Ex-equipment London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

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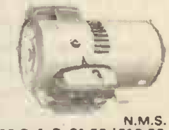
N.M.S.



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4.1 mfd. 440V. A.C	£1·00	(Block)		£1·50
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12FE09	9+9	0·7A EACH	2·66	75p
20FE09	9+9	1A EACH	3·36	75p
50FE09	9+9	2·5A EACH	4·02	90p
60FE09	9+9	3A EACH	5·03	125p
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08FE12	12+12	0·3A EACH	2·40	60p
20FE12	12+12	0·8A EACH	3·36	75p
50FE12	12+12	1·8A EACH	4·02	90p
60FE12	12+12	2·5A EACH	5·03	125p
80FE12	12+12	3A EACH	6·20	125p
06FE15	15+15	0·2A EACH	1·99	60p
08FE15	15+15	0·25A EACH	2·40	60p
12FE15	15+15	0·4A EACH	2·66	75p
20FE15	15+15	0·6A EACH	3·36	75p
50FE15	15+15	1·5A EACH	4·02	90p
60FE15	15+15	2A EACH	5·03	125p
80FE15	15+15	3A EACH	6·20	125p
06FE20	20+20	0·15A EACH	1·99	60p
12FE20	20+20	0·25A EACH	2·66	75p
20FE20	20+20	0·5A EACH	3·36	75p
50FE20	20+20	1·2A EACH	4·02	90p
60FE20	20+20	1·5A EACH	5·03	125p
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BATTERY CHARGER TRANSFORMERS				
48FE12	0-6-12	4A	5·00	125p
66FE12	0-6-12	5A	5·80	125p
70FE12	0-6-12	6A	6·15	150p
90FE12	0-6-12	8A	7·40	150p
06FE30	6-0-6	1·5A	1·95	60p
06FE40	9-0-9	0·5A	1·95	60p
06FE50	12-0-12	0·5A	1·95	60p

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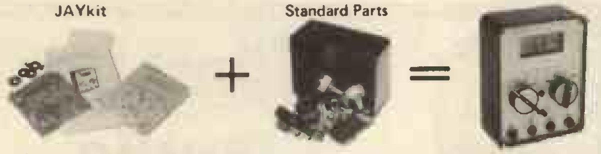

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- Designed around Intersil 7106 IC
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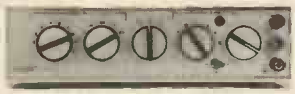

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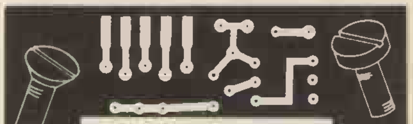

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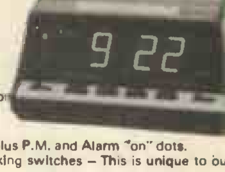

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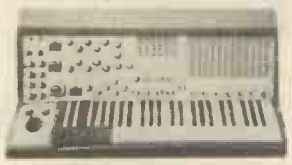

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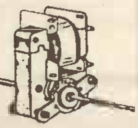

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4553	450p
4560	250p
4569	180p
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4584	90p
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40085	200p
40097	90p
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