Australia 95c New Zealand $1.10 South Africa 90c Malaysia $2.75

PRACTICAL ELECTRONICS

FEBRUARY 1980

55p

ACOUSTICALLY COUPLED TELEPHONE MODEM

PLUS... SPECIAL COMPUKIT/SUPERBOARD II CASE OFFER

4 CHANNEL DIGITAL MEMORY

Also... DYNAMIC NOISE LIMITER

PRACTICAL
ELECTRONICS

VOLUME 16 No. 2 FEBRUARY 1980

CONSTRUCTIONAL PROJECTS

GENERAL FEATURES

NEWS AND COMMENT

OUR MARCH ISSUE WILL BE ON SALE FRIDAY, 8 FEBRUARY 1980
(for details of contents see page 33)

WATFORD ELECTRONICS

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

ALL DEVICES BRAND NEW, FULL SPEC. AND FULLY GUARANTEED. ORDERS DESPATCHED BY RETURN OF POST. TERMS OF BUSINESS: CASH/CHEQUE/P.O.s OR BANKERS DRAFT WITH ORDER. GOVERNMENT AND EDUCATIONAL INSTITUTIONS OFFICIAL ORDERS ACCEPTED. TELEPHONE ORDERS BY ACCESS NOW ACCEPTED (Minimum order £10.00 please). TRADE AND EXPORT INQUIRY WELCOME. P & P ADD 30p 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**.
160V: 10nF, 12n, 39n, 100n, 150n, 220n **11p**; 330n, 470n **19p**; 680n, 1μF **22p**; 2·2μF 32p; 4·7μF **36p**.
1000V: 10n, 15n 20p; 22n 22p; 47n 26p; 100n 38p; 470n 53p; 1μF 175p.

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

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

ELECTROLYTIC CAPACITORS: Axial lead type (Values are in μF).
500V: 10 40p; 47 **68p**; **250V:** 100 **65p**; **63V:** 0·47, 1·0, 1·5, 2·2, 2·5, 3·3, 4·7, 6·8, 8, 10, 15, 22 **8p**; 32, 47, 50 **12p**; 63, 100, **27p**; **50V:** 50, 100, 220 **25p**; 470 **32p**; 1000 **50p**; **40V:** 22, 33μF **8p**; 100 **12p**; 2200, 3300 **85p**; 4700 **98p**; **35V:** 10, 33 **7p**; 330, 470 **32p**; 1000 **50p**; **25V:** 10, 22, 47 **6p**; 80, 100, 160 **8p**; 220, 250 **13p**; 470, 640 **25p**; 1000 **27p**; 1500 **30p**; 2200 **45p**; 3300 **62p**; 4700 **74p**; **16V:** 10, 40, 47, 68 **7p**; 100, 125 **8p**; 220, 330 **14p**; 470 **16p**; 1000, 1500 **20p**; 2200 **34p**; 640

TAG-END TYPE: 450V: 100μF **180p**; **70V:** 4700 **165p**; **64V:** 2500 **98p**; 3300 **130p**; **50V:** 2200 **99p**; 3300 **105p**; **40V:** 15,000 **399p**; 4700 **120p**; 4000 **92p**; 3300 **93p**; 2500 **85p**; 2200 **85p**; 2000 + 2000 **120p**; **30V:** 4700 **90p**; **25V:** 6400 **105p**; 4700 **85p**; 3300 **80p**; 2200 **60p**.

TANTALUM BEAD CAPACITORS
35V: 0·1μF, 0·22, 0·33, 0·47, 0·68, 1·0, 2·2μF, 3·3, 4·7, 6·8. **25V:** 1·5, 10, **20V:** 1·5μ . **16V:** 10μF **13p** each.
16V: 15μ, 22 **25p**; 47, 100, 220 **40p**.
10V: 15μ, 22, 33 **20p**; 100 **35p**; **6V:** 47μ, 68, 100 **30p**; **3V:** 100 **20p**.

POTENTIOMETERS (AB or EGEN)
Carbon Track, 0·25W Log & 0·5W Linear values.

500Ω, 1K & 2K (LIN ONLY) Single	27p
5KΩ-2MΩ single gang	27p
5KΩ-2MΩ single gang D/P switch	65p
5KΩ-2MΩ dual gang stereo	78p

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, 0·2 10p. 50V: 0·47μF	12p

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

5KΩ 500KΩ Single gang	70p
10KΩ 500KΩ Dual gang	80p
Self-Stick graduated Alum. Bezels	30p

CERAMIC CAPACITORS 50V

Range: 0·5pF to 10nF	4p
15nF, 22nF, 33nF, 47nF 5p 100nF	7p

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

POLYSTYRENE CAPACITORS:
10pF to 1nF. 6p. 1·5nF to 47nF 10p.

SILVER MICA (pF)
3·3, 4·7, 6·8, 8·2, 10, 12, 18, 22, 27, 33, 39, 47, 50, 68, 75, 82, 85, 100, 120, 150, 180, 200, 220 **9p.**
250, 270, 300, 330, 360, 390, 470, 600 & 820pF **16p** each.
1000, 2000pF **20p.**

TRIMMERS miniature

2·5pF; 3-10pF; 3-30pF; 3-50pF	22p
5-25pF; 65pF 88pF	30p

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

	p
AC107	25
AC125	20
AC126	20
AC127	20
AC128	20
AC141	24
AC142	24
AC187	24
AC176	24
ACY17	40
ACY18	40
ACY19	40
ACY20	40
ACY21	35
ACY22	40
ACY28	40
ACY39	78
AD149	70
AD161	42
AD162	42
AF114	50
AF115	50
AF116	50
AF117	70
AF118	70
AF139	35
AF178	70
BC107	10
BC107B	12
BC108	10
BC108B	12
BC108C	12
BC109	10
BC109B	12
BC109C	12
BC140	35
BC142	30
BC143	30
BC147	8
BC147B	10
BC148	8
BC148B	10
BC148C	10
BC149	8
BC149C	10
BC153	27
BC154	27
BC157	10
BC158	11
BC159	11
BC160	42
BC167A	11
BC168C	12
BC169C	14
BC170	8
BC171	11
BC172	11
BC173	12
BC177	18
BC178	16
BC179	18
BC181	20
BC182	9
BC183	9
BC184	9
BC182L	11
BC183L	10
BC184L	11
BC187	28
BC212	10
BC212L	11
BC213	10
BC213L	12
BC214	10
BC214L	13
BC307B	20
BC308B	20

	p
BC327	15
BC328	15
BC338	12
BC441	36
BC461	36
BC477	25
BC516	48
BC517	48
BC547	12
BC548	12
BC549C	13
BC557	15
BC558	20
BC559	20
BCY70	18
BCY71	20
BCY72	20
BD121	78
BD123	98
BD124	115
BD131	45
BD132	45
BD133	43
BD135	38
BD136	36
BD137	36
BD138	50
BD139	40
BD140	36
BD144	198
BD145	198
BD205	110
BD378	65
BD434	42
BD517	65
BD695A	65
BD696A	65
BDY56	156
BF115	34
BF167	30
BF177	24
BF178	25
BF179	30
BF180	35
BF194	12
BF195	12
BF196	12
BF197	14
BF198	18
BF199	18
BF200	32
BF244	29
BF244A	28
BF244B	30
BF256	50
BF257	30
BF258	30
BF259	30
BF274	18
BF336	35
BF594	40
BF595	38
BF910	95
BFR39	25
BFR40	25
BFR41	28
BFR79	28
BFR80	28
BFR81	28
BFR98	105
BFX29	28
BFX84	26
BFX85	28
BFX86	28
BFX87	28
BFX88	28
BFY50	20

	p
BFY51	20
BFY52	20
BFY56	45
BFY64	40
BFY71	20
BFY81	90
BSX20	18
BSX29	45
BSY95A	18
BSZ26	75
BU105	140
BU205	190
BU208	225
MD8001	158
MJ491	160
MJ2955	105
MJE340	54
MJE370	58
MJE371	60
MJE2955	105
MJE3055	70
MPF102	66
MPF103	36
MPF104	36
MPF105	36
MPF106	40
MPSA05	25
MPSA06	25
MPSA12	42
MPSA55	25
MPSA56	25
MPSU02	58
MPSU05	50
MPSU06	56
MPSU52	65
MPSU55	55
MPSU56	60
OC23	170
OC26	170
OC28	150
OC35	130
OC36	130
OC41	48
OC42	48
OC43	55
OC44	31
OC45	28
OC70	28
OC71	28
OC72	45
OC74	55
OC76	36
OC81	50
OC82	50
OC83	48
OC84	44
OC140	110
OC170	85
OC171	75
OC200	85
TIP29	43
TIP29A	44
TIP29B	56
TIP29C	60
TIP30	47
TIP30A	50
TIP30B	64
TIP30C	65
TIP31A	52
TIP31C	65
TIP32A	58
TIP32C	75
TIP33A	85
TIP33C	105
TIP34A	85
TIP34C	110
TIP35A	185

	p
TIP35C	220
TIP36A	220
TIP36C	255
TIP41A	66
TIP41B	73
TIP42A	64
TIP42B	82
TIP120	70
TIP121	90
TIP141	190
TIP142	195
TIP147	195
TIP2955	65
TIP3055	65
TIS43	34
TIS44	45
TIS45	45
TIS88A	00
TIS90	20
TIS91	24
ZTX107	12
ZTX108	14
ZTX109	14
ZTX212	28
ZTX300	13
ZTX301	15
ZTX302	20
ZTX303	25
ZTX304	24
ZTX314	24
ZTX320	30
ZTX326	40
ZTX341	20
ZTX500	15
ZTX501	15
ZTX502	19
ZTX503	15
ZTX504	25
ZTX531	25
ZTX550	25
40250	85
40251	97
40311	60
40313	125
40315	55
40316	85
40317	52
40319	71
40320	56
40362	48
40406	65
40407	52
40408	70
40411	295
40412	65
40467	95
40594	90
40595	98
40603	65
40594	90
40595	98
40603	65
40636	125
40673	68
2N697	25
2N698	44
2N699	54
2N706A	18
2N708	19
2N914	32
2N916	27
2N918	40
2N1131	22
2N1132	22
2N1303	50
2N1304	50
2N1305	28

	p
2N1307	50
2N1308	46
2N1670	150
2N1671B	215
2N2219A	22
2N2220A	26
2N2221A	23
2N2222A	20
2N2369A	15
2N2646	48
2N2784	55
2N2904	22
2N2905A	22
2N2906	22
2N2907A	22
2N2926G	10
2N3053	20
2N3054	55
2N3055	48
2N3442	146
2N3504	55
2N3663	26
2N3702	11
2N3703	11
2N3704	11
2N3705	11
2N3706	11
2N3707	11
2N3708	11
2N3709	11
2N3710	16
2N3711	12
2N3822	130
2N3771	233
2N3772	195
2N3773	288
2N3819	22
2N3820	45
2N3823	95
2N3866	90
2N3903	20
2N3904	18
2N3905	18
2N3906	17
2N4037	52
2N4058	17
2N4061	17
2N4062	17
2N4069	45
2N4427	75
2N4829	65
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
3N128	112
3N140	112

Matched Pair **25p** extra

ANTEX Soldering Irons

C15W	395
CX17W	395
CCN15W	410
X25W	395
Spare bits	46
Iron stand	150

DIL SOCKETS (TEXAS)

	Low pofile	Wire wrap
8 pin	10p	25p
14 pin	12p	35p
16 pin	13p	46p
18 pin	16p	52p
20 pin	22p	65p
22 pin	25p	70p
24 pin	36p	78p
28 pin	39p	85p
36 pin		105p
40 pin	50p	109p

SPECIAL OFFER

741	17
555	20
2114	435
2708	675
TMS2716	1750

LINEAR IC's

702	75
709C 8 pin	35
709 14 pin	38
710	67
723 14 pin	39
741 8 pin	17
747C 14 pin	78
748C 8 pin	36
753 8 pin	150
810	159
AY-1-0212	580
AY-1-1313A	660
AY-1-1320	315
AY-1-5050	190
AY-1-5051	145
AY-1-6721/6	195
AY-3-1015	560
AY-3-1270	840
AY-3-8500	390
AY-5-1013	450
AY-5-1224A	260
AY-5-1230	450
AY-5-1315	560
AY-5-1317A	630
AY-5-3500	510
AY-5-3507A	415
AY-5-4007D	638
AY-5-8100	735
CA3011	100
CA3014	137
CA3018	68
CA3020	170
CA3023	170
CA3028A	80
CA3035	240
CA3036	110
CA3043	190
CA3045	140
CA3046	210
CA3048	350
CA3075	175
CA3080E	70
CA3081	190
CA3089E	210
CA3090AQ	398
CA3123	200
CA3130	90
CA3140	70
ICL7106	795
ICL7107	975
ICL8038CC	340
ICM7205	1150
ICM7215	1050
ICM7216A	1950
ICM7216B	1950
ICM7216C	1950
ICM7217A	790

ICM7555	89
LD130	452
LF356	90
LM10	350
LM301A	30
LM308T	110
LM311H	120
LM318H	205
LM324A	68
LM339	70
LM348	90
LM349	125
LM379	375
LM380	80
LM381N	145
LM381AN	248
LM382	125
LM386	99
LM387	150
LM389	93
LM733	125
LM1458	50
LM3900	60
LM3909N	70
LM3911	125
LM3914	258
LM13600	125
M252AA	750
M253AA	795
MC1204	250
MC1301	79
MC1303	88
MC1304P	260
MC1310P	150
MC1312PQ	195
MC1495	350
MC1496L	92
MC1596	225
MC1710	79
MC3302	150
MC3340P	120
MC3360P	120
MC3401	52
MC3403	135
MFC6040	97
MK50398	635
MM5303	635
MM5307	1275
MM57160	620
MSM5526	320
NE518	210
NE543K	210
NE544	185
NE555	20
NE556DB	60
NE560	325
NE561	395
NE562B	410
NE564	425

NE565A	120
NE566	160
NE567V	170
NE570	375
NE571	420
RC4136D	120
SAD1024	1350
SG3402	295
SN76003N	170
SN76013N	140
SN76013ND	130
SN76018	148
SN76023N	140
SN76023ND	130
SN76033N	175
SN76115N	215
SN76131	110
SN76227N	115
SN76477	225
SN76660	90
SP8629	450
TAA621AX1	250
TAA661A	155
TAA960	320
TAD100	159
TBA120S	70
TBA540	220
TBA550Q	330
TBA990Q	270
TBA641-A12/BX1 or BX11	250
TBA651	180
TBA800	90
TBA810S	95
TBA820	70
TBA920Q	260
TCA965	120
TDA1004	290
TDA1008	310
TDA1022	575
TDA1024	105
TDA2020	320
TL061C	76
TL062CP	125
TL071	76
TL064CN	199
TL072CP	125
TL074CN	199
TL081CP	52
TL082CP	96
TL083CP	105
TL084CP	130
UAA170	198
UAA180	198
ZN414	90
ZN424E	130
ZN425E	415
ZN1034	200
ZN1040E	685

COMPUTER IC'S

2102-2	225
2111	195
2112-2N	250
2114	439
2708	675
27L08	995
4116 16K	1025
4047	750
6502	995
74S00	60
74S04	73
74S132	350
74S138	250
74S158	524
74S188	210
74S189	168
74S194	750
74S195	795
74S241	195
74S262	895
74S287	325
74S470	325
74S472	1150
74S475	825
81LS95	125
81LS96	125
81LS97	137
AY-5-2376	980
CP1610	920
MC1488	85
MC1489	90
MC14411	958
MC14412	1080
MK4027 4K	325
MK4027-2	470
MK4027-3	445
MK4027-4	350
MK4116-4	1025
MK4118-4	2099
RO-3-2513	650
74S288	210
TMS 4027	325
TMS2716	1950
TMS 4035	250
TMS 4039	250
TMS 4045	1083
Z80 CPU2·5	990
Z80 4M	1099
Z80 P10	660
Z80 CTC	595

SFS80102	205
SN74265	63
SN74LS163	118
SN74S262	895
SN75450	120
SN75451	70
SN75452	70
SN75454	225
TMS6011	355

VDU IC'S

AY-3-1015	550
AY-5-1013	399
SFF96364E	1050
SFC71301	820

TTL 74 (TEXAS)

7400	11
7401	11
7402	11
7403	12
7404	12
7405	18
7406	28
7407	38
7408	17
7409	17
7410	11
7411	20
7412	17
7413	30
7414	45
7416	30
7417	30
7420	16
7421	29
7422	17
7423	27
7425	27
7426	36
7427	27
7428	35
7430	17
7432	25
7433	40
7437	30
7438	33
7440	15
7441	74
7442	68
7443	115
7444	112
7445	94
7446	94
7447	57
7448	56
7450	17
7451	17
7453	17
7454	17
7460	17
7470	28
7472	25

7473	32
7474	25
7475	38
7476	36
7480	48
7481	86
7482	69
7483	72
7484	95
7485	75
7486	31
7489	140
7490	30
7491	75
7492	38
7493	32
7494	78
7495	65
7496	57
7497	189
74100	119
74104	62
74105	62
74107	29
74109	54
74110	54
74111	68
74112	125
74116	198
74118	83
74119	149
74120	115
74121	25
74122	46
74123	48
74125	38
74126	57
74128	74
74132	73
74136	65
74141	56
74142	209
74143	314
74144	314
74145	65
74147	175
74148	109
74150	99
74151	64
74153	64
74154	96
74155	53
74156	80
74157	65
74159	185
74160	82
74161	92
74162	92
74163	92

74164	105
74165	105
74166	140
74167	200
74170	185
74172	625
74173	120
74174	87
74175	87
74176	75
74177	78
74178	153
74180	85
74181	165
74182	88
74184	135
74185	135
74188	275
74190	95
74191	95
74192	98
74193	98
74194	98
74195	98
74196	93
74197	80
74198	150
74199	150
74221	132
74246	204
74247	204
74248	240
74249	204
74251	125
74265	63
74273	320
74278	220
74279	119
74298	185
75108	350
75150	175
75491	92
75492	92

74L

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

74LS

LS00	11
LS01	11
LS02	12
LS03	12
LS04	12
LS05	23
LS08	22
LS09	22
LS10	20
LS11	22
LS12	23
LS13	38
LS14	75
LS15	30
LS20	20
LS21	22
LS22	22
LS26	48
LS27	28
LS28	48
LS30	22
LS32	27
LS33	39
LS37	39
LS38	39
LS40	28
LS42	98
LS47	63
LS48	120
LS49	120
LS51	24
LS54	28
LS55	30
LS63	150
LS73	46
LS74	41
LS75	48
LS76	40
LS78	40
LS83	115
LS85	118
LS86	43
LS90	38
LS91	104
LS92	89
LS93	89
LS95	116
LS96	116
LS107	44
LS109	55
LS112	55
LS113	50
LS114	50
LS122	70
LS123	70
LS124	180
LS125	60
LS126	60

LS132	95
LS136	55
LS138	85
LS139	85
LS145	108
LS147	170
LS148	173
LS151	96
LS153	76
LS155	96
LS156	96
LS157	76
LS158	96
LS160	128
LS161	98
LS162	138
LS163	102
LS164	114
LS165	75
LS166	226
LS168	155
LS169	150
LS170	288
LS173	105
LS174	106
LS175	110
LS181	398
LS183	298
LS189	348
LS190	140
LS191	140
LS192	132
LS193	130
LS194	166
LS195	136
LS196	100
LS197	140
LS202	345
LS221	96
LS240	236
LS241	231
LS242	232
LS243	232
LS244	155
LS245	270
LS247	190
LS248	190
LS249	190
LS251	134
LS253	142
LS257	110
LS258	110
LS259	160
LS261	450
LS266	52
LS273	244
LS275	250
LS279	66
LS280	250

LS290	128
LS293	128
LS295	185
LS298	68
LS299	468
LS300	175
LS302	175
LS323	468
LS324	240
LS325	290
LS326	294
LS327	286
LS327	286
LS346	185
LS347	206
LS348	186
LS352	228
LS353	228
LS365	65
LS366	65
LS367	65
LS368	66
LS373	180
LS375	160
LS374	165
LS377	212
LS378	184
LS379	215
LS384	86
LS385	155
LS386	86
LS390	230
LS393	230
LS395	218
LS396	215
LS398	276
LS399	230
LS445	150
LS447	144
LS490	180
LS668	182
LS669	182
LS670	248
LS673	1050
LS674	1450
LS677	1050

CMOS

4000	14
4001	14
4002	15
4006	87
4007	18
4008	82
4009	38
4010	38
4011	20
4012	18
4013	42

4014	80
4015	82
4016	45
4017	82
4018	87
4019	48
4020	99
4021	95
4022	85
4023	22
4024	66
4025	19
4026	180
4027	45
4028	81
4029	99
4030	58
4031	205
4032	100
4033	145
4034	116
4035	111
4036	335
4037	100
4038	108
4039	320
4040	105
4041	80
4042	76
4043	94
4044	95
4045	145
4046	128
4047	87
4048	58
4049	48
4050	48
4051	72
4052	73
4053	72
4054	110
4055	128
4056	135
4057	1950
4059	480
4060	115
4061	1425
4062	995
4063	110
4066	58
4067	380
4068	22
4069	20
4070	32
4071	21
4072	21
4073	21
4075	23
4076	85
4077	40
4078	21

CMOS (CONT.)

4081	20
4082	21
4085	74
4086	73
4089	150
4093	78
4094	190
4095	105
4096	105
4097	372
4098	110
4099	145
4160	109
4161	109
4162	109
4163	109
4174	110
4175	99
4194	108
4408	720
4409	720
4410	720
4411	958
4412V	1380
4415F	795
4415V	795
4419	280
4422	545
4433	995
4435	825

4440	1275
4450	295
4451	295
4452	
4490F	695
4490V	525
4501	19
4502	120
4503	69
4535	75
4506	51
4507	55
4508	298
4510	99
4511	150
4512	98
4513	206
4514	265
4515	299
4516	120
4517	382
4518	102
4519	55
4520	108
4521	228
4522	149
4526	149
4527	152
4528	99
4529	145
4530	85
4531	135
4532	115
4534	575
4536	365
4538	142
4539	105
4541	135
4543	155
4549	375
4550	398
4554	150
4556	72
4557	451
4558	105
4559	375
4560	210
4561	65
4562	533
4566	155
4568	268
4569	280
4572	26
4580	594
4581	297
4582	130
4583	75
4584	63
4585	105

WATFORD ELECTRONICS

(Continued from opposite side)

DIODES	
AA119	15
AA129	25
AAY30	25
AAZ15	15
BA100	10
BY100	24
BY126	12
BY127	12
CRO33	157
OA9	75
OA47	12
OA70	12
OA79	12
OA81	15
OA85	12
OA90	6
OA91	6
OA95	8
OA200	9
OA202	8
IN914	4
IN916	5
IN400/2	5
IN4003	6
IN4004/5	6
IN4006/7	7
IN4148	4
IS44	20
3A/100V	18
3A/400V	20
3A/600V	27
3A/1000V	30

SCR's Thyristors	
0·6A/200V	30
0·8A30V	28
0·8A100V	30
0·8A200V	35
1A600V	70
5A300V	35
5A600V	43
8A300V	48
8A600V	85
12A300V	59
12A500V	92
12A800V	150
15A700V	195
8T106	150
BT116	150
C106D	38
TIC44	22
TIC45	28
2N4444	140

BRIDGE RECTIFIERS (plastic case)	
1A/50V	20
1A/100V	22
1A/200V	25
1A/400V	29
1A/600V	34
2A/50V	35
2A/100V	44
2A/200V	46
2A/400V	53
2A/600V	65
4A/100V	72
4A/200V	75
4A/400V	79
4A/600V	105
4A/800V	120
6A/100V	73
6A/200V	78
6A/400V	85
BY164	56
VM18 DIL	50

ZENERS
Rng: 2V7-39V 400m W 8p
Rng: 3V3-33V 1 3W 15p

VARICAPS	
MVAM115	140
BA102	25
BB104	40
BB105B	40
BB106	40

Noise Diode
Z5J 160

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

DIAC
ST2 20

SPEAKERS	
8Ω 0·3W 2"; 2½"	74
2·5; 3"	74
40Ω 2·5"	88
64 Ω 2·5"	74
8Ω 5W 7"x4"	250
8Ω 3W 6"x4"	160

ALUM.BOXES	
3x2x1"	55
2¾x5x1½"	75
4x4x1½	75
4x2¾x1½"	75
4x5¼x1½	100
4x2½x2"	75
5x4x2"	98
6x4x2"	110
7x5x2½"	185
8x6x3"	185
10x7x3"	210
10x4½x3"	198
12x5x3"	215
12x8x3"	265

VEROBOARD

	Pitch 0·1 (copper clad)	0·15	0·1 (plain)	0·15
2½x3¾"	46p	39p	31p	24p
2½x5"	55p	50p	—	31p
3¾x3¾"	55p	50p	—	—
3¾x5"	62p	67p	50p	43p
3¾x17"	218p	180p	141p	120
4¾x17"	280p	—	—	183p

Pkt of 36 pins 20p . VQ board 90p
Spot face cutter 85p DIP board 268p
Pin insertion tool 120p 'S' board 1270p

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

FERRIC CHLORIDE
1 lb bag Anhydrous
95p + 35p P&P
DALO ETCH RESIST
Pen + Spare tip 95p

EURO BREADBOARD £5.30

BIMBOARDS £8.58

COPPER CLAD BOARDS

Fibre Glass	Single-sided	Double-sided	SRBP 9·5"x8·5"
6"x6"	75p	90p	80p
6"x12"	130p	175p	

SOLDERCON PINS
100 pins 50p: 500 pins 200p

OPTO ELECTRONICS

LEDS Plus. Clip	
TIL209 Red 125"	13
TIL211 Grn 125"	18
TIL212 Yellow	22
TIL32 Infra Red	58
TIL2200·2" Red	15
0·2" Yellow, green and Amber	18
Rectangular LEDS. Red, Green and Yellow	36
OCP71	120
ORP12	63
2N5777	45

OPTO Isolators	
IL74	48
TIL111/2	85
TIL117	110

7 Segment Displays	
LS400	255
TIL307	675
TIL312 & 313·3"	105
TIL321 ·5" C.An	115
TIL322 ·5" C.th	115
DL704 ·3" C.Cth	99
DL707 ·3" C.Anod	99
DL747 ·6" An	180
FND357	120
MAN3640	165
XAN351 ·3" Green	180

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	65p		7905	75p
12V	7812	65p		7912	75p
15V	7815	65p		7915	75p
18V	7818	65p		7918	75p
24V	7824	65p			
100mA	TO92	Plastic Casing			
5V	78L05	30p		79L05	65p
6V	78L62	30p			—
8V	78L82	30p			—
12V	78L12	30p		79L12	65p
15V	78L15	30p		79L15	65p

CA3085	95	LM323K	625
LM300H	170	LM325N	240
LM305H	140	LM326N	240
LM309K	135	LM327N	270
LM317K	350	LM723	39

78H05 + 5V/5A 595p;
78H6 + 5 to + 24V 650p

SWITCHES

SLIDE 250V	
1A DPDT	14
1A DPDT C/OFF	15
½A DPDT	13
4 pole 2-way	24

PUSH BUTTON
Spring loaded

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

TOGGLE 2A 250V	
SPST	28
DPST	34
DPDT	38
4 pole on off	54

SUB-MIN TOGGLE	
SP changeover	59
SPST on off	54
SPST biased	85
DPDT 6 tags	70
DPDT C/OFF	79
DPDT Biased	115
3 pole c/over	150

MINIATURE
Non Locking
Push to make 215 Push Break 25

ROCKER: 5A, 250V, SPST 23

ROCKER: (white) 5A 250V SP change-over centre off 40

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

ROTARY: "Make-A-Switch" Make your own multiway Switch. Adjustable Stop Shafting Assembly, Accommodates up to 6 Wafers 75

Mains Switch DPST to fit 34

Break Before Make Wafers, 1 pole/12 way, 2p/6 way, 3p/4 way, 4p/3 way, 6p/2 way 47

Spacer and Screen 5

ROTARY: (Adjustable Stop)
1 pole/2 to 12 way, 2p/2 to 6 way, 3 pole/2 to 4 way, 4 pole/2 to 3 way 41

ROTARY: Mains 250V AC, 4 Amp 45

OHIO SUPERBOARD II Only £188.00 ex stock

Yes, we are now selling this single board microcomputer at only £188.00. Due to the recent devaluation of US Dollar against £ Sterling, we have been able to purchase Superboards at lower price. Naturally, we wish to pass this price advantage on to our customers. Buy now to avoid disappointment should Mrs. Thatcher & Co. decide to devalue the pound.
Superboard II is supplied fully assembled and tested to British T.V. spec. Requires +5V at 3A and a Video Monitor or TV with RF Converter to be up and running. (Data sheet supplied. We can also supply the RF Converter and Power Supply in kit form or ready-built).
8k Microsoft BASIC IN ROM. 4k Static RAM on BOARD expandable to 8k. Full 53 Key Keyboard with Upper/Lower Case & user programmability and a lot more. See it for yourself.
Continuous demonstration on at our retail shop.
Specially designed case for Superboard available at **£25.00.**

CRYSTALS

		6·5536MHz	200p
100kHz	385p	7·680MHz	323p
455kHz	385p	9·375MHz	323p
1MHz	323p	10MHz	323p
1·008MHz	323p	10·7MHz	323p
1·80MHz	385p	12MHz	392p
1·832MHz	362p	14·318118M	300p
1·6MHz	395p	18MHz	323p
3·2768MHz	323p	18·432M	33p
4MHz	290p	20MHz	362p
4·032MHz	323p	27·648MHz	350p
4·433619M	135p	48MHz	323p
5·0MHz	355p	100MHz	300p

Rhythm Generator, Diamatic Modern, etc. Send SAE for list.

Power Supply Kit (5V/3A)
incl. RF Modulator £21.50
Readybuilt and tested £28.50
Extra 4k of RAM £35.00
UHF Modulator 250p
Wide Bandwidth Modulator Special for Computers 470p
Power Supplies, Readybuilt:
±6V – 0.5A £14.95
±12V – 0.25A £14.95
±15V – 0.2A £14.95
KEYPADS, 4 x 4 matrix, Reed switch assembly 350p
Full ASCII Keyboard Model 756 £45.50
10" MONITOR, suitable for alphanumerics or analogue signals. 220V mains or 12V DC. Compatible to most Computer System. Value for money £85.00

'D' CONNECTORS
(Cannon type)
(Special introductory prices)
Plug Sockets Covers (Plastic)

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

DIL switches (SPST) 4 way, 6 way, 8 way

EDGE CONNECTORS double type

	1	·15
2x10 way	—	85p
2x15 way	—	99p
2x18 way	115p	120p
2x22 way	130p	135p
2x25 way	149p	160p
2x30 way	170p	120p
2x36 way	194p	—
2x40 way	210p	160p
2x43 way	232p	180p

TRANSFORMERS (mains Prim. 220-240V)
6-0-6V 100mA; 9-0-9V 75mA; 12-0-12V 75mA 95p.
8VA type: 6V-·5A 6V-·5A; 9V-·4A 9V-·4A; 12V-·3A 12V-·3A; 15V-·25A 15V-·25A 195p.
12VA: 4·5-1·3A 4·5V-1·3A; 6V-1·2A 6V-1·2A 12V-·5A 12V-·5A 220p (20p p&p)
24VA: 6V-1·5A 6V-1·5A; 9V-1·2A 9V-1·2A; 12V-1A 12V-1A; 15-·8A 15-·8A; 20V-·6A 20V-·6A 290p (45p p&p)
50VA: 6V-4A 6V-4A; 9V-2·5A 9V-2·5A; 12V-2A 12V-2A; 15V-1·5A 15V-1·5A; 20V-1·2A 20V-1·2A; 25V-1A 25V-1A; 30V-·8A 30V-·8A 350p (50p p&p)
100VA: 12V-4A 12V-4A; 15V-3A 15V-3A; 20V-2·5A 20V-2·5A; 30V-1·5A 30V-1·5A; 40V-1·25A 40V-1·25A; 50V-1A 50V-1A 650p (60p p&p)
(N.B. P&P charge to be added above our normal postal charge.)

FASTER THAN A SCOPE— SAFER THAN A VOLTMETER

LOGIC MONITOR
LM-1

ONLY £28·70

plus 15% VAT, plus post and packing
Total £34.44 including box and instruction manual.

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Telephone: SAFFRON WALDEN 21682.
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Instant – simultaneous monitoring of the logic state of all IC nodes

Just clip it over your IC.
LM-1 Instantly and accurately shows both static and dynamic logic states on a bright 16 LED display.
LM-1 finds its own power.
LM-1 cuts out guesswork, saves time, and eliminates the risk of short circuits.
LM-1 is suitable for all dual-in-line logic ICs.
LED on = logic state 1 (high), LED off = logic state 0 (low), and each LED is clearly numbered 1 to 16 in the conventional IC pattern.

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The Perfect Lead...

Acorn Microcomputer System 1

Price £65 plus VAT in kit form

This compact stand-alone microcomputer is based on standard Eurocard modules, and employs the highly popular 6502 MPU (as used in APPLE, PET, KIM, etc). Throughout, the design philosophy has been to provide full expandability, versatility and economy.

Specification

The Acorn consists of two single Eurocards.

1. MPU card
6502 microprocessor
512 x 8 ACORN monitor
1 K x 8 RAM
16-way I/O with 128 bytes of RAM
1 MHz crystal
5 V regulator, sockets for 2K EPROM and second RAM I/O chip.

2. Keyboard card
25 click-keys (16 hex, 9 control)
8 digit, 7 segment display
CUTS standard crystal controlled tape interface circuitry.

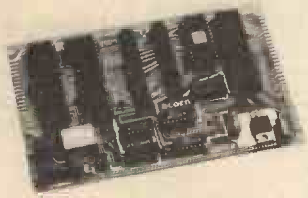
Keyboard instructions:
Memory Inspect/Change (remembers last address used)
Stepping up through memory
Stepping down through memory
Set or clear break point
Restore from break
Load from tape
Store on tape
Go (recalls last address used)
Reset

Monitor features
System program
Set of sub-routines for use in programming
Powerful de-bugging facility displays all internal registers
Tape load and store routines

Applications

As a self teaching tool for beginners to computing.
As a low cost 6502 development system for industry.
As a basis for a powerful microcomputer in its expanded form.
As a control system for electronics engineers.
As a data acquisition system for laboratories.

START WITH SYSTEM 1 AND CONTINUE AS AND WHEN YOU LIKE

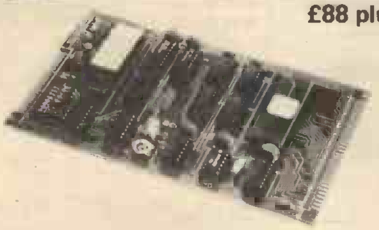


Acorn Controller
£35 plus VAT (min config.)

the CPU card of System 1, it allows for up to 4½ k EPROM, 1¼ k RAM and 32 I/O lines. It has on board 5 V regulator and optional crystal control. Custom programs may be developed on System 1 and the card makes an ideal dedicated hardware module.

Acorn Memory 8 k
£95 plus VAT (kit form)

A fully buffered memory card allowing up to 8 k RAM plus 8 k EPROM on one eurocard, in an Acorn system both BASIC and DOS may be contained in this module. Static RAM (2114) is used and the card may be wired into other systems.



Acorn VDU
£88 plus VAT (kit form)

A memory mapped seven colour VDU interface with adjustable screen format. Full upper and lower ascii and teletext graphics are features of this module which along with programmable cursor, light pen, hardware scroll etc., make this the most advanced interface in its class.

Acorn Software in ROM

Acorn BASIC — a very fast integer BASIC in 4 k
Acorn COS — a sophisticated cassette operating system with load and save and keyboard and VDU routines in 2 k
Acorn DOS — a comprehensive disc operating system in 4 k

Acorn Computers Ltd.
4A Market Hill, Cambridge, Cambs.
Cambridge (0223) 312772.

Order Form

P.E.2

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☐ (qty) Acorn Memory kit @ £95 plus £14.25 VAT.
☐ (qty) Acorn VDU kit @ £88 plus £13.20 VAT.
☐ (qty) Acorn Power Supply (for System 1 only) @ £5.95 plus £0.89 VAT.
☐ (qty) Acorn Microcomputer assembled and tested @ £79 plus £11.85 VAT.
☐ (qty) Acorn VDU assembled and tested @ £98 plus £14.70 VAT.

Post and packing free on all orders.

I enclose a cheque for £ . . . . .
(indicate total amount) made out to Acorn Computers Ltd.
Please send me further details of this and other Acorn options

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Address ______________________

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ACORN COMPUTER

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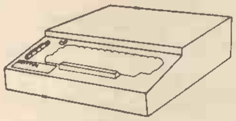

NEW FIRMWARE OPTIONS

L4·1		The level 4·1 Triton consists of Triton main PCB with 3K resident firmware. 1K monitor and 2K tiny basic. Complete Kit.	£286
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L8·1	NEW	Triton with resident PASCAL in EPROM. New TCL PASCAL compiler in 20K on board. Includes 4K monitor/editor. A total of 24K of firmware	£611
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★ TCL* PASCAL COMPILER

★ CP/M* DISK INTERFACE

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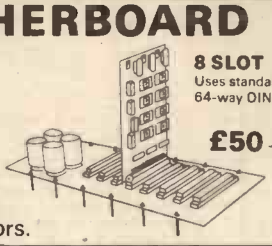
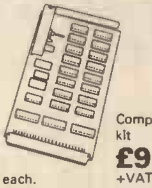


8 SLOT Uses standard 64-way DIN CON.

£50 +VAT

8K RAM CARD



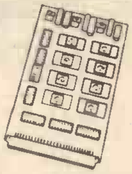
Triton 8k static Ram card. Kit uses 2114 Low power 4k. Static Rams. On board regulation, memory jump select.

Compl. kit **£97** +VAT

PCB only £15 Rams £5.50 each.

Kit less Rams £35 incl. all sockets & components.

8K EPROM CARD



Triton 8k Eprom card kit. Designed to take up to 8x2708 Eprom (1kx8)

PCB only £15

Kit less Eproms £31

Eproms (blank) £9

Plus VAT

Complete kit **£97** +VAT

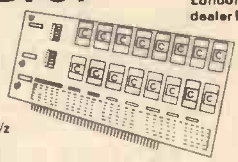
S100 boards

8k Static RAM board (450ns)	£123.75
8k Static RAM board (250ns)	£146.25
Z80 cpu board (2MHz)	£131.25
Z80 cpu board (4MHz)	£153.75
2708/27 16 EPROM board	£63.75
Prototype board (bare board)	£18.75
Video display board (64 x 16, 128U/L Ascii)	£108.75
Disk controller board	£131.25
K2 disk operating system	£56.25
Assemble/z Macro Assm	£37.50

ITHACA DPS1

your London dealer!

Pascal/z



Build your own Pascal Micro Development system. IEEE-S100 bus system using DPSI mainframe. Supports K2, assemble/z and pascal/z on 8" disk.

We stock the full range of ITHACA products.

PCB CONNECTORS

Edge connectors, gold contact double sided PCB connectors

·1"	Price	·156"	Price
		6/12	£1.25
22/44	£3.20	12/14	£1.50
25/50	£3.60	10/20	£2.00
28/56	£3.90	15/30	£2.20
30/60	£4.15	18/36	£2.36
35/70	£4.60	22/44	£2.65
36/72	£4.75	28/56	£3.30
40/80	£5.00	36/72	£3.90
43/86	£5.50	43/82	£4.60
50/100	£5.80 (S100 BUS) Plus VAT		

TRAP!

Triton resident assembly language package

Links via the L6·1 monitor and new scientific basic to make Triton a stand alone development system. Trap is an 8k package in EPROM and resides on our EPROM card. Set of 8x2708 only £80 including document.

- EDITOR
- ASSEMBLER
- DISASSEMBLER
- SYMBOL TABLE CREATE
- BREAKPOINT
- SINGLE STEP
- TRACE
- PROGRAMME LOAD
- MONITOR
- DEVELOPMENT SYSTEM

COMPONENTS 74LSXX

SN74LS00N	.18	SN74LS40N	.26	SN74LS113N	.44	SN74LS165N	1.70	SN74LS248N	1.96
SN74LS01N	.18	SN74LS42N	.78	SN74LS114N	.44	SN74LS166N	1.75	SN74LS249N	1.30
SN74LS02N	.20	SN74LS47N	.95	SN74LS122N	.78	SN74LS168N	1.95	SN74LS251N	1.46
SN74LS03N	.18	SN74LS48N	.96	SN741S123N	.99	SN74LS169N	1.85	SN74LS253N	1.25
SN74LS04N	.20	SN74LS49N	1.09	SN74LS124N	1.50	SN74LS170N	2.50	SN74LS257N	1.40
SN74LS05N	.28	SN74LS54N	.21	SN74LS125N	.85	SN74LS173N	2.20	SN74LS258N	.95
SN74LS08N	.20	SN74LS55N	.21	SN74LS128N	.86	SN74LS174N	1.16	SN74LS259N	1.46
SN74SL09N	.22	SN74LS63N	1.50	SN74LS132N	.75	SN74LS175N	1.05	SN74LS260N	.38
SN74LS10N	.18	SN74LS73N	.35	SN74LS133N	.39	SN74LS181N	2.76	SN74LS261N	3.50
SN74LS11N	.28	SN74LS74N	.40	SN74LS136N	.75	SN74LS190N	1.75	SN74LS266N	.38
SN74LS12N	.26	SN74LS75N	.48	SN74LS138N	40	SN74LS191N	1.76	SN74LS273N	1.86
SN74LS13N	.66	SN74LS76N	.35	SN74LS145N	1.29	SN74LS192N	1.45	SN74LS279N	.79
SN74LS14N	.89	SN74LS78N	.35	SN74LS146N	1.76	SN74LS193N	1.75	SN74LS280N	1.75
SN74LS15N	.26	SN74LS83AN	1.15	SN74LS151N	.85	SN74LS194AN	1.89	SN74LS283N	1.80
SN74LS20N	.20	SN74LS85N	1.10	SN74LS153N	.60	SN74LS195AN	.85	SN74LS290N	1.80
SN74LS21N	.28	SN74LS86N	.40	SN74LS154N	1.80	SN74LS196N	1.20	SN74LS293N	1.80
SN74LS22N	.28	SN74LS90N	.65	SN74LS155N	1.25	SN74LS197N	1.20	SN74LS295AN	2.20
SN74LS26N	.29	SN74LS91N	.99	SN74LS156N	1.25	SN74LS221N	1.25	SN74LS298N	2.20
SN74LS27N	.35	SN74LS92N	90	SN74LS157N	.60	SN74LS240N	2.20	SN74LS324N	1.80
SN74LS28N	.35	SN74LS938N	.65	SN74LS158N	.99	SN74LS241N	1.90	SN74LS325N	2.55
SN74LS30N	.26	SN74LS95AN	1.20	SN74LS160N	1.15	SN74LS242N	1.90	SN74LS326N	2.55
SN74LS32N	.27	SN74LS96N	1.75	SN74LS161N	1.16	SN74LS243N	1.95	SN74LS327N	2.56
SN74LS33N	.39	SN74LS107N	.39	SN74LS162N	1.15	SN74LS244N	2.10	SN74LS352N	1.35
SN74LS37N	.28	SN74LS109N	.39	SN74LS163N	90	SN74LS245N	3.60	SN74LS353N	1.50
SN74LS38N	.28	SN74LS112N	.39	SN74LS164N	1.50	SN74LS247N	1.25	SN74LS365N	.85

MEMORY AND SUPPORT CHIPS (Prices exclude VAT)

SUPPORT

8212	2.20
8216	2.28
8224	2.80
8226	2.20
8228	4.20
8238	4.20
8245	11.00
8246	11.00
8251	5.00
8253	11.00
8255	5.00
8257	11.00
8259	12.50
8292	18.00
6820P	4.50
6821P	4.50
6850P	4.60
6852P	5.50
AY-5-2376	11.50
MC14411	12.00
M57109	12.43
M57160	10.00
M57161	10.00
TMS6011	5.00
81LS95	1.80
81LS96	1.80
81LS97	1.80
81LS98	1.80

RAMS

2101	2.32
2102L-4	1.20
2111	2.32
2112	2.46
5810	4.08
8154	11.95
2114	6.50
2102L-3	1.60
74C920	11.00
74C921	11.00
74C929	11.00
4027	6.00
4044	8.00
4045	8.15
4050	6.80
4060	7.80
2107	7.00
4116	8.00
4118	20.00
Z80P10	10.00
Z80 CTC	10.00
Z80A P10	14.00
Z80A CTC	14.00

EPROMS

1702	6.00
520K	8.00
2706	8.00
2516	28.00
2716	22.00
2532	56.00

ROMS

74S287	4.00
74S472	12.00
74S470	5.00
74S473	12.48
74S474	12.48
74S471	5.50

I/O

2513	7.50
96364	10.95
14412	12.00

LINEARS

LM301AH	.30
LM301AN-8 (Mini Dip)	.30
LM308N	.99
LM309K (T03)	1.46
LM311N	1.29
LM318N	2.25
LM323K	6.00
LM324N	.79
LM339N	.54
LM555N	.30
LM556N	.75
LM709CN	.37
LM709CN	.38
LM723CH	.58
LM723CN	.48
LM733CN	1.30
LM739CN	1.30
LM741CH-14	.33
LM741CN-S	.26
LM747CN-14	.79
LM747CH	1.10
LM748CN-8	.46
LM748CN	.46
LM1458H	.72
LM1458M-8	.46
LM1488D	.06
LM1490	.05
LM1489AD	1.26
LM1495N-14	.05
LM3302N	.06
LM3401N	.05
LM3402N	1.20
LM3900N	.54
TL080CP	1.48
TL081CP	.06
TL082CP	1.20
TL083CN	1.86
TL084CN	1.60

VOLT REGS

7805	90
7812	.90
7815	.80
7824	.90
7805K	1.50
7812K	1.50
7815K	1.50
7824K	1.50
7905	1.10
7912	1.10
7915	1.10
7924	1.10
7905K	1.00
7912K	1.00
7915K	1.50
7924K	1.89

DIL SOCKETS

8 DIL	.14
14 DIL	.15
16 DIL	.17
18 DIL	.24
20 DIL	.27
24 DIL	.28
28 DIL	.38
48 DIL	.50

CRYSTALS

100K	3.00
200K	3.70
1MHZ	3.00

CMOS—FULL RANGE IN STOCK

CPU'S

8080	6.33
6800	10.00
Z80	8.00
Z80A	15.00
8085	12.95
6502	8.00
SCMPII	10.00
6802	13.95
9900	30.00
6809	37.00

W/WRAP SKTS

8 DIL	.20
14 DIL	.35
16 DIL	.42
18 DIL	.60
24 DIL	.62
28 DIL	.74
40 DIL	.85

TRITON DOCUMENTATION

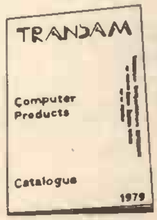
Available separately as follows   Prices include P&P

Triton manual. Detailed circuit description and constructional details and user documentation on level 4·1 monitor and basic	£5.70
L4·1 Listing listing of 1k monitor 2k tiny basic	£4.20
L5·1 User documentation on level 5·1 firmware	£1.20
L5·1 Listing listing of 1·5k monitor and 2·5k basic	£5.50
L6·1 User documentation on 7k basic interpreter	£1.80
Motherboard, 8k Ram and 8k Eprom constructional details	£5.00

User group newsletter subscription £4 per annum. Triton software send SAE for list of programs available for Triton.

HOME COMPUTING CATALOGUE

If you're in town, visit our showroom in Chapel Street, next to Edgware Road tube station. We have Tritons on display plus a comprehensive range of components and accessories, specifically for personal computer users. Books, mags, tapes, data, cables plus much more. Showroom open 6 days a week. (Half day Thurs., from 1.30).



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★ Supplied with 16K of RAM
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★ Full alphanumeric Characters plus 64 User Definable Graphics
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400V Plastic Case (Texas)

3A	**49p**	16A	**90p**
8A	**58p**	20A	**165p**
12A	**70p**	25A	**190p**
6A with trigger			**80p**
8A isolated tab			**82p**
Diac			**18p**

24 HOUR CLOCK/APPLIANCE TIMER KIT

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

CT1000K Basic Kit	**£14.90**
CT1000KB with white box (56/131x71mm)	**£17.40**
Ready Built	**£22.50**

MINI KITS

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

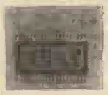
TEMPERATURE CONTROLLER/THERMOSTAT
Uses LM3911 IC to sense temperature (80°C max.) and triac to switch heater. PCB (4 cm.sq.) potentiometer, plus all other components included with instructions.
500W **£3.20** 1KW **£3.50**

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**

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

BURST FIRE/PROPORTIONAL TEMPERATURE CONTROLLER
Based on the TDA1024 Zero Voltage Switch this kit contains all the components required to make 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**

DVM/THERMOMETER KIT



Based on the ICL 7106. 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**

INTEGRATED CIRCUITS

555 Timer	21p
741 Op. Amp	18p
AY-5-1224 Clock	£2.60
AY-5-1230/2 Clock/Timer	£4.20
AY-3-1270 Thermometer	£8.20
ICL7106 DVM (LCD drive)	£7.00
LM377 Dual 2W Amp	£1.45
LM379S Dual 6W Amp	£3.50
LM380 2W Audio Amp	80p
LM382 Dual low noise preamp	£1.00
LM386 250mW low voltage amp	75p
LM1830 Fluid Level Detector	£1.50
LM2907 f-v Converter	£1.40
LM3909 LED Flasher/Oscillator	55p
LM3911 Thermometer	£1.20
LM3914 Dot/Bar Driver	£2.10
MM57160 (stac) Timer	£5.90
MM74C911 4-digit display controller	£6.50
MM74C915 7-segment-BCD converter	96p
MM74C926 4-digit counter with 7-seg outputs	£4.50
S5668 Touchdimmer	£2.50
S9263 Touchswitch 16-way	£4.85
TBA800 5W Audio Amp	58p
TBA810AS 7W Audio Amp	85p
TDA1024 Zero Voltage Switch	£1.00
TDA2020 20W Audio Amp	£2.85
ZN1034E Timer	£1.80

All ICs supplied with data & circuits. Data sheets only 5p

LEDs

0.1" Red	9p
0.2" Red	9p
Green	12p
Yellow	12p
Square Red 5x2.5x 9mm	20p

DISPLAYS

DL727 0.5" 2-digit display CA **£1.50**
DL304/DL307 (pin compatible with **DL704**) **DL407/DL707** 0.3" CC Red 70p
DL847/DL850 (pin compatible with **DL747/750**) 0.8" CA/CC **£1.80**

IC SOCKETS 0.3" CC/CA
8 pin 8p, 14 pin 12p, 16 pin 14p, 18 pin 17p, 28 pin 24p, 40 pin 36p
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QUARTZ LCD 5 Function

Hours, mins, secs., month, date, auto calender, back-light, quality metal bracelet.

£6.65

Guaranteed same day despatch. Very slim, only 6mm thick.

M1

SOLAR QUARTZ LCD 5 Function

Genuine solar panel with battery back-up. Hours, mins., secs., day, date. Fully adjustable bracelet. Back-light. Only 7mm thick.

£8.65

Guaranteed same day despatch.

M2

QUARTZ LCD 11 Function SLIM CHRONO

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

£10.65 Thousands sold!

Guaranteed same day despatch.

M3

QUARTZ LCD ALARM 7 Function

Hours, mins., secs., month, date, day. 6 digits, 3 flags plus continuous display of day and date or seconds. Back-light Only 9mm thick.

£12.65

Guaranteed same day dispatch.

M4

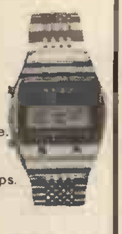
MULTI ALARM 6 Digits 10 Functions

- Hours, mins., secs.
- Months, date, day.
- Basic alarm.
- Memory date alarm.
- Timer alarm with dual.
- Time and 10 country zone.
- Back-light.
- 8mm thick.

£18.65

M5

FRONT-BUTTON Alarm Chrono Dual Time



6 digits, 5 flags, 22 functions. Constant display of hours and mins., plus optional seconds or date display. AM/PM indication, month, date. Continuous display of day. Stop-watch to 12 hours 59·9 secs., in 1/10 second steps. Split and lap timing modes. Dual time zones. Only 8mm thick. Back-light. Fully adjustable open bracelet. Guaranteed same day dispatch

£22.65

M6

SOLAR QUARTZ LCD Chronograph with Alarm Dual Time Zone Facility

6 digits, 5 flags. 22 functions. Solar panel with battery back-up. 6 basic functions. Stop-watch to 12 hours 59·9 secs., in 1/10 sec., steps. Split and lap timing modes. Dual time zones. Alarm. 9mm thick. Back-light. Fully adjustable bracelet.

£27.95

M7

ALARM CHRONO with 9 world time zones

- 6 digits, 5 flags.
- 6 basic functions.
- 8 further time zones.
- Count-down alarm.
- Stop-watch to 12 hours 59·9 secs. in 1/10 sec. steps.
- Split and timing modes.
- Alarm.
- 9 mm thick.
- Back-light.
- Fully adjustable bracelet.

£29.65

M8

SOLAR QUARTZ LCD Chronograph

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

£13.65

Guaranteed same day despatch.

M9

QUARTZ LCD Ladies Day Watch

Only 25 x 20mm and 6mm thick. Hours, minutes, seconds, day, date, backlight and auto calendar. Elegant metal bracelet in silver or gold fully adjustable to suit very slim wrists. State colour preference.

£9.95

Guaranteed same day despatch.

M15

QUARTZ LCD Ladies Fashion Watch

Elegant bracelet in bronze/gold finish or silver colour. Hours, mins, secs, day, date, backlight and auto calendar. Adjustable for the slimmest of wrists. State colour preference.

£14.95

Guaranteed same day despatch

M17

QUARTZ LCD Ladies Cocktail Watch

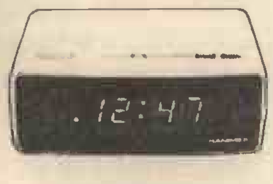
Highly functional watch which also suits those special occasions. Beautifully designed with a very thin bracelet which retains strength as well as elegance. Hours, mins, secs, day, date, backlight and autocalendar. Bracelet fully adjustable to suit slim wrists. State gold or silver finish.

£19.95

Guaranteed same day despatch

M18

HANIMEX Electronic LED Alarm Clock



Features and Specification: Hour/minute display. Large LED display with p.m. and alarm on indicator. 24 Hours alarm with on/off control. Display flashing for power loss indication. Repeatable 9-minute snooze. Display bright/dim modes control. Size: 5.15" x 3.93" x 2.36" (131mm x 11mm x 60mm). Weight: 1.43 lbs (0.65 kg). AC power 220V.

£10.20 Thousands sold!

Mains operated.

Guaranteed same day despatch.

M13

EXECUTIVE ALARM WATCH

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

£14.95

M60

MACY QUARTZ ANALOGUE

Automatic Calendar Day and Date infinite bracelet. This mans watch has elegance as well as the robust appearance provided by a watch with traditional features. Accuracy is provided by a quartz crystal powered by a long life miniature battery.

£24.95

M21

Metac price breakthrough for an Alarm Chronograph with Dual Time only

£18.95

OUTSTANDING FEATURES

- DUAL TIME. Local time always visible and you can set and recall any other time zone (such as GMT). Also has a light for night viewing.
- CALENDAR FUNCTIONS Include the date and day in each time zone.
- CHRONOGRAPH/STOPWATCH displays up to 12 hours, 59 minutes, and 59.9 seconds.
- On command, stopwatch display freezes to show intermediate (split/lap) time while stopwatch continues to run. Can also switch to and from timekeeping and stopwatch modes without affecting either's operation.
- ALARM can be set to anytime within a 24 hour period. At the designated time, a pleasant, but effective buzzer sounds to remind or awaken you!

Guaranteed same day dispatch.

M16

HOW TO ORDER

Payment can be made by sending cheque, postal order, Barclay, Access or American Express card numbers. Write your name, address and order details clearly, enclose 40 pence per single item for post and packing or the amount stated in the advert. All products carry 1 year written guarantee and full money-back 10 day reassurance. Battery fitting and electronic calibration service is available to customers at any Metac shop. All prices include VAT currently at 15%.

Metac Wholesale:

Trade enquiries – send for a complete list of prices for all the goods advertised plus many more not shown also minimum order details.

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MICRODIGITAL 1980

Apple II plus

Apple II Plus will change the way you think about computers. That's because it is specifically designed to handle the day to day activities of education, business, financial planning, scientific calculation and entertainment.

* APPLESOFT
A fast, extended 10K BASIC with 9-digit precision and graphics extensions.
* HIGH RESOLUTION GRAPHICS
On a matrix of 280 x 192 individually addressable points.
* AUTO-START ROM
With power on boot of applications programs, reset protection and improved screen editing.
* INTERNAL MEMORY EXPANSION TO 64K BYTES
For big system performance at a low cost.
* EIGHT EXPANSION SLOTS
To let the system grow with your needs

	Nett	V.A.T.	Total
Apple II Plus, 16K RAM	750.00	112.50	862.50

APPLE PASCAL
Apple Pascal is the new extension to microcomputer power.

Pascal Incorporating UCSD PASCAL TM, offers extended features in a complete interactive package employing todays most sophisticated structured programming language. It provides advanced capabilities that boost performance and cut development time for large business, scientific and educational programs.

This software package provides the most powerful set of tools yet available for the microcomputer programmer.

	Nett	V.A.T.	Total
APPLE Pascal System	296.00	44.40	340.40

FLOPPY DISCS
Gives your system immediate access to large quantities of data. The subsystem consists of an intelligent interface card, a powerful Disk Operating System and one or two mini-floppy drives.

	Nett	V.A.T.	Total
Floppy disk Subsystem	398.00	59.70	457.70
Second disk drive and connecting cable	355.00	53.25	408.25

Parallel Printer Interface Card
Allows you to connect almost any popular printer to your apple, A BASIC program can produce hard-copy output as easily as it prints to the TV monitor screen. Command interpretation and printer control details are handled by the firmware built into the card, to eliminate user programming requirements.

	Nett	V.A.T.	Total
Parallel Printer Interface Card	110.00	16.50	126.50

Communications Interface Card
Allows your Apple to "talk" (through a modem) with other computers and terminals over ordinary telephone and load programs over the phone, send messages to remote terminals or access your office computer from the comfort of your home

	Nett	V.A.T.	Total
Communications Interface Card	110.00	16.50	126.50

High Speed Serial Interface Card
Allows Apple to exchange data with printers, plotters and computers in serial format at up to 19.2K Baud.

	Nett	V.A.T.	Total
High Speed Serial Interface Card	110.00	16.50	126.50

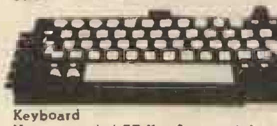
apple computer
Sales and Service

Nascom 2

Microprocessor
Z80A 8 bit CPU. This will run at 4 MHz but is selectable between 1/2/4/ MHz.

Hardware
12" x 8" Card
All bus lines are to the Nasbus specifications
All bus lines are full buffered

Memory
On-board, addressable memory:
2K Monitor — Nas-sys 1
1K Video RAM (MK4118)
1K Work space/User RAM (MK4118)
8K Microsoft Basic (MK3600 ROM)
8K Static RAM/2708 EPROM



Keyboard
New expanded 57 Key Licon solid state keyboard especially built for Nascom. Uses standard Nascom, monitor controlled, decoding.

T.V.
The T.V. Peak to peak video signal can drive a monitor directly and is also fed to the on-board modulator to drive the domestic T.V.

I/O
On-board UART (Int. 6402) which provides serial handling for the on-board cassette interface or the RS 232/20mA teletype interface. The cassette interface is Kansas City standard at either 1200 or 300 baud. This is a link operation on the Nascom-2.

PIO
There is also a totally uncommitted PIO (MK3881) giving 16, programmable, I/O lines.

Character Generator
The 1K video RAM drives a 2K ROM character generator providing the standard ASCII Character set with some additions, 128 characters in all. There is a second 2K ROM socket for an on-board graphics package which is software selectable.

	Nett	V.A.T.	Total
Nascom-2 in kit form	295.00	44.25	339.25
Power Supply ..	24.50	3.68	28.18
Graphics ROM ..	15.00	2.25	17.25

REED RELAY BOARD

Put your Nascom to work with the new Microdigital Relay Board.
* 16 Reed Relays, totally isolated 200 mA, 50 V.D.C. 5W max each. Operate and release time 1 ms (Including bounce).
* Single sided, glass fibre board, with gold plated edge connectors and silk screened component layout.
* Plugs directly into Nasbus, does not interfere with normal Nascom operation, all interupt and D.M.A Daisy Chain Links carried on. Draws only 250 mA from each of the + and + 12V Rails.
* All components supplied, all IC's socketed, easy to build, and easy to program in Basic or Machine Code.
* Occupies 2 consecutive ports, link selectable — several boards can be used on one Nascom system.
* Output is via front edge connector on 0.1" centres. Uses standard edge connectors for connection to controlled devices.
* Complete manual with sample software.

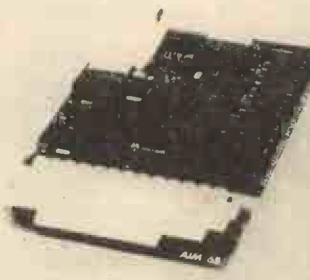
Applications
* Light displays
* Industrial process control
* Model Railway Control.
* Pre programmed music generation
* Robots, Central Heating Systems
* Stepping Motors
* ......?

	Nett	V.A.T.	Total
P.C.B. (+ Manual)	15.00	2.25	17.25
Kit	49.95	7.49	57.44
Assembled	60.00	9.00	69.00

Rockwell Aim 65

Thermal Printer
* Wide 20 column printout.
* Versatile 5 x 7 dot matrix format
* Complete 64 — character ASCII alphanumeric format
* Fast 120 lines per minute
* Quiet thermal operation
* Full Size Alphanumeric Keyboard
* Standard 54 key, terminal-style layout
* 26 alphabetic characters
* 10 number characters
* 22 special characters
* 9 control functions
* 3 User-defined functions

True Alphanumeric Display
* 20 characters wide
* 16-segment characters
* High contrast monolithic characters
* Complete 64 — character ASCII alphanumeric format
* Read/Write Memory, using R2114 Static RAM devices. Available in 1K byte and 4K byte version.
* 8K Monitor Program Memory, using R2332 Static ROM devices. Has sockets to accept additional 2332 ROM or 2532 PROM devices, to expand on-board Program memory up to 20K bytes.
* R6532 RAM Input/Output-Timer (RIOT) combination device. Multipurpose circuit for AIM 65 Monitor functions.
* Two R6522 Versatile interface Adaptor (VIA) devices, which support AIM65 and user functions.



	Nett	V.A.T.	Total
AIM-65 with 1K	249.50	37.43	286.93
AIM-65 with 4K	315.00	47.25	362.25
8K BASIC ROM	70.00	10.50	80.50
4K ASSEMBLER ROM	59.50	8.93	68.43
CASE (includes P.S.U.)	78.00	11.70	89.70
P.S.U.	41.83	6.27	48.10
MOTHERBOARD	136.50	20.48	156.98

Texas

The remarkable TI-99/4 Home Computer. Superior colour, music, sound and graphics — and a powerful extended BASIC all built in. Plus a unique, new Solid State Speech Synthesizer and T.I.'s special Solid State Software.

The T.I.99/4 was designed to be the first true home computer — skilled computer users and beginners alike will be able to put it to effective use right away. You can begin using the TI Home Computer minutes after unpacking it; simply snap in a Solid State Software Module, touch a few keys and step-by-step instructions appear on the screen.

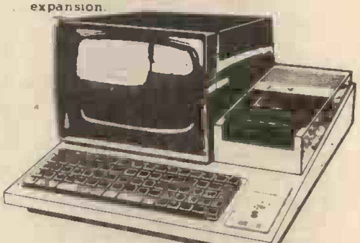
* Powerful TI-Basic: Accuracy and power for demanding technical applications, yet easy to use for the beginner. 13-digit, floating point Basic, with special features and extensions for colour, sound and graphics.
* 16-colour graphics capability — Easy to use, high resolution graphics with special features that let you define your own characters, create animated displays, charts, graphics . . . and more, with a resolution of 256 x 192 individually addressable points.
* Music and sound effects: provides outstanding audio capability. Build three-note chords and adjust frequency, duration and volume quickly and simply.

Console:
CPU: 9900 family, 16 bit microprocessor, plus 256 byte scratchpad RAM.

Memory:
Total combined memory capacity72K Bytes
Internal ROM.................. 26K Bytes

Sharp

SHARP MZ-80K
* Z-80 based CPU.
* 4K Byte monitor in ROM.
* Internal memory capacity from 4 to 48K RAM
* 14K Extended BASIC.
* 10 in video display, 40 chars of 24 lines
* 80 x 50 bit mapped graphics.
* Extensive character set with upper, lower case, graphics etc
* Full 79 Key Keyboard.
* Built in music synthesizer with 3 octaves.
* Fast reliable cassette unit with tape counter 1200 b p s
* Wide variety of system software on cassette
* 50 pin bus connector for system expansion.



A complete personal computer system for the microcomputer user, at an economic price. The Sharp comes complete with all necessary peripherals, sample software and excellent documentation — giving the user a personal system of unmatched flexibility and ease of use. At the heart of the machine is the Z-80 CPU — widely accepted as the most powerful 8-bit CPU on the market. A 4K byte system monitor controls system operation. From 4 to 48K of RAM can be resident on board; enough room for the most demanding applications.

An extensive graphics character set, plus 3 octave sound generator and fast cassette unit hi-resolution video monitor complement these basic facilities. It has the ease of use and compactness of "black box" computer combined with extensive peripherals and facilities for expansion.

Sharp Basic occupies 14K of RAM and offers extended features above those of normal microcomputer implementations.

Model	Nett	V.A.T.	Total
6K.............	520.00	78.00	598.00
10K	540.00	81.00	621.00
18K	620.00	93.00	713.00
22K	640.00	96.00	736.00
34K	740.00	111.00	851.00

Internal RAM.................... 16K Bytes
External ROM (Plug in software modules) .... 30K Bytes

Keyboard:
Staggered QWERTY Layout, full travel with overlay for second functions.

Sound:
5 Octaves, 3 simultaneous tones plus noise generator

Colours: 16

Graphics resolution: 256*192

Input/Output:
Composite video and audio output for monitor. Interface for 2 audio cassette recorders 44-pin peripheral connector with system memory and address signals available. Mini-earphone jack. Hand controller interface.

Built in software:
14K Byte T.I. BASIC, equation calculator and control software.

Size: 25.9*38.1*7.1 cm.

Display:
Uses colour monitor, 24 lines of 32 characters.

	Nett	V.A.T.	Total
Console	569.57	85.43	655.00
Modules			15–40.00*
Joysticks			25.00*
Speech synthesizer			45.00*

*Please note these are estimated prices only.

Bigger and better than ever!

Commodore Pet

A complete Computer for the price of a good typewriter! With a library of over 200 programs in business, science, education and entertainment.

Pet can store and retrieve data which conventially occupies large storage capacity, and solve numerical problems traditionally tedious and time consuming.

Ease of Operation
The Commodore PET comes complete with a built-in T.V. screen, and keyboard as well as its full computer circuitry. It is plugged into any 13 amp and no special computer knowledge is needed for running standard programs. Personal programs can readily be written in the BASIC computer language of PET which is easily learned.

An Expandable System
Further expansion is a prime design concept enabling PET to be made the heart of a much larger system incorporating printers, floppy discs etc., as and when required.

Computers
PET 2001-8 — PET with integral cassette and calculator type keyboard. 8K bytes memory.

Nett	V.A.T.	Total
550.00	82.50	632.50

PET 2001-16N — PET with 16K bytes memory and large keyboard. External cassette optional.

Nett	V.A.T.	Total
675.00	101.25	776.25

PET 2001-32N — PET with 32K bytes memory and large keyboard. External cassette optional.

Nett	V.A.T.	Total
795.00	119.25	914.25

Computhink Disk Units

400K Random for 8K Pet	795.00	119.25	914.25
400K Random for New Pet 2	840.00	126.00	966.00
800K Random for New Pet 2	995.00	149.25	1,144.25

Acorn

This compact stand-alone micro-computer is based on Eurocard modules, and employs the highly popular 6502 MPU. Take a look at the full specifications, and see how Acorn meets your requirements.

The Acorn consists of two single Eurocards:
1. MPU card; 6502 microprocessor, 512 x 8 ACORN Monitor, 1K x 8 RAM; 15-way I/O with 128 bytes of RAM; 1 MHz crystal; 5V reg. sockets for 2K EPROM and second RAM I/O chip.
2. Keyboard card; 25 click-keys (16 hex, 9 control); 8 digit, 7 segment display. CUTS standard crystal controlled tape interface circuitry.

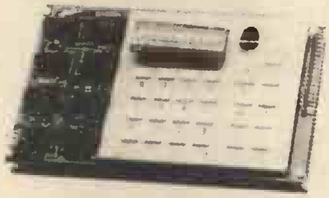
Acorn Operating Manual
With Acorn, you'll receive an operating manual that covers computing in full, from first principles of binary arithmetic, to efficient hex programming with the 6502 instruction set. The manual also includes a listing of the monitor programs and the instruction set, and other useful tabulations; plus sample programs.

	Nett	V.A.T	Total
Kit	65.00	9.75	74.75
Ready Built	75.00	11.25	86.25

Acorn Memory
A high quality fibre glass, through hole plated, PCB with solder resist and component identification, this eurocard has provision for 8K of RAM (2114) and 8K of EPROM (2732).

	Nett	V.A.T.	Total
8K RAM (Kit)	95.00	14.25	109.25

ACORN V D U
The Acorn V.D U Board connects to the Acorn Computer Bus and contains memory mapped character storage RAM which is transparently written to or read from, by the C.P.U.



An MC 6845 programmable controller I C. Provides all the synchronisation signals to drive a 625 line 50 fields per second V.D U. together with read addresses for the character R.A M. Characters are then fed to an SAA 5050 character generator IC which produces the necessary dot patterns to create the characters to refresh the V.D U

The SAA 5050 produces Teletext standard characters and has Red, Green and Blue drive outputs giving coloured characters or graphics.

	Nett	V A T	Total
V D U Card (Kit)	88.00	13.20	101.20

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5 packages which are:

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Payroll	£360.00

These packages are now available, demonstrations on request

Ring 051-227 2535 and ask for Graham Jones (Software Manager).

These are fully tested systems which run on the Apple/ITT 2020 with one or two disc drives.

The Stock Control package can handle up to 1250 stock items and uses two disc drives.

The Mighty Microdigital

Microdigital are one of the largest and longest established Microcomputer firms in Europe.
We sell a wide range of systems, backed up by support services that are second to none.
Our present retail outlet is at 25 Brunswick Street, Liverpool. Our well informed staff are happy to demonstrate equipment, provide technical help, or just chat.
Microdigital (mail order) is the fastest, friendliest and most efficient mail order service available. All orders (or an acknowledgement if the goods are temporarily out of stock) are despatched by return post. Telephone orders are welcome (24 hours a day) and we even have a "Freepost" service so you don't have to remember the stamp!
Microdigital Manufacturing is our hardware department. We carry out repairs and servicing in-house rather than depending on the manufacturer. In addition we design and manufacture our own peripheral boards for the systems we support. Custom design services are also available

Microdigital (Software) is responsible for the development of commercial, high quality, computer programs. We can advise on the suitability of an existing package, modify the package, or write a completely new system to the customers specification.
Microditial (Hire) provides a service for potential customers — the capabilitities of a particular machine can be evaluated without a substantial capital investment
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(PROGRAMMABLE UNIJUNCTION)

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				Price each
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1502	.125	LED Diffused	GREEN	£0.11
1505	.2	LED Diffused	GREEN	£0.11
1503	.125	LED Diffused	YELLOW	£0.11
1506	.2	LED Diffused	YELLOW	£0.11
SJ80	.2	LED Bright	YELLOW	£0.14
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AC126	£0.14	BC460	£0.28	TIP30B	£0.32
AC127	£0.16	BC461	£0.28	TIP30C	£0.34
AC128	£0.15	BC477	£0.15	TIP31	£0.30
AC128K	£0.24	BC478	£0.15	TIP31A	£0.30
AC176	£0.16	BC479	£0.15	TIP31B	£0.32
AC171K	£0.24	BC547	£0.08	TIP31C	£0.34
AC187	£0.16	BC548	£0.08	TIP32	£0.30
AC187K	£0.26	BC549	£0.08	TIP32A	£0.30
AC188	£0.16	BC557	£0.10	TIP32B	£0.32
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BC142	£0.18	BFR40	£0.20	2N706	£0.09
BC147	£0.07	BFR79	£0.22	2N706A	£0.10
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BC177	£0.13	MJE2955	£0.75	2N2221	£0.18
BC178	£0.13	MJE3055	£0.50	2N2221A	£0.20
BC179	£0.13	MPSA05	£0.15	2N2222	£0.18
BC182	£0.07	MPSA06	£0.15	2N2222A	£0.18
BC182L	£0.07	MPSA55	£0.15	2N2369	£0.12
BC183	£0.07	MPSA56	£0.15	2N2904	£0.16
BC183L	£0.07	OC25	£0.50	2N2904A	£0.17
BC184	£0.07	OC26	£0.45	2N2905	£0.16
BC184L	£0.07	OC28	£0.60	2N2905A	£0.18
BC207	£0.08	OC29	£0.55	2N2906	£0.14
BC208	£0.08	OC35	£0.55	2N2906A	£0.16
BC209	£0.09	OC36	£0.60	2N2907	£0.15
BC212	£0.07	OC42	£0.18	2N2907A	£0.16
BC212L	£0.07	OC44	£0.20	2N2926G	£0.08
BC213	£0.07	OC45	£0.18	2N3053	£0.15
BC213L	£0.07	OC71	£0.12	2N3054	£0.30
BC214	£0.07	OC72	£0.16	2N3055	£0.35
BC214L	£0.07	OC75	£0.18	2N3702	£0.07
BC251	£0.10	OC81	£0.20	2N3703	£0.07
BC261	£0.14	TIP29	£0.30	2N3704	£0.06
BC327	£0.12	TIP29A	£0.30	2N3705	£0.06
BC328	£0.12	TIP29B	£0.32	2N3706	£0.07
BC337	£0.12	TIP29C	£0.34	2N3771	£1.00
BC338	£0.12	TIP30	£0.30	2N3772	£1.10
BC440	£0.25			2N3773	£1.50

DIODES

Type	Price	Type	Price	Type	Price
AA119	£0.06	OA70	£0.06	IN4004	£0.06
BA100	£0.08	OA79	£0.08	IN4005	£0.07
BA148	£0.13	OA81	£0.08	IN4006	£0.08
BA173	£0.13	OA90	£0.08	IN4007	£0.09
BAX13	£0.05	OA91	£0.08	IN5400	£0.12
BAX16	£0.06	OA95	£0.08	IN5401	£0.13
OA200	£0.06	IN34	£0.06	IN5402	£0.14
OA202	£0.07	IN60	£0.07	IN5404	£0.15
BY100	£0.18	IN4148	£0.05	IN5406	£0.19
BY126	£0.12	IN4001	£0.04	IN5407	£0.23
BY127	£0.14	IN4002	£0.04	IN5408	£0.28
OA47	£0.06	IN4003	£0.05	IS44	£0.03

LINEAR

Type	Price	Type	Price	Type	Price
CA270	£0.95	SL414A	£1.75	TBA810	£0.85
CA3089	£1.70	SN76013N	£1.65	TBA820	£0.85
CA3090	£3.00	SN76023N	£1.60	uA703	£0.20
LM380	£0.80	SN76115	£1.60	uA709C	£0.25
LM381	£1.35	TAA550	£0.30	uA710	£0.25
LM3900	£0.50	TAA621A	£1.80	uA711	£0.26
MC1310P	£0.85	TBA120B	£0.60	741P	£0.16
NE555	£0.18	TBA641A	£1.10	TAA661	£1.25
NE556	£0.55	TBA800	£0.75	TAA661B	£1.25

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SJ2	200 Carbon resistors ¼-½ watt preformed	0.50
SJ3	100 ⅛ watt miniature resistors mixed values	0.50
SJ4	60 ⅛ watt resistors mixed values	0.50
SJ5	50 1-2 watt resistors mixed pot values	0.50
SJ6	50 Precision resistors 1-2° tol. mixed	0.50
SJ7	30 5-10 watt wirewound resistors mixed	0.50
SJ11	150 Capacitors mixed types & values	0.50
SJ12	60 Electrolytics all sorts mixed	0.50
SJ13	50 Polyester/polystyrene capacitors mixed	0.50
SJ14	50 C280 type capacitors mixed	1.00
SJ15	40 High Quality electrolytics 100-470mf	1.00
SJ16	40 Low Vts Electrolytics mixed up to 10v	0.50
SJ17	20 Electrolytics transistor types mixed	0.50
SJ18	20 Tantalum bead capacitors mixed	0.50
SJ20	2 large croc clips 25A rated	0.30
SJ21	Large 7½" 'Mains Neon Tester' screwdriver	0.85
SJ22	Small pocket size 'Mains Neon Tester'	0.55
SJ23	Siemens 220v AC Relay DPDT contacts 10amp rating – housed in plastic case	1.00
SJ24	Black PVC tape (⅝) 15mm x 25m – strong tape for electrical & household use	0.35 per roll 1.50 5 rolls
SJ25	100 Silicon NPN transistors all perfect & coded – mixed types with data & equivalent sheet	2.50
SJ26	100 Silicon PNP transistors all perfect & coded – mixed types and cases data and equivalent	2.50
SJ27	50 Assorted pieces of SCR's diodes & rectifiers incl. stud types all perfect – no rejects fully coded – data incl.	2.50
SJ28	20 TTL 74 series gates – assorted 7401 – 7460	1.00
SJ33	PC Board – mixed bundle PCB fibreglass/paper single & double sided – super value!	0.75
SJ34	200 sq. ins. (approx) copper clad paper board	0.80
SJ35	100 sq. ins. (approx) copper clad fibre glass	0.80
SJ49	8 dual gang carbon pots log & lin mixed values	1.00
SJ50	20 assorted slider knobs – chrome/black	1.00
SJ51	1 Switchbank 5 way incl. silver knobs	0.50
SJ52	1 pak of vero board approx 50 sq. ins mixed	1.00
SJ53	1 Mammoth I.C. Pack: approx. 200pcs assorted fall-out integrated circuits including logic 74 series, linear-audio and D.T.L. many coded devices but some unmarked – you to identify	1.00
SJ54	20 slider pots mixed values & sizes	1.00
SJ56	6 100K lin 40mm slider pots	0.50
SJ57	6 100K log 40mm slider pots	0.50
SJ58	6 1K lin 40mm slider pots	0.50
SJ59	6 5K lin 40mm slider pots	0.50
SJ60	4 5K log 60mm single	0.50
SJ61	4 100K log 60mm single	0.50
SJ62	5 15mm chrome knobs standard push fit	0.50
SJ63	1 Instrument knob – black winged (29 x 20mm) with pointer ¼" standard screw fit	0.15
SJ64	1 Instrument knob – black/silver aluminium top (17 x 15mm) ¼" standard screw fit	0.12
METAL CASE DUAL SLIDER POTS: 45mm travel		
SJ65	10K log	0.25 each
SJ66	100K lin	0.25 each
SJ67	Chrome slider knobs to fit	0.10 each
SJ68	30 ZTX300 type transistor NPN pre-formed for P/C Board colour coded blue – all perfect	1.00
SJ69	30 ZTX500 type transistor PNP pre-formed for P/C Board colour coded white – all perfect	1.00
SJ70	25 BC107 NPN TO106 case perfect transistors code C1359	1.00
SJ71	25 BC177 PNP TO106 case perfect transistors code C1395	1.00
SJ72	4 2N3055 silicon power NPN transistors TO3	1.00
SJ73	6 TO64 SCRs 5Amp assorted 50v – 400v all coded	1.00
SJ74	8 way ribbon cable – colour coded individually PVC insulated solid tinned copper conduction	0.20 meter
SJ75	FM coax cable – plain copper conduction cellular polythene insulated and plain copper braided PVC sheath – impedance 75 ohms	0.10 meter
SJ76	1 Board containing 2 x 5 pin DIN sockets 180° O 2-2 pin DIN loudspeaker sockets	0.30
SJ77	A 5 pin DIN 180° chassis/normal socket incl. DPDT switch	0.20
SJ83	5 Germ. OCP71 type photo transistors	1.00
SJ84	10 BD131 NPN transistors low Hfe rejects	0.50
SJ85	6 PNP Darlington Power Transistors TO-126	0.50
SJ86	5 PNP TO-3 germ. power transistors at VLTS10-20VCB	0.50
SJ87	20 Asst. heat sinks TO1/5/18/92	0.50
SJ88	2 Post Office relays	0.50
SJ89	20 Mixed values 400mW zener diodes 3-10v	1.00
SJ90	20 Mixed values 400mW zener diodes 11-33v	1.00
SJ91	10 Mixed values 1W zener diodes 3-10v	0.50
SJ92	10 Mixed values 1W zener diodes 11-33v	0.50
SJ95	8 Silicon Bridge Rectifiers up to 4Amp 200v + Data	£1.50
SJ96	1 Battery holder to take 6 x HP7's	£0.10
16168	5 assorted ferrite rods	0.50
16169	2 tuning gangs MW/LW	0.50
16170	50 meters asst. colours single strand wire	0.50
16171	10 Reed switches	0.50
16172	3 Micro switches	0.50
16173	15 assorted pots	0.50
16177	1 pack assorted hardware	0.50
16178	5 Main slider switches assorted	0.50
16179	1 pack assorted tag strips	0.50
16180	15 assorted control knobs	0.50
16181	3 Rotary wave change switches	0.50

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PE VOLUME 16 No. 2 FEBRUARY 1980

BREADBOARD

AT THE time of writing the Breadboard exhibition is pulling in the crowds in London and the editorial staff of PE are at full stretch manning the stand, visiting exhibitors and producing this issue—we hope it doesn't show! Breadboard looks like becoming the premier event for the electronics hobbyist. In only its second year it has attracted large crowds, is very well presented and has an excellent atmosphere—even though it is sometimes difficult to talk to people over the raucous noise being generated by various synthesisers, organs, discos etc. (organisers please note!).

An exhibition such as this gives us a chance to meet casual and dedicated readers. We take the opportunity to discuss various projects and enquire into your views on PE. Thankfully most are full of praise and often some new project ideas get thrown up for our consideration. Some, of course, are not so happy—unfortunately we have failed to please them. It would appear that in these cases we are not giving enough space to their particular subject or, more commonly, we are giving too much space to another facet of our hobby in which they are not interested.

The problem is, having talked to a number of readers, often with widely varying views, just what do we do with all the information. It is all too easy to twist it around so that it fits in with our own views, or to balance out two divergent attitudes and take the middle path; which may in fact please neither party.

For instance, two comments which came up were (a) we carry too many microprocessor oriented articles and (b) we give too much space to music and audio projects. Now we could please both parties by cutting back on these subjects, but wait, we know these are very popular areas by the number of kits and components sold—2000 Compukits (at £250 each) at the last count and excellent quantities of mixers, guitar sound multiprocessors etc. So we would probably offend many readers by cutting back on either subject. We do try to keep the balance right, to be aware of new trends and to provide the right information at the right time but it's not easy to please everyone.

PROJECTS

One thing that fascinates us is that virtually all the comments are concerned with projects. Although we try to publish about five projects, or parts thereof, each month these normally make up less than half of our total number of editorial pages—presumably everyone is over the moon with the rest of the contents?

Another interesting angle is uncovered when one enquires as to how many projects most readers construct during a year—the average is probably about one project per reader per year. So why are some readers so much in favour of reading about their pet subject but so much against learning, or even just reading, about ideas and circuitry from another discipline? Any comments?

Finally, our thanks to all those who visited our stand at Breadboard. To those who live too far away or who just could not come along—it's a great event—if you get the chance we would be pleased to see you next time.

We hope to publish a review of the exhibition next month; our apologies to those who have seen it all first hand.

Mike Kenward

EDITOR
Mike Kenward

Gordon Godbold ASSISTANT EDITOR
Mike Abbott TECHNICAL EDITOR
David Shortland PROJECTS EDITOR

Jack Pountney ART EDITOR
Keith Woodruff ASSISTANT ART EDITOR
John Pickering SEN. TECH. ILLUSTRATOR
Isabelle Greenaway TECH. ILLUSTRATOR

ADVERTISEMENT MANAGER **D. W. B. Tilleard** } 01-261 6676
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CLASSIFIED MANAGER **Colin Brown** 01-261 5762

Editorial Offices:
Practical Electronics,
Westover House,
West Quay Road, Poole,
Dorset BH15 1JG
Phone: *Editorial* Poole 71191

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

Advertising Offices:
Practical Electronics Advertisements,
King's Reach Tower,
King's Reach, Stamford Street, SE1 9LS
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Technical Queries
We are unable to offer any advice on the use or purchase of commercial equipment or the incorporation or modification of designs published in Practical Electronics.

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

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

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

Binders
Binders for PE are available from the same address as back numbers at £3·75 each to UK or overseas addresses, including postage and packing, and VAT where appropriate. Orders should state the year and volume required.

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

Market Place

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

by David Shortland

AUDIO VISUAL

Two new AV machines have just been launched on the market. The 340 model is a cassette recorder with four identical audio channels, each with full metering facilities and Dolby Noise Reduction. Each channel has two inputs, microphone and line, a fixed level

line output, and a controlled output which can give in excess of +8dBm.

Independent record selection is provided for each pair of tracks to facilitate stereo recording (tracks 1 and 2) or all four tracks simultaneously. If required, tracks 1 and 2 can be recorded first then tracks 3 and 4 added whilst replaying tracks 1 and 2. Alternatively, tracks 1 and 2 can be recorded after tracks 3 and 4.

The 330 model has two audio channels with a separate sync track for audio visual applications.

The two audio channels have full metering facilities and Dolby Noise Reduction and each audio channel has the same specification as the 340. They sync channel also provides full metering facilities and selection for the use of normal and special tapes.

When the 330 is used with external sync pulse coding/decoding equipment, the sync channel has a single line input and a line output. It also has an internal sync pulse generator triggered by a button on the front panel to provide a recorded pulse for direct connection to a projector.

For further details including price and delivery contact: **Neal-Ferrograph, Simonside Works, South Shields, Tyne & Wear NE34 9NX.**

FLUKE DMM

Microprocessor techniques have allowed Fluke to incorporate some very useful features in their latest low cost 4½ digit 8050A DMM. This highly accurate bench/portable model with 39 measurement ranges and nine functions also provides unique dB computing and offset modes in addition to a high performance true r.m.s. capability.

In the dB mode, the 8050A DMM allows the user to call up any of 16 reference impedance levels from 8 to 1,200 ohms and to display the readings directly in dBs.

Additionally, a reference/offset mode allows any input signals to be stored either as a reference value for relative dB readings or as an offset against any reading. In offset mode, the user can zero-out any lead resistances for really high resolution impedance measurements or set up a reference offset and display only the variance from that reading.

These absolute and relative dB modes with offset greatly simplify measurements in audio, amplifiers and telecommunications circuits as well as in production testing where only the variance from the stored value may be required. The offset facility is available on all functions such as a.c./d.c. volts or amps, resistance or conductance.

The high resolution 4½ digit l.c.d. display is matched by a basis d.c. accuracy of 0·03 per cent specified over a full year. A.c. or d.c. measurements can be made down to 10µV, 10 nA or 10 milliohms.

In addition to its volts, ohms and amps ranges, the 8050A also has two conductance ranges for high impedance measurements to

100,000 Megohms, as well as low power ranges for in-circuit measuring.

A wide range of accessories such as high voltage probes, current transformers, shunts, temperature and r.f. probes, remote hold probe, battery pack, and safety leads make the 8050A a complete measurement system for the bench or field.

The 8050A is priced at £199 ex. VAT and carriage.

Fluke International Corporation, Colonial Way, Watford, Herts WD2 4TT.

BOOTS VIDEO

All Boots audio departments are now selling the Ferguson VHS Videostar recorder (Model 3V00) which has a maximum recording time of 3 hours.

The 3V00 has a remote hand-held "pause unit" which can be used to edit unwanted material during recording or playback. Boots

will also carry a wide range of blank video tapes not only for the Videostar and other VHS recorders but also for machines using VCR and Beta format tapes.

Also available is a full colour catalogue of 45 pre-recorded programmes and feature films.

The price of the 3V00 is £595·00 with blank cassettes from £6·95 to £16·95 and pre-recorded films from £17·50.

ELECTRONIC NOTEBOOK

Like the first model introduced last year, the Toshiba LC-1038MN calculator offers alpha-numeric facilities which has now been expanded to a full ten digit alphabetic and/or numeric entry and display, plus sign. There is an independent 30-register memory bank, each register able to retain data consisting of 10-alphabetic characters and 10-numerals. The addition of a 26-location world-time display, plus clock/calendar and alarm. There is instant retrieval of the world-time display; the calendar indicates month, date and day of

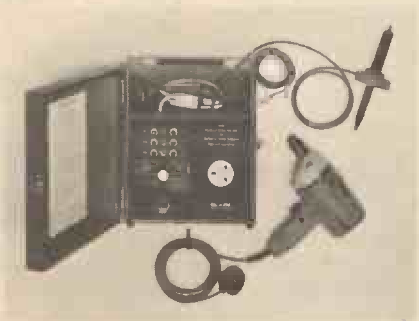
week; and the alarm can be set up to one year in advance and to prompt an alpha display.

The calculator is ideal for the storage of information in constant use, but which is subject to frequent change such as currency exchange rates; share buying and selling prices; bank and audit card balances; train and plane departure and arrival times; stock levels; metric conversion factors; travellers cheque numbers.

The LC-1038MN operates on batteries lasting around 9,000 hours; is sized 70 × 10 × 137mm and weighs 80g (2·8oz). It is priced around £75, plus VAT.

SAFETY TESTER

Clare Instruments Limited have developed a portable safety test unit for checking double insulated and earthed electrical equipment.



The V152, will flash test double insulated appliances at 4kV. Another noteworthy feature, is the high current used for earth bond testing (25A at 8V). Too many testers, at present available, offer only a simple continuity check for this important test.

The unit operates from a mains supply and the appliance under test is plugged into the 13 amp socket on the front panel of the tester. When the test button is pressed, neon lamps indicate that the series of tests is completed, with green lights for passes and red lights for failures.

The tester which is housed in a hardwood case is priced at £144·50 ex. VAT and p&p.

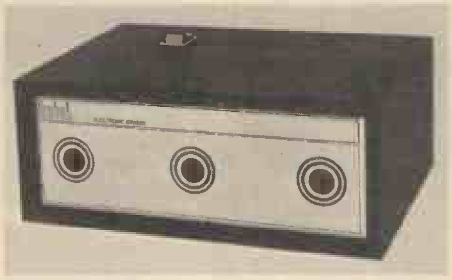
Clare Instruments Limited, Clare Works, Woods Way, Goring-by-Sea, Worthing.

NEGATIVE ION GENERATORS

Most of the air around us is electrically neutral with only a few of the air molecules gaining or losing electrons and therefore acquiring a positive or negative charge.

The effect of these charged molecules, which are called air ions, on individual health has been researched over many years and it has become clear that it is the balance of negative and positive ions rather than high ion concentration which is important.

Research has also shown that sufferers from asthma, hay fever and bronchitis can benefit from having the air they breathe charged with negative ions. There is also considerable evidence that ion depletion, such as



occurs in offices or crowded rooms, produces discomfort, drowsiness, fatigue and loss of mental and physical efficiency.

The concentration of negative ions in the air can be increased using a negative ion generator. Two such generators have just been introduced by J. P. Bell Ltd., the Kobelair Model 20 is a desk unit suitable for individual usage whereas the Model 40 is suitable for rooms up to 40 cubic metres (1500 cubic feet) with a maximum effectiveness over a range of 0·5 to 2·5 metres (2 to 8 feet).

The model 20 is priced at £57·50 and the Model 40 at £98·50 excluding VAT and p&p.

J. P. Bell (Machinery) Ltd., Jubilee works, London Road, Woolmer Green, Knebworth, Herts.

SUPERDECK FOR MPUs

The V&T Superdeck is a high speed cassette unit which will, under CPU control, find any file stored on a C60 cassette (one megabit of unformatted memory on each side) in under one minute using fast forward and fast reverse speeds (up to 50 i.p.s.).

Other features of the Superdeck include: 5000 baud CUTS format as standard (which can be switched to other lower speeds, error detection and correction (it will also write protected areas of tape containing hard errors), it will write into the first empty file, on tape or into any file number or name specified (unless that particular file is write protected in which case an error message is generated).

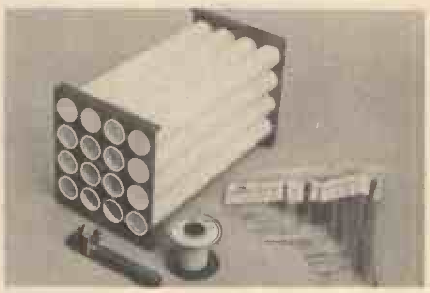
At the present time only a Z80 operating system is available.

The unit which connects to any 8bit I/O port and UART includes a 240V supply unit.

The price of the Superdeck is £110 plus VAT and p&p. V&T Electronics, 82 Chester Road, London N19.

WIRE BIN

The WB-16 wire bin has been designed for both storage and wiring table use, keeping assorted wires separated in their correct size groups and preventing wasteful tangling.



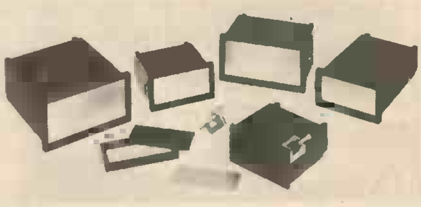
The sixteen wire storage tubes have adjustable depth stops to take wire lengths from 25mm and 350mm. The price of the WB-16 is £33·81 excluding VAT and p&p.

OK Machine & Tool (UK) Ltd, Dulton Lane, Eastleigh, Hants. SO5 4AA

PANEL MOUNTED CASES

A new range of panel mounted cases which are ideal for housing projects such as clocks, meters, counters etc., have just been introduced by Perancea Ltd.

The black ABS cases are supplied with two front panels, one is an anti-reflective filter for displays and the other is anodised aluminium for mounting controls. Other features include



p.c.b. guides and slots, matt black clip-on bezels and optional mounting clamps for wood or metal panels.

There are four sizes of cases available, 96 × 48 mm and 72 × 36 mm front panels in two lengths 120 mm and 75 mm.

These cases could also make excellent housings for our *Car Instrument Devices* if the l.e.d. mountings were altered.

Distributors for the cases include Watford Electronics, Home Radio and Bi-Pak all of whom advertise in the magazine.

EPI

The 1978 edition of the Electronic Projects Index is now available. This index covers all the constructional projects published in sixteen magazines including PE, radio, television, hi-fi and computing. The projects are arranged under thirty six headings arranged alphabetically from aerials to Zener testers.

Other information given with each article includes a component guide and method of construction used, i.e. p.c.b., Veroboard etc.

The index is priced at £1·30 including p&p, and is available from **M.L. Scaife, Central Library, Northumberland Square, North Shields, Tyne & Wear, NE30 1QU.**

Market Place

ELECTRONICS 79

The Electronics 79 Show was held this year at Olympia and many of the leading UK component manufacturers and distributors were exhibiting there together with equipment, instrumentation and packaging companies.

VIEWDATA

The latest Viewdata adaptor from Labgear, the 7050 Viewdapta, was on display. This is a compact unit for receiving Viewdata which can be used with an existing TV set without modification to the receiver.

The 7050 consists of a desk top keyboard and a wall mounted Viewdata Processing Unit which are connected together via a multiway cable. A built in loudspeaker gives an audible indication of engaged, dialling and other tones obtained.

TRIACS AND THYRISTORS

Motorola were showing their range of 15 to 40A triacs which they have now fitted into a TO-3 base type package with push-on terminals.

These 200 to 800V triacs are primarily designed for full-wave control to a.c. loads and are electrically isolated from the mounting base with a high isolation voltage of 2500V. Applications include appliance controls, power supplies, solid-state relays, heating and motor controls.

Motorola were also displaying their 8A MCR 72 thyristor which needs just 30μA to trigger on and can easily be directly coupled with an MPU or other driver i.c. for power control applications.

CIRCUIT TESTER

Among the many instruments on display Vero Systems had their "Soundout" touch sensitive cable continuity tester on display which uses the body as a conductor leaving both hands free of probes.

The unit which is battery operated (9V) has a dual input impedance (15MΩ and 2·5kΩ) and is available in two versions with the MK II model having the additional feature of an earphone for noisy environments or where more than one unit is in use.

Both units have a volume control and are supplied with an interchangeable crocodile lead. A wrist strap and probe lead are available as accessories. The price of the MK I is £20·00 and the MK II is £24·00.

ZIP SOCKETS

With the high cost of LSI circuits many constructors are now using zero insertion pressure sockets to prevent pin damage to components whilst they are being inserted.

The BFI range of ZIP sockets included several new types never exhibited before. The socket range is one of the most comprehensive currently available and may be used for almost any device, including multi-pin integrated circuits axial lead components, power transistors and non-standard hybrid circuits.

Of particular interest is a new range of sockets for use with LSI devices in test equipment or development "breadboards". The sockets will accept 28 (0·4" pitch), 42 and 64 pin devices with no insertion pressure, thus eliminating the lead damage and distortion which can occur when leads are forced into spring contact sockets.

Each socket has a lever at one end which is connected to an internal cam. The device is simply dropped into the socket and the lever flicked up to positively clamp the leads inside the socket. This protects the leads from damage and ensures a good electrical connection. When the lever is released the device may be removed without force.

PLASMA PANELS

Included in the Thompson-CSF display was their TH 7604 plasma-panel module which is intended for low-capacity alphanumeric-display applications.

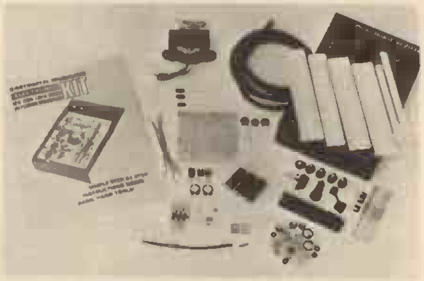
This module which includes all the necessary panel-drive electronics has a power consumption of less than 30W. Being a.c. driven, the panel itself features inherent storage which means that the high-intensity display is also free of flicker,

The module's overall dimensions are 295 × 125 × 57 mm. Its useful panel area (219 × 52mm) permits displaying up to 6 lines of 40 characters (5 by 7), with the possibility of adding underlining or a mobile cursor.

BREADBOARD KIT

The latest kit from the CSC is the protoboard PB-203AK. This kit, featured in a special pre-release offer in PE (Nov. 79), contains all the components needed to make a solderless breadboard unit with three regulated d.c. power supplies.

The kit comes complete with all the elec-



tronic components, case and breadboard modules, as well as nuts, bolts, connecting wire and solder. The assembly instructions have been written without any assumptions about the constructor's past experience.

The finished Proto-Board incorporates three large breadboards plus four long busbars and one shorter one, giving a constructional area sufficient for 24 integrated circuits in 14-pin packages. In addition, terminal posts allow connection to earth and to the +5V, 1A and ±15V, 0·5A power supplies. The power supplies are independent and fully regulated, and the ±15V supplies can be internally adjusted over the range 7–18V. The three power-supply rails allow the board to be used with most types of circuitry, including TTL and CMOS logic.

The PB-203AK is supplied with an earthed metal case measuring 248 × 168 × 83mm, and is still available for a short period at a special offer price of £55·00 excluding VAT and p&p.

DYNAMIC NOISE LIMITER

R.A.Penfold

ALTHOUGH compact cassettes have certain advantages over other forms of recording medium, they have the major disadvantage of a comparatively poor signal-to-noise ratio unless they are used in conjunction with some form of noise reduction system. Many pre-recorded cassettes are encoded using the Dolby system and are capable of excellent results, but there are still numerous pre-recorded cassettes currently available that are non-Dolby as are many cassettes purchased some time ago.

The dynamic noise limiter (DNL) which forms the subject of this article was designed for use with a high quality cassette deck to enable an improved signal-to-noise ratio to be obtained when playing non-Dolby cassettes. Of course, the unit can also be employed with a cassette deck which does not incorporate any form of noise reduction circuitry when playing any cassette. It can also be used in addition to some other form of noise reduction system to further increase the dynamic range. This can effect a very worthwhile improvement when the original recording is fairly old, and a significant amount of tape hiss has been recorded onto the cassette. It is even possible to use the unit to improve noisy f.m. radio reception, or any other programme source that is affected by low level high frequency noise.

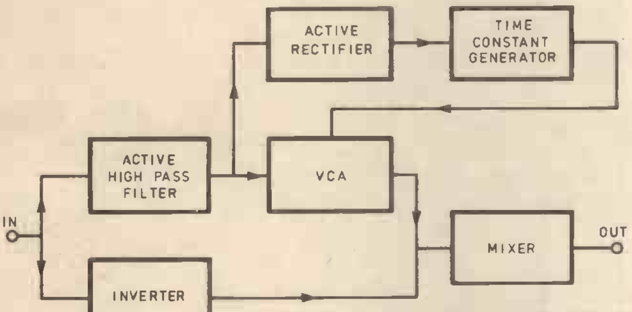


Fig. 1. Block diagram

DNL PRINCIPLE

Tape noise consists mainly of high frequencies, or to be more accurate, it is this high frequency content that tends to be most noticeable and objectionable. Turning back the treble control while playing a cassette will show this quite clearly by apparently greatly reducing the noise. It is by reducing the upper frequency response during playback that a DNL effects a reduction in tape noise, but it only applies the full amount of treble cut at low signal levels. It is then that the noise is most noticeable.

At high signal levels the treble cut is removed to some degree, and at very high signal levels it is totally eliminated. The increased tape noise will not be audible as it will be masked by the main signal.

In this way a DNL provides a very significant reduction in background noise, but there is a minimum loss of treble response.

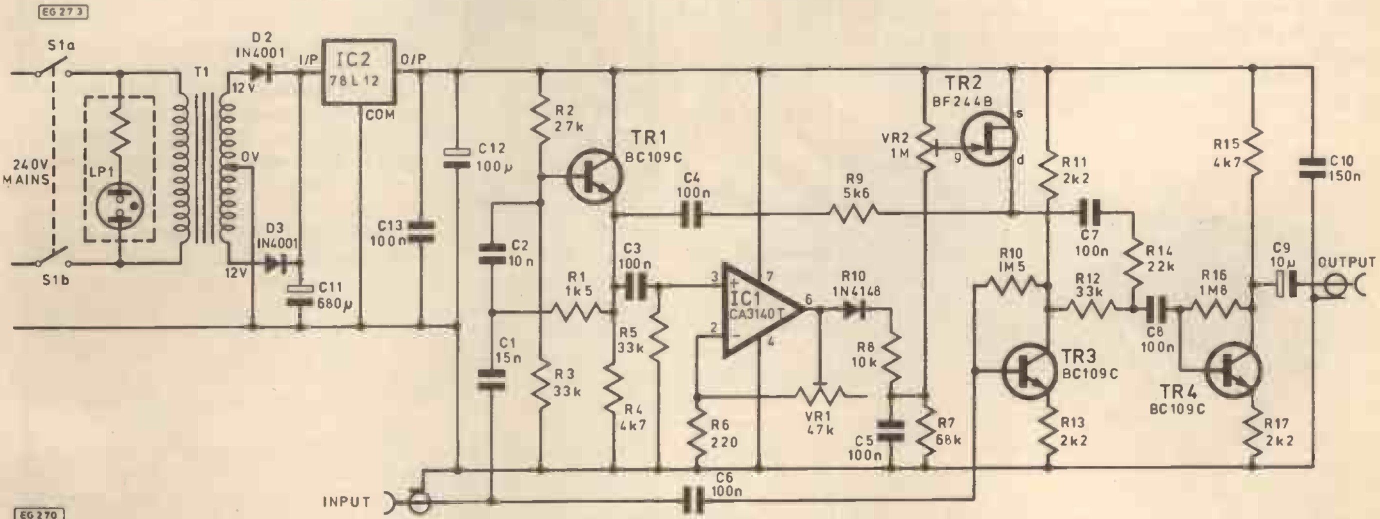


Fig. 2. Complete circuit diagram of the DNL

The DNL described in this article operates in the manner shown in the block diagram of Fig. 1. The input signal is split into two parts which are then mixed in a simple passive mixer circuit. One part of the signal is simply inverted before being fed to the mixer, and the other part is fed to the mixer via a high pass filter and a voltage controlled attenuator. The high pass filter rolls off signals below about 4kHz.

The two signals at the mixer are out of phase and therefore tend to cancel one another out. However, as only high frequencies are present at one input, it is only these high frequencies that are attenuated to a significant extent. Under quiescent conditions the VCA is adjusted to balance the two inputs and so optimise the high frequency cut. The output of the mixer is coupled to a low gain amplifier which compensates for circuit losses and provides the unit with almost exactly unity voltage gain.

Some of the output from the high pass filter is used to generate a control voltage for the VCA. An active rectifier and smoothing network are used to provide this voltage. Under low signal conditions only a very small voltage will be generated, and this will not greatly affect the circuit. Higher signal conditions will produce a large enough voltage to significantly attenuate the signal through the VCA. The higher the signal level, the great the attenuation.

If the output from the VCA is reduced, the high frequency cancelling effect on the signal from the inverter will also be reduced, and so the higher the input signal level, the less the amount of treble cut that the circuit applies. Thus the desired circuit action is provided.

The reason the active rectifier stage is fed from the high pass filter rather than the main input is that high frequency signals mask the tape noise far better than low or middle frequencies do. The unit is therefore designed to respond more readily to high frequency input signals.

CIRCUIT DESCRIPTION

The circuit diagram for one channel of the DNL is shown in Fig. 2. TR1 is used as a conventional high pass filter of the type often encountered in rumble filters, but the component values have been modified to provide a much higher cut off frequency of course. TR1 is connected in the emitter follower mode and so the filter has approximately unity voltage gain at pass frequencies.

The VCA is formed by R9 and TR2, the latter being a JUGFET which is used here as a voltage controlled resistance. TR3 is used as the inverting amplifier and this is a common emitter stage. As the emitter resistor (R13) is not bypassed and is equal in value to the collector load resistor (R11), this stage has almost unity voltage gain. R12 and R14 form a simple passive mixer circuit and TR4 is used as the output amplifier. TR4 only needs a voltage gain of a little

COMPONENTS . . .

Resistors

*R1	1k5
*R2	27k
*R3	33k
*R4	4k7
*R5	33k
*R6	220
*R7	68k
*R8	10k
*R9	5k6
*R10	1M5
*R11	2k2
*R12	33k
*R13	2k2
*R14	22k
*R15	4k7
*R16	1M8
*R17	2k2

All resistors ¼W 5% (10% over 1M)

Potentiometers

*VR1	47k hor preset
*VR2	1M hor preset

Capacitors

*C1	15n
*C2	10n
*C3	100n
*C4	100n
*C5	100n
*C6	100n
*C7	100n
*C8	100n
*C9	10µ 16V elect
*C10	150n
C11	680µ 25V elect
C12	100µ 16V elect
C13	100n

All capacitors C280 type except where otherwise stated

Semiconductors

*IC1	CA3140T
IC2	78L12
*TR1	BC109C
*TR2	BF244B
*TR3	BC109C
*TR4	BC109C
*D1	1N4148
D2	1N4001
D3	1N4001

Switches

S1	Rocker switch d.p.s.t.
S2	Rocker switch d.p.d.t.

Transformer

T1	Mains primary, 12–0–12V 50mA secondary, miniature type with flying leads (M.E.S.)

Miscellaneous

BEC case type GB1a or similar
Four phono sockets
Miniature panel neon
p.c.b.

*Indicates that two devices are required for stereo operation

EG272

Fig. 3. Frequency response (low level inputs)

more than two in order to make good the losses in the circuit, and so again an unbypassed emitter resistor is used to introduce negative feedback and set the voltage gain of the stage at the required level.

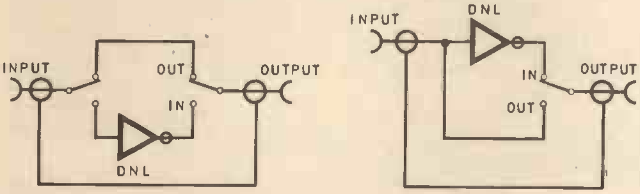
IC1 is used as a form of active rectifier, and its voltage gain is controlled by feedback potentiometer VR1. This enables the input signal level required in order to remove the treble cut to be varied over a considerable range so that the unit is suitable for use with any normal cassette deck.

VR2 enables the bias on TR2 gate to be adjusted and this control is set to slightly reverse bias TR2 so that there is only a small amount of attenuation through the VCA under quiescent conditions, and the two inputs to the mixer are precisely balanced. Only positive going output signals are produced from the active rectifier in the presence of a suitable input, and these have the effect of raising the voltage at the lower end of VR2 and removing the reverse bias from TR2. This increases the attenuation through the VCA and removes the treble cut.

C5 integrates the output pulses from the rectifier in order to prevent significant distortion, but the attack and decay times are both short so that the circuit quickly responds to changes in dynamic level. As is normal for this type of device, the circuit has hysteresis. This simply means that the attack time is faster than the decay time, which helps the unit to act as fast as possible without generating significant distortion.

The hysteresis is produced by D1 and R8. C5 is charged through the relatively low impedance of R8, but it cannot discharge through the same path since D1 prevents this. Instead it must discharge into the relatively high impedance of R7. This is the only reason for including D1 in the circuit since the CA3140 used in the IC1 position is only operated from a single supply rail, and will provide a rectifier action without D1.

With a high level input the frequency response of the unit is virtually flat over the audio spectrum, but on low level inputs the frequency response of Fig. 3 is obtained on the prototype. The attenuation rate is about 12dB per octave from 3·5kHz to 8kHz. There is a slight peak in the response at approximately 3kHz and the roll off rate above 8kHz is only very gradual, but neither of these points are of any real consequence in practice.



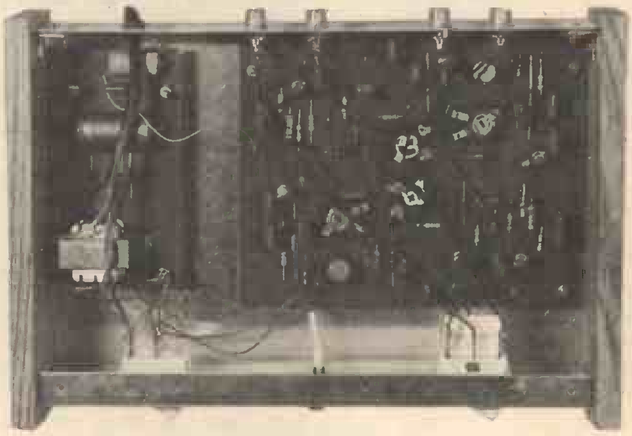
EG271 **Fig. 4 a & b. Switching alternatives**

P.S.U. AND SWITCHING

The filter is powered from a simple stabilised mains p.s.u. This is quite straight forward and consists of a push pull rectifier and smoothing network feeding a monolithic regulator i.c. A well smoothed and regulated output is provided, and the regulator i.c. has output current limiting and thermal overload protection circuitry.

In most cases it will be desirable to have some means of switching the unit out of circuit so that the cassette deck can be used normally. Some amplifiers and receivers have built in switching in the form of a tape monitor facility, or something of this nature, which could be used to accomplish this. An alternative is to use the simple in/out switching arrangement used on the prototype and shown in the circuit of Fig. 4a. This leaves the filter input permanently connected to the cassette deck output, but this does not seem to affect performance even if the cassette deck is used while the filter is switched off.

If preferred, the system shown in Fig. 4b can be used. Here the filter is switched completely out of circuit when the switch is in the "out" position, but a four pole switch is required. It would be possible to gang the on/off and in/out switches, but if this is done care must be taken to ensure that mains hum is not picked up in the in/out switch wiring. Also, care must be taken to ensure that the mains wiring cannot accidentally come into contact with the input or output wiring!



Internal view

CONSTRUCTION

The prototype unit was housed in a BEC cabinet but any case of mainly metal construction and having similar dimensions (230 × 150 × 50mm) should also be suitable. The filters and power supply are constructed on two separate p.c.b.s and these are shown in Figs. 5 to 8 respectively. The negative supply rail connection between the two panels is carried via the mounting bolts and the metal case. The earth connections between the filter p.c.b. and the input and output sockets is obtained in the same manner. The filter and p.s.u. boards should be mounted as far apart as possible.

ADJUSTMENT AND USE

In use the filter is either connected between the cassette deck output and the "tape" input of the amplifier, or it is

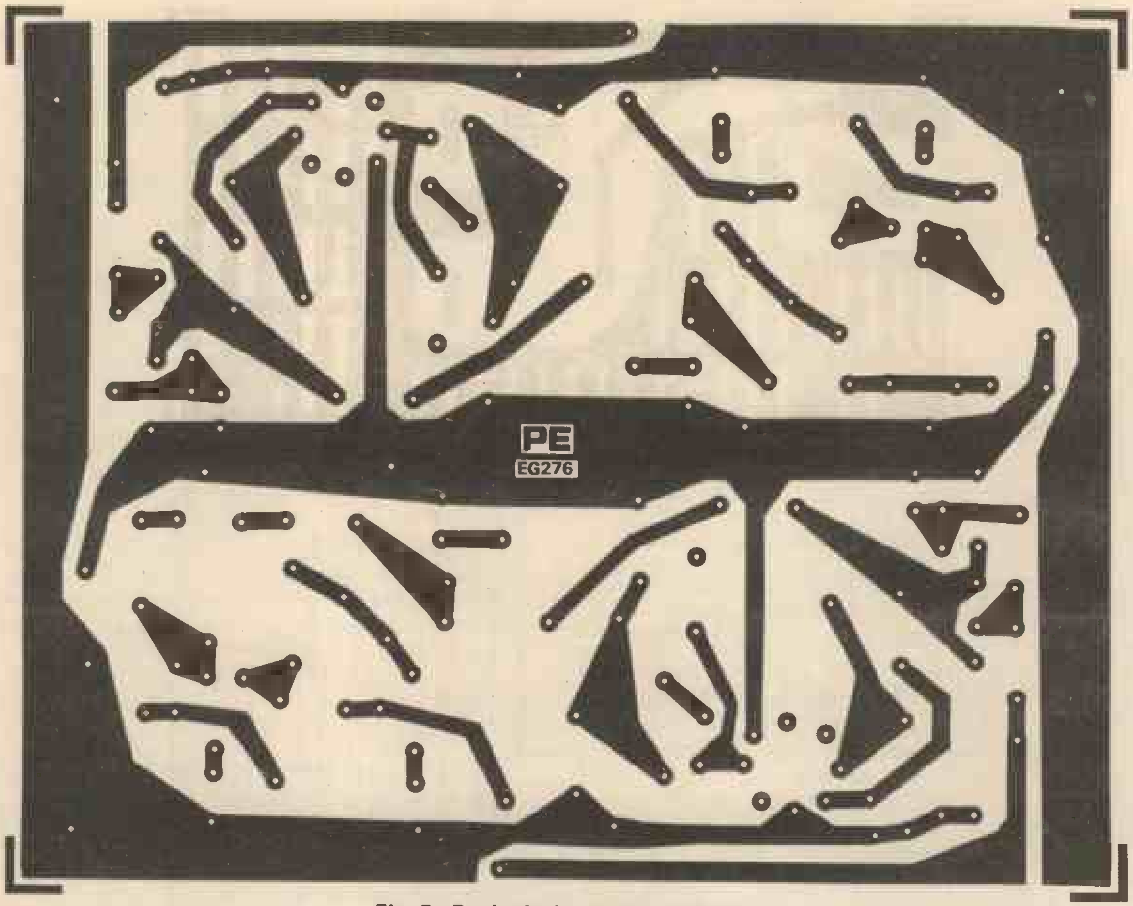
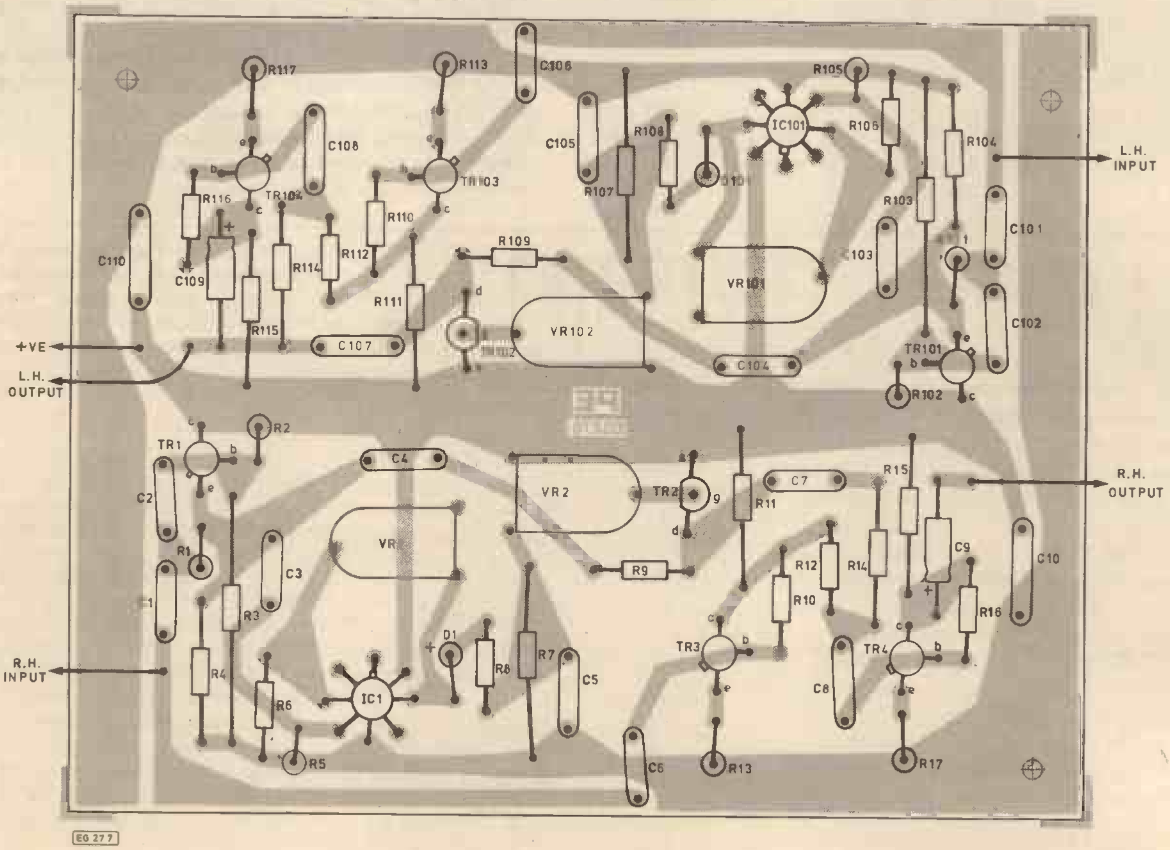


Fig. 5. P.c.b. design for the main board

Fig. 6. Component layout



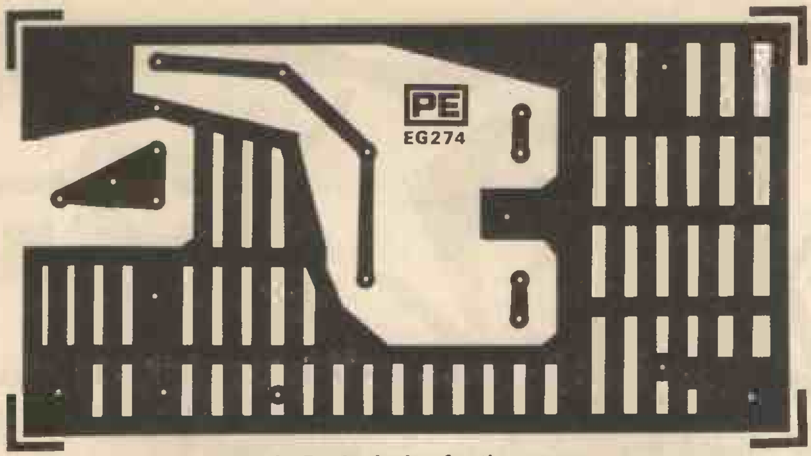


Fig. 7. P.c.b. design for the p.s.u.

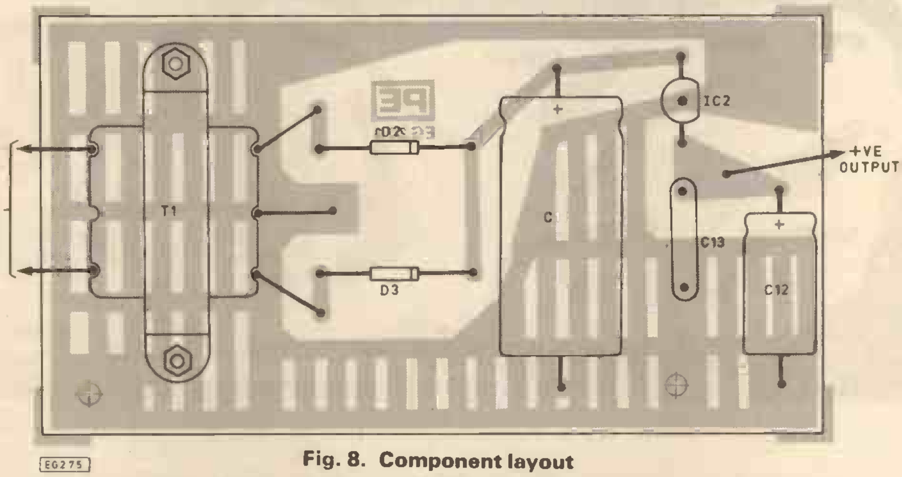


Fig. 8. Component layout

connected into the tape monitor or some similar facility. In either case both the input and output leads should be proper screened types.

Initially VR2 is adjusted in an almost fully clockwise direction and a blank cassette is played through the system to provide a source of tape noise. If VR2 is now adjusted in an anti-clockwise direction a point should be reached where there is a slight but noticeable null in the noise, with further adjustment causing a rise in the pitch and intensity of the noise. The correct setting for VR2 is at this null point and both channels are adjusted in this way.

The best setting for VR1 can be found by trial and error. The further it is adjusted in a clockwise direction, the lower the input signal level at which the treble cut starts to be lifted. It should therefore be adjusted as far in a clockwise direction as possible without the lifting of the treble cut becoming audible on low level signals. ★

MICRO PROMPT

The hardware and software exchange point for PE computer projects

If you have ever built a computer, or computer peripheral using plans from the pages of PE, then it is likely that you would have appreciated some "follow up" data on such matters as interfacing and software. Keep an eye on this new column then, if you have constructed Champ, the UK101 or a peripheral device such as our printer or VDU; for it is from this column that we hope hints and snippets of information, short programs, applications and discoveries will spring forth eternal . . . with your help of course!

Sir—Having recently built the Compukit 101 computer, I must say that I am delighted with it, although it has its limitations (one small annoying one being the lack of PRINT USING).

I find that I am learning BASIC by using the computer (hit and miss), and am following your article on learning BASIC.

However, as far as my programming is concerned, one or two things have so far eluded me, and I hope that you or your staff can help.

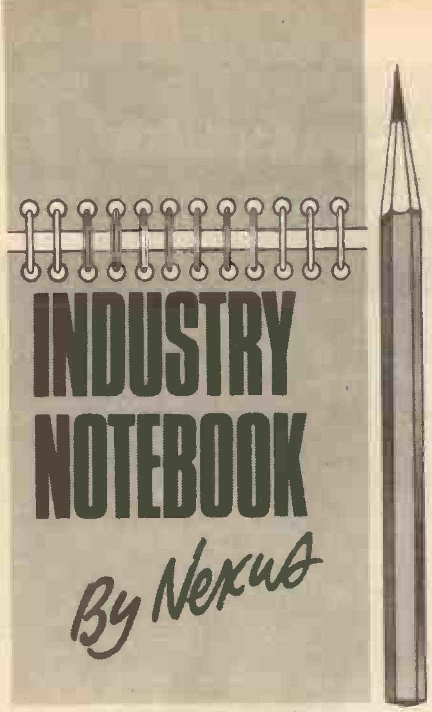
(a) What are the POKE commands to switch to printer, and to VDU, when writing programs in BASIC.

(b) Having written and loaded a program which has variables giving running totals, how can I load and save these updated programs? (I have a feeling that machine code, POKE, or something of the like is involved but what?) (I have already worked out that to run these programs, RUN sets the variables to 0, and I have to use GOTO 1 to run them without clearing the variables. The books on BASIC I have do not mention these things, which for a real beginner are a nightmare).

Iain Corrance
Glasgow

Ideally, to carry data over, and update it at will, a cassette file should be generated so that the operating program is recorded on one tape and a data file on another. Alas, the 101 does not have cassette file firmware, but we have been told it can be done using machine code routines which of course can be accessed from BASIC via USR(I). An alternative, if somewhat clumsy, is to list as DATA statements those variables you wish to maintain, before re-recording the program.

We shall endeavour to answer all questions in due course. Next month we will be publishing a game for the 101 called "Torpedo Run", and give details of an independent UK101 users club.



Shake-out

Whatever people may say of the electronics industry they can never accuse it of being dull. Change is always around. It is difficult enough to keep track of the technology, even harder to keep up with business fortunes, changing markets and who owns what, and how performance and expectations will be affected by the dynamic economic climate both at home and abroad.

How the tight monetary policy, stiffened even further by the mid-November increase in interest rates, will affect the electronics industry in the UK is still anyone's guess. So is the long-term effect of the abolition of foreign currency exchange after 40 years of restriction. And what happens in the USA affects the whole of the Western world. The dollar is unhealthy, and the USA is in another energy crisis as well as being unsettled by the run-up to the Presidential election.

Pity the poor managers and market analyists struggling with their five year business plans, so beloved and promoted by the business schools! There are so many variables in the equation in these turbulent days that it is practically impossible to formulate a coherent long term policy.

Confusion and an uncertain future, however, has not deterred people from having a go at seizing what they see as good business opportunities. Expect Racal to make further acquisitions soon. Action in this respect may also be anticipated from GEC and Thorn. Expect, too, to see more foreign investment in the UK during 1980, not excluding the Japanese. There is some timidity among overseas investors on labour relations problems in the UK but fortunately the record in the electronics industry is almost miraculously good. *Apropos* the Japanese, Toshiba alone already has manufacturing plants in seven countries outside Japan. This trend will continue.

God and Virtue

How do the Japanese do it? Have they some secret formula denied to the rest of the industrial world? There have been many attempts at analysis.

In two recent commentaries one suggests that the secret is that to a Japanese company and its employees the customer is regarded as God. Actually, not an attitude to be despised although strange for a country whose religious beliefs are principally in Buddhism which has no God and Shinto in which the object of veneration in the shrine may be anything from a stone to a household utensil in which resides the spirit.

The other preaches a virtuous circle of good industrial relations allowing management to get on full time with managing and innovation, coupled with lifetime jobs generating confidence in accepting new technology by employees instead of, as in the UK, resisting it.

In all the years of *Industry Notebook* I never imagined I should use such a heading as that above! Nonetheless, such abstract concepts are very real to the Japanese character with their singing of company songs before taking to their work benches, and their dedication to a cause as exemplified by the terrifying suicide attacks by Kamikaze pilots in World War 2.

Sting Ray

Marconi Space and Defence Systems have won their biggest ever contract in the Sting Ray project. More than £200 million in the first instance and probably worth £800 million over its lifetime of 20 years. Among the other heady statistics, 50,000 man years of work spread over a dozen cities (if you include the subcontractors) make good reading.

Sting Ray is a lightweight homing torpedo with an advanced on-board computer, a multi-mode, multi-beam sonar which detects and tracks the target while resisting false echoes and enemy countermeasures, and a quiet yet high speed propulsion system. Deliveries to the Royal Navy should start in the early 1980s and there are expectations of it being adopted by other NATO navies.

Energy

The energy crisis persists but it is now almost a way of life, the previously unthinkable £1 per gallon being now a matter of history. The Americans have a conservation policy well reflected in energy-saving campaigns in manufacuring plants strongly re-inforced by publicity in house journals. But are they taking it seriously? I had my doubts when I read in one house journal from an electronics company that temperature in the offices and factory was being maintained at a steady 78°F. Surely a misprint, but then I read that the company dress code had been relaxed to permit jackets off and ties loosened. Slowly the penny dropped. This was the Texas summer, not the UK winter. Their problem is cooling as well as heating. As much as 20 per cent is being saved by some companies by simple expedients and even further gains by the addition of MPU-controlled fine tuning of air conditioning.

Paradox

The EMI Scanner, according to the medical profession, was the greatest advance in medical diagnostics since the Röntgen's discovery of X-rays in 1895. Its creator, Godfrey N. Hounsfield, had engineering ambitions when he was a five year old tot, yet he was a late developer who didn't complete his formal engineering education until he was 30. But his most useful period of training, on his own admission, was self-tuition between the ages of 13 and 19—an encouragement to every hobbyist!

Few people could ever have received so many awards and honours for a single invention, culminating in a Nobel Prize and even more recently the 1979 Aachen and Munich Prize for Technology and Applied National Sciences. And he deserved every one of them as well as the gratitude of the sick.

What a fantastic success story for the man and, initially, for the product which up to the mid 70s was a jack-pot profit maker for EMI. Then came the big cut backs in procurement in the USA, then the biggest market, and an increasing flood of competitive equipment. As the honours poured in for Godfrey Hounsfield the debts poured in for EMI.

Bad organisation, bad management, bad luck? It is difficult to analyse, no single factor being responsible. Hounsfield's great technological achievement still stands, whatever the fortunes of his employer. All the same, one imagines he must be looking over the past five years with very mixed feelings.

A similar story, perhaps less dramatic is the scanning electron microscope, a world-beater for Cambridge Instruments, a company now in the protective embrace of the National Enterprise Board but still losing millions on a good product. And older readers may remember the British company Perdio who bravely produced the first transistor portable radio in the world before going broke.

Does it pay?

Does it pay to be first in the field? There is much to be said for the "me-too" philosophy which, put crudely, means letting someone else bear the major development costs and carry the burden of breaking open the market, then moving in at the right moment saying "me-too". I recall Motorola, in its early and middle period in semiconductors, regarding Fairchild as the innovator, TI as the market developer and themselves as the "me-too" company with special skills in manufacturing coming in later with fast delivery and keen prices.

On the bid front Decca looks even more vulnerable. Thorn, at the time of writing, was still battling for EMI and GEC for Avery, their bid having been upped to a £98 million package.

FRANK W. HYDE

DEATH OF A SATELLITE

One of the most remarkable satellites launched in recent years is the United Kingdom, ARIEL V. It has enjoyed 5 years of great activity. When it was originally launched it was not expected that its operable life would be much more than a year because the propane fuel thrusters would run out of gas. This would deprive the control centre of means to "point" the satellite at suitable targets. The amount of data accumulated for the estimated period alone would have been a major contribution. In fact the satellite has been operational far beyond expectations. This has been due to the expertise developed by the team at the control centre, the Appleton Laboratory near Slough at Ditton Park.

Among other things this team developed a technique which enabled them to economise the gas use thereby adding years to the useful operation. This in itself was a magnificent contribution. Even when the gas was finally exhausted, use was made of the Earth's magnetic field to maintain some control. In all this the team have been very modest. This official statement of the record of this mission is extremely restrained:

> "The success of Ariel V is twofold: Outstanding scientific observations have been made by Ariel V and have established the UK group at the forefront of X-ray Astronomy.
>
> "The technical expertise and knowhow in the fields of satellite and data management which have been built up in the Control Centre at the Appleton Laboratory are second to none and invaluable for subsequent projects, and could be an important factor in the UK involvement in future international space programmes."

Ariel V was launched on the 15th of October 1974 to make observations of cosmic X-ray sources. With 5 years of observations completed it is clearly the most successful UK satellite to date, both operationally and scientifically. The spacecraft, designed and constructed for SRC by Marconi Space and Defence Systems, contains six scientific experiments provided by the Mullard Space Science Laboratory, of University College London, The University of Leicester, Imperial College, London and the Goddard Space Flight Centre of the US.

TECHNICAL ACHIEVEMENTS

The establishment of the Ariel V Control Centre at Slough in 1974 was the beginning of a major initiative in the area of satellite control and space data support as a complement to the established space project management. It is being further improved for support of the Infra-Red Astronomical Satellite (IRAS).

The staff responsible for the design of the Ariel V covered the following expertise. Electronics, real time software, data communications, celestial mechanics, operational research and large scale data processing. The electronics were needed for the building of the special computer interfaces and data display equipment; the real time software knowledge was needed for the satellite control and data reception; data communications skill was required for the setting up of links between Control Centre real time computers, the Laboratory mainframe computer, back-up computers and computers at four University sites. The celestial mechanics knowledge was required for the design of orbit prediction programmes, attitude computation and observation programmes; O.R. techniques were used to optimise the gas control, finally data base on a large scale was needed for preprocessing of the satellite data.

The Control Centre had two objectives:

1. To control the spacecraft and its experiments and, by monitoring the critical satellite sub-systems, keep the satellite in a safe and healthy state.
2. To interact rapidly with the astronomers.

FLEXIBILITY

Both these objects were achieved successfully. The second objective was however the most successful for it had a major impact on the programme. The key was the observing programme which was so flexible that astronomers were able to interact with the Control Centre and alter plans within an hour or so. The system operates as follows. The prime Ground Station for Ariel V is the NASA Ground station at Quito in South America. The satellite passes over Quito every 90 minutes. During a satellite pass commands are sent to the satellite and data received from it on-line in the Control Centre. As soon as the raw telemetry data are received they are checked and re-formatted. Orbit and Attitude computations are carried out and data tapes created for each experimenter. These preprocessed data are then transmitted by Post Office lines to Birmingham, Imperial College, Leicester and the Mullard Space Science Laboratory. Data will be received within 45 minutes of the satellite passing over Quito. Thus it is feasible for the experimeter to examine his on-line data and request a change in the observing programme *in time for the next pass*. This important feature was a basic requirement for the Control Centre because of the nature of the experiments. Frequently one of the two scanning experiments would detect an X-ray source which was new. The versatility of the control would enable the satellite to be manouevred so that the four pointing experiments could examine this source in detail. The value of this facility is very great for the reason that many sources are transient and in a few hours could fall in brilliance below detectable level.

MAGNETIC MANOEUVRES

In the early days the attitude of the satellite was controlled by the propane gas jets at the base of the satellite. The gas was expected to last a year, in the event it was prolonged by nearly three years by the ingenuity of the control team. The gas finally ran out in June 1977. Since then attitude has been controlled by using a magnetic dipole cancellation system. This was of course not installed for that purpose but to prevent magnetic drift. In a sense it could be said that it was used in reverse. Since the satellite has an equatorial orbit it passes through the field lines of the earth's magnetic field. By passing a small current round the loop the earth's field was used to control the attitude of the satellite. The torques made available thus, were able to achieve manoeuvre rates of 10°/day in right ascension and 0·5°/day in declination.

The death of Ariel V is expected between the middle of January and February 1980.

THE EXPERIMENTS

Project Scientist: Professor A. P. Willmore, Department of Space Science, University of Birmingham.

A. **University College London's Mullard Space Science Laboratory, Holmbury St. Mary, Dorking.**
Measurement of X-ray source positions and sky survey in the energy range 0·3 to 30keV. This pointing experiment uses a rotation modulation collimator with proportional counters and channel electron multipliers as X-ray detectors, together with a collimated photomultiplier for optical star detection. **Principal Investigator:** Professor R. L. F. Boyd.

B. **Physics Dept., University of Leicester, University Road, Leicester LE1 7RH.**
Sky survey in the energy range 1·5 to 20keV. This scanning experiment, which views from the side of the spacecraft, uses large proportional counters. **Principal Investigator:** Professor K. A. Pounds.

C. **UCL Mullard Space Science Laboratory.**
Study of the spectra of individual sources in the 2 to 30keV range. This is a pointing experiment using a proportional counter. **Principal Investigator:** Professor R. L. F. Boyd.

D. **Physics Dept., University of Leicester.**
Measurement of the polarisation of X-rays from 1·5 to 8keV. This pointing experiment will determine polarisation or line emission by means of a Bragg crystal spectrometer using moveable plane crystals. **Principal Investigator:** Professor K. A. Pounds.

F. Physics Dept., Imperial College, London SW7.
The study of sources of high energy X-rays up to 2·0MeV. This pointing experiment uses an active collimator, a caesium iodide scintillator and photomultiplier detectors. It is designed to investigate the energy spectra and time variations of known sources and to measure the spectrum of the diffused cosmic X-ray background. **Principal Investigator:** Professor H. Elliot.

G. Goddard Space Flight Centre, Greenbelt, Maryland, USA.
An all-sky monitor in the energy range 3 to 6keV. This survey experiment uses two pinhole sensors to detect transient effects in the X-ray sky enabling the other experiments to make the earliest possible measurements on these important phenomena. **Principal Investigator:** Dr. S. S. Holt.

ARIEL 6

Ariel 6 which followed Ariel 5 has also a lifetime of about one year. It has not so far achieved full design operation because the control system has been subject to interference from both Russian and American radar systems. The effects are varied but one troublesome one is that the satellite switching is corrupted. However valuable data is still being acquired.

THE MAGNETIC FIELD SATELLITE (MAGSAT)

MAGSAT is for the purpose of studying the movements of the Earth's crust and the location of mineral deposits. It is a polar orbiting satellite, and is designed to measure the Earth's near surface magnetic fields and indirectly crustal features related to earthquakes. During the life-span of this satellite which is 120 days it will measure the strength and trace the direction of both the global magnetic field and surface magnetic fields. The surface magnetic fields are caused by the electric currents effect of magnetic storms and by certain elements in the Earth's crust. For example one large magnetic surface anomaly is due to an iron deposit in Africa. This was detected by a satellite magnetometer. After making this survey it will be possible to make available maps of the Earth's surface showing the location of magnetic irregularities and a global magnetic field model.

Having completed the surface irregularities it will be possible to gain a better understanding of the evolution of the crust of the Earth and the various geological processes which have led to the formation of ore and petroleum deposits. This satellite possibility has only recently been understood when satellites, carrying magnetometers for the measurement of the global fields, mainly due to the Earth's core and working in low orbits showed anomalies which were localised.

It has been known for many years that some rock formations are better conductors of electricity than others and that these played a part in indicating where mineral and petroleum deposits could be found. What was a surprise was that satellite location was possible. The data produced by six satellites carrying magnetometers has led to this special satellite experiment. It is hoped also to shed more light on the reversing of the Earth's magnetic field over cycles of time. It is known now that the field suddenly collapses and slowly rises but in the opposite mode where north becomes south. The building up may take a longer time perhaps a thousand years. There are many consequences of such a happening. It could be responsible for sudden destruction of species of animals or other life.

The clues to drift of continents may help to anticipate earthquake events when the magnetic and gravitational anomalies are better understood. This project will involve most countries in the world over the next two years.

Countdown

Organisers: Please send details of exhibitions, club open days and other events to Mike Abbott at least six weeks in advance. Inclusion will be subject to space etc.

BEX Feb. 20-21. Pavilion Bournemouth. **K**
IEA/Electrex Feb. 25-29. National Exhibition Centre, Birmingham. **I**
Viewdata March 26-28. Wembley Conference Centre, London. **O**
Computer-Aided Design (conference & exhibition) March 31-April 2. Metropole, Brighton. Details: CAD 80/0483-31261
Seminex April 14-18. Dept. Physics, Imperial College, London. **HI**
Communications 80 April 14-18. National Exhibition Centre. **I**
Electronic Test & Measuring Information April 22-24. Wythenshaw Forum, Manchester. **T**
International Conference On The Electronic Office April 22-25. London Penta Hotel. Organised principally by the Institute of Electronics & Radio Engineers. 99 Gower St., London WC1E 6AZ
North Midlands Mobile Rally April 27. Drayton Manor Park, Tamworth, Staffs. Details: Norman Gutteridge, 68 Max Rd., Quinton, Birmingham.
All-Electronics Show April 29-May 1. Grosvenor House, London. **E**
The Mersey Micro Show April 30-May 2. Adelphi Hotel, Liverpool. **O**
Compec Europe May 6-8. Centre International Rogier, Brussels. **L**
Great British Electronics Bazaar June 20-22. Alexandra Palace. **E**
Intel Fair June 24. Wembley Conference Centre, London. **U.**
Tempcon July 1-3. Wembley Conference Centre. Exhibition devoted to temperature control & measurement. **T**
Transducer July 1-3. Wembley Conference Centre. **T**
Microsoftware (symposium) July 7-10. University of Sussex. **SI**
The 1980 Microcomputer Show July 10-12. Royal Lancaster Hotel, London. **O**
Avionics (symposium) Sept. University of Surrey. **SI**
Harrogate International Festival of Sound Aug. 16-19 (18 & 19 trade). The Exhibition Centre + hotels. **X**

E Evan Steadman, 34-36 High st., Saffron Walden, Essex. ✆ 0799 22612
HI Seminex Ltd., 79 High st., Tunbridge Wells, Kent. TN1 1XZ. ✆ 0892 39664/5
I Industrial Trade Fairs, Radcliffe Ho., Blenheim Court, Solihull, W. Midlands B91 2BG. ✆ 021-705 6707
K Douglas Temple Studios, 1046 Old Christchurch Rd., Bournemouth, Dorset BH1 1LR. ✆ 020 20533
L Iliffe Promotion, Dorset Ho., Stamford St., London SE1 9LU. ✆ 01-261 8437/8
O Online Conferences, Cleveland Rd., Uxbridge, Middx. UB8 2DD. ✆ 0895 39262
T Trident International Exhibition, Abbey Mead Ho., 23a Plymouth Rd., Tavistock. Devon PL19 8AU. ✆ 0822 4671
U Brian Crank Associates, 58 London Rd., Southborough, Kent. ✆ 0892-31812 38414
X Exhibition & Conference Services, Claremont Ho., Victoria Ave., Harrogate, Yorks. ✆ 0423-62677
SI Society of Electronic & Radio Technicians, 57-61 Newington Causeway, London SE1 6BL. ✆ 01-403 2351

News Briefs

SEASIDE COMPUTER CLUB

A COMPUTER club in the Bournemouth area has successfully taken off, the first meeting of which was held at the Poole Arts Centre on October 28th last year.

The response was very good and the club looked all set to form a committee. A second meeting was organised for November 30th at Kinson Community centre, where it was expected that a representative from Tandy would demonstrate some equipment.

Details from Robin Pink, 10 Harbour View Road, Poole, Dorset.

Semiconductor UPDATE...

FEATURING ZN419CE 87C48 MCM68732

R.W. Coles

MODEL CIRCUIT

If you are interested in the radio control of model 'planes, ships, cars or robots, then you will be very pleased with the Ferranti ZN419CE device because it could save you money on servos. For the uninitiated, servos are used in radio control models to position control surfaces and other mechanisms. Their great advantage over the now rather outdated "on-off" escapement actuator is that they provide a proportional control action which is not jerky.

The R/C modeller controls his creation by adjusting a joystick potentiomenter which causes the transmitter to send out a pulse width modulated signal where the width of pulses is proportional to the deflection of the control. If more than one control function is required, then the associated pulse width signals are time multiplexed and sent to the model in a repeating sequence.

At the receiver the separate channel signals are recovered by demultiplexing, and it is the function of the servo to respond to the changing width of individual channel pulses by producing at its output an angular change proportional to the joystick deflection at the transmitter. The servo output is linked to control surfaces or engine controls, with the result that the model responds in a smooth, proportional manner to every new control setting selected by the modeller.

The clever bit, as if you hadn't guessed, is turning those variable width pulse signals into a proportional mechanical movement, and that is where the Ferranti ZN419CE comes in. The motive power for the servo is usually provided by a small d.c. motor linked via gearing to the output shaft or lever, and to a variable potentiometer which rotates in synchronism with the servo output. The pot is there to provide information on the present servo output setting, and the pulse signal is there to tell the servo system what new setting is required. Inside the ZN419CE there is a monostable which has to be connected to the servo-pot so that the monostable pulse width is proportional to the pot position. A pulse comparator in the chip compares the monostable pulse width with the received pulse width for the channel, and the result is an error pulse which is stretched and used to turn on one of a pair of external *p.n.p.* drive transistors which control the motor current.

The motor turns to drive the servo pot (and of course the servo output shaft) until the monostable pulse width is equal to the received pulse width, whereupon the motor stops.

A great deal of "electrickery" is necessary to produce a practical servo decoder and driver, but fortunately you can get most of it in the 14 pin package of the ZN419CE.

Complete servo modules are already available for R/C modellers of course, but by using the ZN419CE in a home-built servo it should be possible to save money. It would also be possible to use this device in "special" servos, just what you need, perhaps, for that towering microprocessor based robot you've been working on in the garage!

CMOS SINGLE CHIPPER

Intel were one of the first in the field with a true single-chip microprocessor CPU, RAM and ROM all in a single 40 pin package. Their original 8048 and 8748 devices have now been joined by a whole family of similar devices such as the 8021, 8022, 8035, 8039, 8041 and 8741 featuring various combinations of memory and input/output lines.

Most of these devices are of little interest to hobbyists because they utilise mask-programmed ROM to hold their programs, but those with a "7" as their second digit are useful, even for one-off projects, because they employ program memory of the erasable and reprogrammable (EPROM) variety.

The 8748 for example, although intended as a prototyping aid for the pin compatible 8048, can be very useful where the small size of a single chip system is desirable. It contains within its 40 pin package a digital processor system complete with 1K of EPROM, 64 bytes of RAM a programmable counter/timer and no less than 27 lines of I/O.

Hats off to Intel then for a useful workhorse, but it is not the 8748 I want to tell you about because it isn't really new. The 87C48, however, is very new and it comes from Intersil, the CMOS wizards of Cupertino, California. It seems that Intersil have an agreement to second source the highly successful Intel device, but although identical to the 8748 in most respects, the 87C48 adds that magic ingredient, CMOS technology, to make a good thing even better. It runs from a 5 volt supply, just like the NMOS 8048 but the Intersil device consumes a maximum of 50mW against well over 300 mW for the Intel part at the same 6Mhz clock frequency.

Rumour has it that the 87C48 will actually cost less than the 8748 when it starts to appear on stockists shelves early in 1980, a fact which could make it very attractive for battery powered hobby projects. One problem though, the 87C48 uses a different EPROM technology to that of its Intel cousin and cannot therefore be programmed by using a standard 2716 programmer and a pin-out adapter. Putting together a special programmer circuit may prove to be well worth the effort, however!

HALF A LOAF

Talking of EPROMs, you may already know about the current world shortage of devices such as the 2716, an effect which has apparently been caused by the popularity of 5 volt EPROM technology in general, combined with a long delay before the appearance of alternative sources to challenge Intel.

Some second sources have appeared however, notably Texas Instruments, closely followed by a collection of Japanese manufacturers, but now Motorola have made a surprise entry into the fray by introducing not just another second source for the 2716, but a brand new device with four times the capacity, the MCM68764. This monster 8K x 8 EPROM has leap-frogged the biggest Intel device, the 4K x 8 2732, and will surely carve out a useful niche for its canny manufacturer—you could get a fair sized BASIC interpreter into a single MCM68764!

Making a device with no less than 65,536 separate bits to go wrong is quite a challenge but Motorola obviously hope to achieve useful yields. Those devices that do get rejected may not be wasted however, because Motorola have also announced the MCM68732 which is, surprise surprise, half of an MCM 68764!

They don't saw an MCM 68764 down the middle, they just use a reject device where one complete half of the memory is still fully serviceable. The new '32 comes in two versions, −1 or −0, where the suffix indicates whether the most significant address bit (pin 21) should be tied permanently high or low. This technique is becoming more widespread as memories grow in size, and Intel themselves already sell "partial" versions of some of their memory parts, particularly 16K dynamic RAMs.

Half a loaf is better than none seems to be a fitting motto for tomorrow's memory makers!

SOLDERING IRON CONTROLLER

M.S. DHINGRA

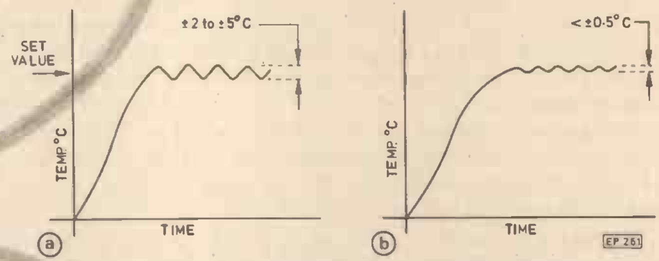


Fig. 1. Control characteristics of (a) on/off controller (b) proportional controller

IN the workshop probably the least cared for tool is the soldering iron, excessive temperature of which can ruin present day CMOS devices and f.e.t.s. This article describes a highly sensitive and responsive unit for controlling the tip temperature of soldering irons. The unit can also be used for other appliances like a colour developer bath etc., where a very accurate temperature within the range of ±0·5°C is required to be maintained, by a single adjustment.

In the ordinary solid state heat control systems, power to the element is usually delivered through a triac. At the preset temperature level the triac is switched off. Power to the element is switched on with the differential drop of the controller which is in the order of ±2° to ±5°C. Such 'on–off' control produces large overshoots and undershoots and therefore the heat regulation is coarse.

For more accurate control, power is delivered to the element continuously. Only the duty cycle of the power is varied to achieve the maintaining level. The variation of duty cycle or the pulse width, controls the temperature. Such a method is termed as proportional heat control system as it draws the energy in proportion to the requirement. The temperature control characteristics of the above two systems are shown in Fig. 1.

SCHEMATIC

A block schematic of the proportional heat control unit is shown in Fig. 2. A1 is an integrator, which integrates any error signal developed due to the difference in sensor diode drop and set reference. The resulting integrated voltage change on biasing resistance R regulates the charging current to capacitor C of the square wave generator A2. The charging and discharging of C determines the output pulse width of A2. The regulated pulse width in turn controls the duty cycle of the firing of the triac correcting the sensor temperature and returning the sensor voltage to that of reference. As the sensor temperature is gradually corrected, the pulse width of A2 also changes due to decreasing error. At equilibrium, the pulse width stays at the maintaining level, when the error signal is zero. Maintainance of the constant temperature is possible only due to the holding feature of integrater A1. When the integrator input error signal is at zero level, the integrator output holds at existing level, this in turn holds the controller output pulse width. The resultant input and control curves are shown in Fig. 3.

CIRCUIT

The circuit diagram of the system is shown in Fig. 4. General purpose 741 operational amplifiers are used for the integrator as well as multivibrator.

The split supply to the system is ±5·6 volt derived from a centre tapped transformer T1 and regulated by Zener diodes D3 and D4. Capacitors C1 to C4 serve for storage and to supply ripple free current.

Two 6 volt batteries can also be used. Silicon diode (D5's) negative temperature coefficient characteristics has been used for the sensor. For this purpose the author used a diode type 1N914, however silicon *n.p.n.* transistors like BC107 etc., with the base and collector tied, can also be used with the same accuracy.

Current to the sensor diode is limited within 1 to 5 mA by resistance R3.

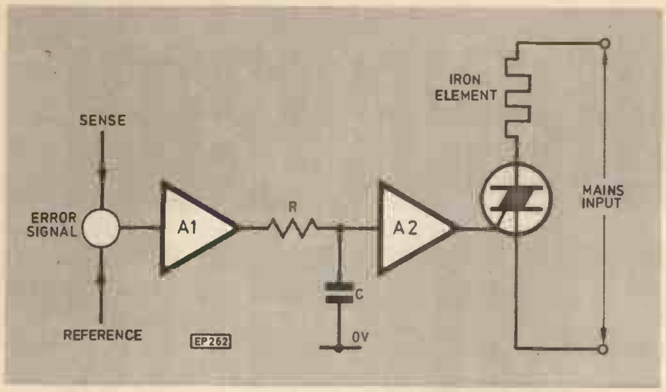


Fig. 2. Block diagram

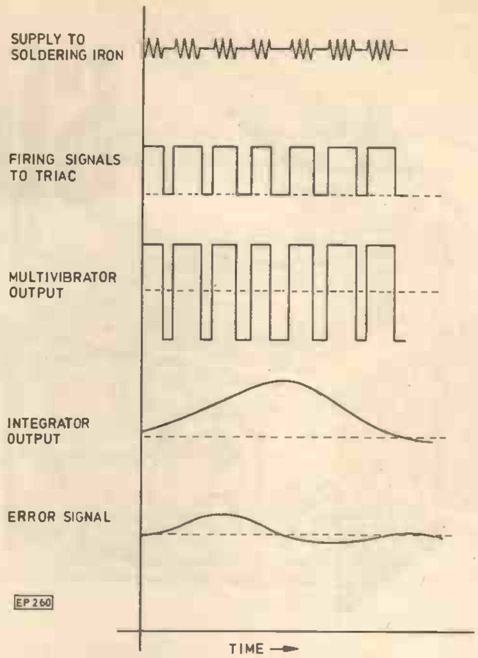


Fig. 3. Control graphs

The sensors output is fed to the inverting input at pin 2 of integrator IC1, through a resistor R8. The reference signal is generated by a 2·2 volt Zener diode D6 and this reference potential is divided by the chain VR1, VR2, R6, and R5. While VR1 is the calibration preset, VR2 is the control potentiometer.

The potential at the wiper of VR2 is fed to the non-inverting input at pin 3 of integrator IC1 through a resistor R7. C5 is the integrating capacitor. Its value in combination with R8 defines the rate of charge.

Integrator output at pin 6 is fed to C6 of the multivibrator formed around IC2, through resistor R9. The potential here regulates the charging current of C6 and therefore the output pulse width at pin 6 of the multivibrator IC2.

The frequency of the multivibrator is defined by the value of R12, which is about 70Hz with the values used. The ratio of R11 to R10 defines the maximum mark-to-space ratio, that is the maximum conduction period for the triac during one cycle of the multivibrator.

The pulse width controlled output at pin 6 of IC2 swings between the positive and negative supply lines and rectified by diode D7 to give positive pulses for triac firing. These are fed to the gate of the triac through current limiting resistor R13. The triac remains on during the entire positive gate pulse period providing a supply to the soldering iron.

ASSEMBLY

The p.c.b. of the control unit is shown in Fig. 5 and the component placement in Fig. 6. Fix the components in place with due care for polarities. The assembled p.c.b., supply transformer, triac and the three pin socket outlet should be mounted in a suitable metal box.

Mount the triac on a heatsink, well insulated from the metal cover. Fix the control pot VR1 on the front of the cover, with a knob graduated evenly to read 200° to 300°C for its full variation.

Clamp the sensor diode onto the metal body of the soldering iron, near the insulated handle grip, well away from the tip. This is because silicon diodes operation is limited to 150°C. Further, for a 100°C variation of tip temperature from 300° to 200°C, a variation of 10°C from 145° to 135°C is present at the location indicated, making it the best place for monitoring the tip temperature. Connect the sensor leads with the control unit by means of a screened shielded cable, caring for the proper polarity of the diode.

CALIBRATION

Before energising the unit, check once again that all connections are made properly. Now switch on the supply to the unit, without a soldering iron at the socket outlet and measure across Zener diodes D3, D4 and D6 that the voltages are +5·6, −5·6 and +2·2 volts with respect to common point. Also check the functioning of free-running multivibrator by a multimeter set to the range 10 volts d.c.

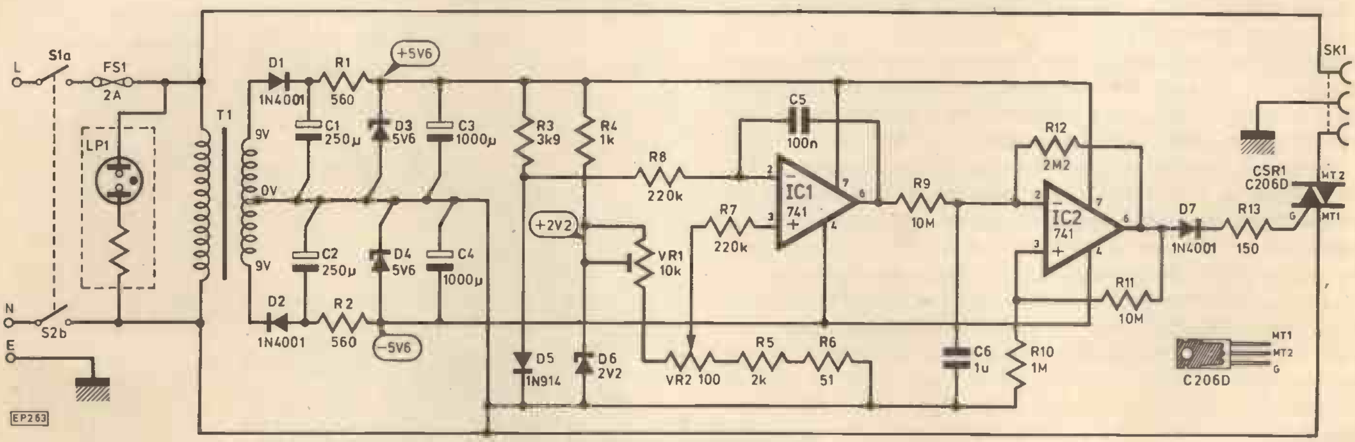
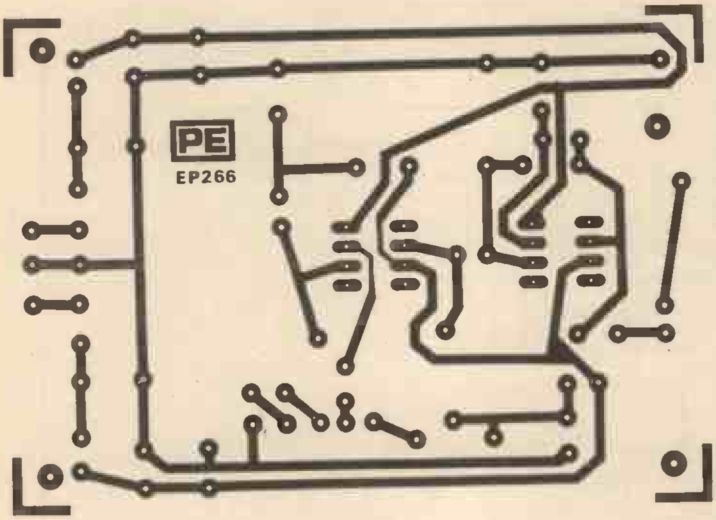
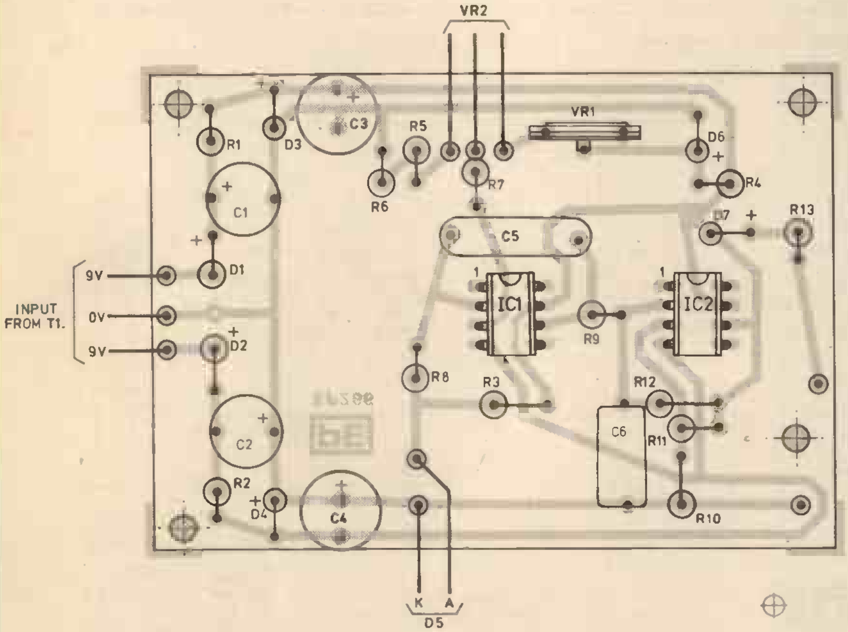


Fig. 4. Circuit diagram





COMPONENTS

Resistors

R1, R2	560 1W
R3	3k9
R4	1k
R5	2k 2%
R6	51 2%
R7, R8	220k
R9, R11	10M
R10	1M
R12	2M2
R13	150

Capacitors

C1, C2	250μ elect
C3, C4	1,000μ elect
C5	100n polyester
C6	1μ polyester

Semiconductors

D1, D2, D7	1N4001
D3, D4	BZX85–5·6 1·3W Zener
D6	BZY88–5·6 400mW Zener
IC1–IC2	741
D5	1N914
CSR1	C206D 400V/3A triac

Potentiometers

VR1	10k
VR2	100 linear

Transformer

T1	230V pri.—9–0–9V, 400mA sec

Miscellaneous

S1	Double pole mains on/off, FS1-2A fuse, LP1-mains neon

Fig. 5. P.c.b. layout of controller

Fig. 6. Component layout and external wiring

between pin 6 of IC2 and neutral, oscillations should be observed.

Now, energise the soldering iron from a normal supply source, not through the unit, and let it heat for about thirty minutes, to get the iron's temperature and in turn the sensor's output stabilised. Keep pot VR1 set to maximum resistance and turn the control potentiometer anticlockwise, i.e. at 200°C mark. Connect a multimeter set to the 10 volt d.c. range between pin 6 of IC1 and common point.

The voltage indicated will be zero. Now slowly reduce the resistance of VR1 until the meter needle remains at about 5V. Slow needle movement is due to integrator action.

Now turn VR2 to its other extreme (300°C), and the meter needle will swing back to zero value.

With careful setting of VR1, arrange that the transition of the meter deflection from 0 to 5 volt commences at exactly mid position of the control pot VR2, i.e. at 250°C mark. You will be able to achieve this state in two to three steps. Now plug in the soldering iron at the socket outlet of the control unit and temperature control is yours.

NEXT MONTH

CAR-RADIO...

A five push button long and medium waveband car radio for under £11. This design employs an excellent tuner head with a ceramic i.f. module and 6W i.c. output stage to give exceptional performance for price. Our article will give full constructional details.

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Four frequency ranges giving 10Hz to 5MHz minimum, at 200mV sensitivity. A detailed article and straightforward construction, plus a 200MHz prescaler make this one of the best designs ever published.

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PRACTICAL
ELECTRONICS

OUR MARCH ISSUE WILL BE ON SALE FRIDAY 8 FEBRUARY 1980

THE ULA

UNCOMMITTED LOGIC ARRAY

E. FRY B.Sc.

CUSTOM designed integration may be every designers dream, but it is the financial planners nightmare, for with every i.c. needing its own individual mask the cost is enormous and must be borne by the buyer. Therefore, custom designed integration is usually confined to applications involving large volume production, and is impractical for smaller low cost projects.

Universal logic elements endeavour to maintain the advantage of custom circuits while reducing some of their disadvantage. They are produced as standard devices designed to fit user application with little modification required, this consisting of custom design for the metallisation mask used on a standard logic array. Such universal logic elements appear in the ROM, PLA (programmable logic array) and ULA (uncommitted logic array) and it is this which will be looked at.

THE ULA DESCRIBED

As the name implies, the ULA consists of a single chip containing an array of uncommitted gates or cells in which the silicon wafers are processed up to the stage just before the final metallisation and then stored. Each cell is separate and all that is required is a mask for an interconnection pattern, this being designed for the users specific circuit requirements. As the individual component in each cell can be readily interconnected, a combination of linear and digital circuits can be produced.

The success of the ULA is due to Ferranti who developed the CDI (collector diffusion isolation) process. A feature of CDI which gives it its facility is that the bulk semiconductor material used within the i.c. can be used for supply and ground return currents. This process greatly assists the manufacture of ULAs as all power rails are removed from the top interconnection plane, enabling the interconnection pattern to be devoted to purely programming the cells.

SCHEMATIC

A schematic diagram of the CDI process is shown in Fig. 1.

The low resistivity of the collector isolation diffusion allows supply connections to be made without metal, and earth connections can be made direct as the epitaxial p layer is on a p type substrate.

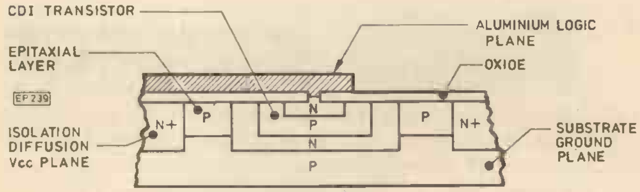


Fig. 1. The CDI process

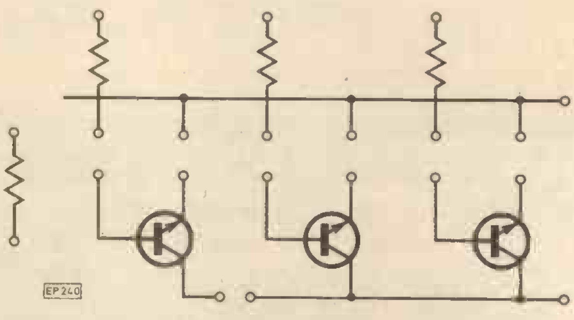


Fig. 2. Basic uncommitted cell

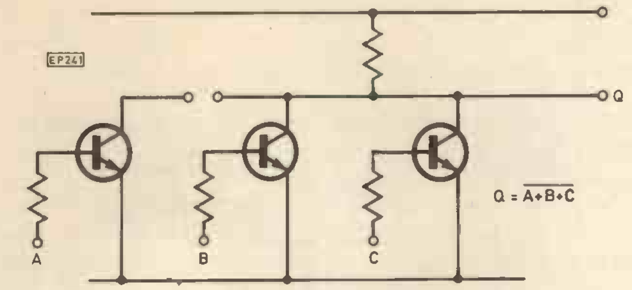
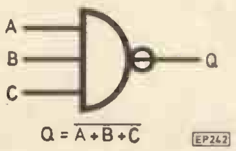


Fig. 3. Gate cell



A	B	C	Q
0	0	0 =	1
1	0	0 =	0
0	1	0 =	0
1	1	0 =	0
0	0	1 =	0
1	0	1 =	0
0	1	1 =	0
1	1	1 =	0

Fig. 4. Logic symbol and truth table

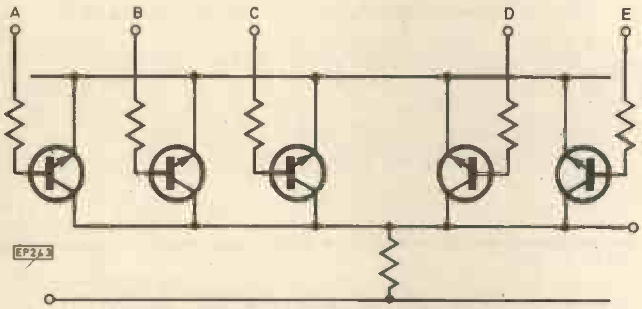


Fig. 5. Collector ORing to increase fan-in

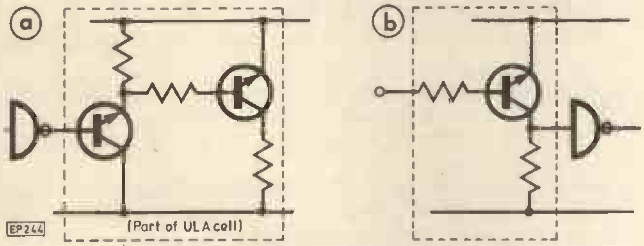


Fig. 6(a). Input interfacing (b) Output interfacing

The basic uncommitted cell (Fig. 2) consists of three transistors and four resistors, thus providing the usual RTL logic. Though each individual component can be connected as required, the most common cell connection to be found in the array is shown in Fig. 3. This is called the basic gate cell. It is a positive NOR gate, giving great versatility as a basic building block. Fig. 4 shows the truth for this gate. How these gates can be used as complete circuit functions will be shown later.

INCREASING FAN IN

An example of inter-cell connecting can be seen when designing for a higher fan-in, as in Fig. 5, where components from two cells are used to increase the fan-in to five. This technique termed 'collector ORing' can be used to increase the fan-in up to a maximum of ten. The remaining transistor and two resistors can be used in some later stage.

Owing to the cell being uncommitted, interfacing can be achieved directly for most types of logic and circuitry. In Fig. 6 we see how interfacing is done by using components from one cell. As the maximum input current for the interface gate is in the order of 40μA, it allows several gates to be driven from any of the typical logic families. For example TTL will drive up to ten ULA interface gates, CMOS, ten also. DTL up to six, etc. Output interfacing is capable of driving much lower numbers though, such as TTL—three gates. This can be increased by paralleling the interface gates, thus three ULA gates will drive nine TTL gates.

ULA is also capable of driving directly l.e.d.s, and discrete transistors, etc, and in such a mode of operation a total of 10mA drive current is available.

APPLICATIONS

The basic uncommitted cell can be connected to provide a large variety of linear and digital circuits. A few of the many ways in which the basic ULA can be used as building blocks are shown in Figs. 7 to 10.

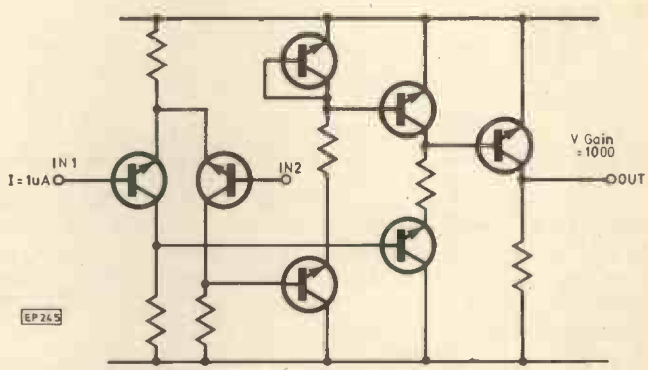


Fig. 7. Operational amplifier, using 13 components from three cells

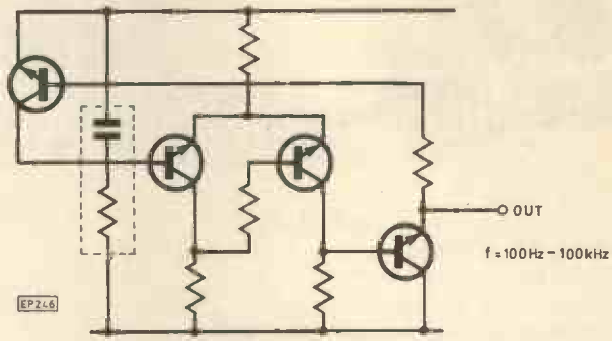


Fig. 8. Basic oscillator, using ten components from two cells and external timing R/C network

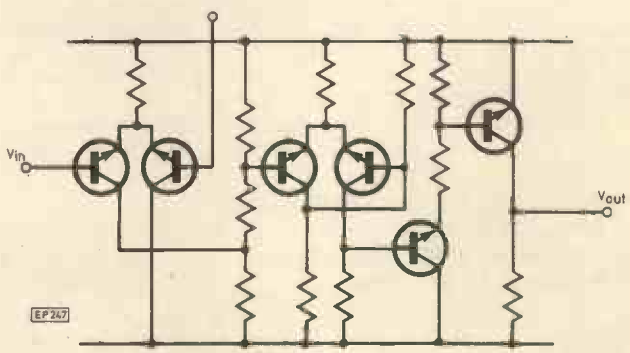


Fig. 9. Analogue voltage comparator using 17 components from four cells

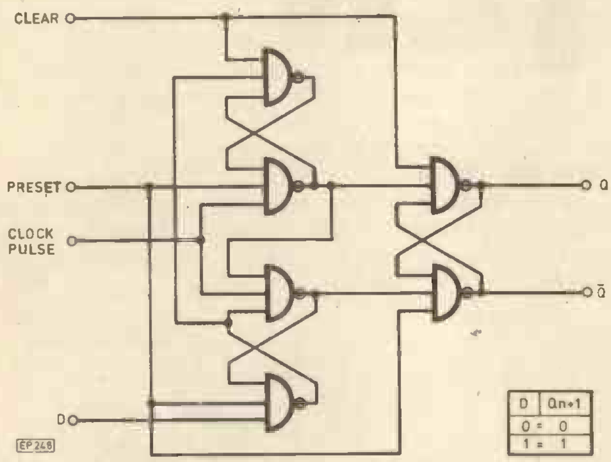


Fig. 10. D type flip-flop using all components from 6 cells

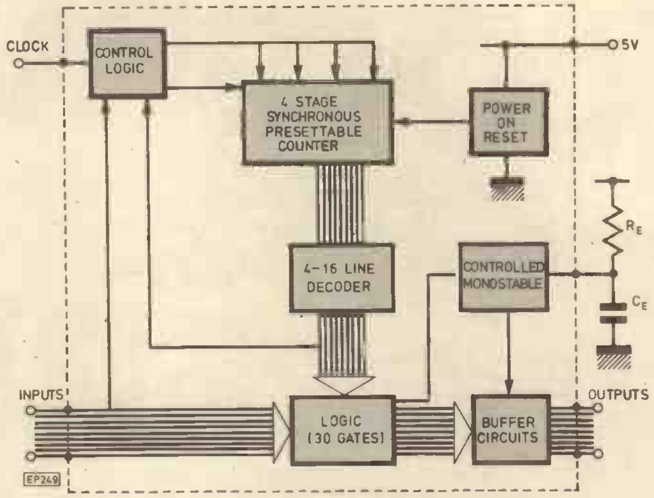


Fig. 11. A photographic control system using ULA

An example of how an entire array may be committed to perform a set function is shown in Fig. 11. An automatic control for an item of photographic equipment, containing all the necessary logic in one 28 pin i.c. package. It utilises approx. 140 of the cells, and replaces an equivalent 20 packages of MSI.

To summarise then—ULA, because of low cost and quick availability is ideal for smaller projects, and as an evaluation vehicle. It saves space and assembly costs. Both reliability and performance are greatly improved; basically everything that custom designed integration offers, but cheaper and faster. ★

TELECOMMUNICATIONS SYSTEMS FOR TECHNICIANS 1
by Walker & Danielson
Published by Newnes-Butterworths
103 pages. Price £2·95

PRIMARILY intended for TEC (Technician Education Council) level students taking courses in electronics, telecommunications and marine radio, this volume should prove popular to a wide readership as it covers a wide range of subjects at elementary level; information transmission, radio, radar, radio navigation, telephony, telegraphy, routing and data communication.

The text is well illustrated by over 180 diagrams and where applicable, BS symbols are maintained throughout.

To check recall simple revision exercises terminate each chapter.

SEMICONDUCTOR TECHNOLOGY
Edited by G. W. A. Dummer
Published by Pergamon Press
203 pages. Price £20

THIS is a collection of papers read at the Seminex technical seminars held at Imperial College, London, during the period 10–14 April, 1978. Topics cover a variety of developments in semiconductor technology.

TELEVISION PRINCIPLES AND PRACTICE
by Zarach & Morris
Published by Macmillan Press
294 pages. Price £12·50 hardback, £5·95 paperback

ANOTHER volume that caters for the various television options within the TEC framework as well as City and Guilds courses.

Throughout, circuits relate to modern TV receivers which include transistor, i.c.s., thyristors, etc.

The first three chapters cover the science of colours and the formation of monochrome and colour signals. Then follows a review in block form of the receiver which forms the basis of circuit analyses for future chapters.

Throughout the book emphasis is placed on the practical aspects of TV servicing and as such should prove invaluable to anyone professionally involved whether experienced or just beginning a career. This applies equally to the enthusiastic amateur.

AUDIO SYSTEM DESIGN FOR SCHOOLS AND COLLEGES
by R. H. Welch, B.Sc.
Published by NCST Trent Polytechnic
195 pages. Price £2·75

IN contrast to many books on this subject which set out the relative merits of design bricks in the audio chain tailored to a specification with the inevitable juxtaposing of commercially available systems, this book introduces the basic ideas necessary for the enquiring reader to design and build his own.

Aimed primarily at sixth formers and college students it forms an excellent practical guide and reference for the construction of turntable, pick-up arm, amplifier and loudspeaker cabinets etc., in project work allied to formal Engineering courses.

Albeit motivated academically it is pitched at a level which should prove enlightening to anyone brave enough to go it alone on a d.i.y. system. Take heart, lasers and digital encoding aren't mentioned.

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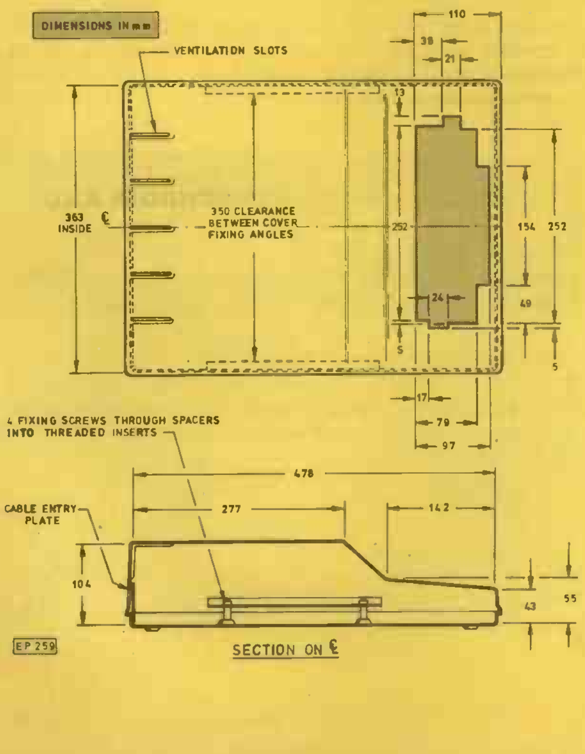
This beautiful orange and black finish plastic case is available for Superboard II, Compukit UK101 or, with an uncut keyboard panel, for mounting many other hobby computers. It is supplied with a mounting wedge to give a suitable keyboard angle and fixing screws for Superboard or Compukit. The case is strong enough to support a small portable TV or video monitor and has ventilation slots and a cable access panel at the back. It **does not** carry the "PE Compukit" badge shown in the photograph.

The dimensions of the case (with Superboard keyboard cut out) are shown below—case material is approximately 2mm thick with 4mm radius corners. We recommend that the power regulator fitted to Compukit boards is mounted on a heatsink and fixed to the outside back of the case.

The front cover illustration shows part of our own office system employing this case. PE has been able to arrange this special price so don't miss out as the offer closes Friday 29th February 1980.



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PATENTS REVIEW...

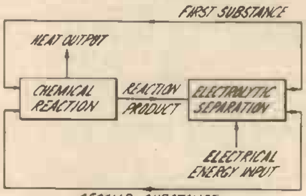
BATTERY ALTERNATIVE

The Secretary of State for Industry has patented (British patent No 1 552 436 which dates from 1976 and is thus issued under the old laws), an interesting idea for storing large quantities of electrical energy by chemical means other than a vast and expensive battery of electrolytic cells. The inventor, Albert Montgomery, suggests that the system could be used either to even out the peak and low load demands on an electric power station or to drive a vehicle.

The invention relies on a reversible exothermic chemical reaction, that is to say a reaction which produces heat from the mixture of two materials which are subsequently recovered and regenerated by electrolysis. This process is, under some conditions, more efficient at the bulk storage of energy than a conventional battery.

Fig. 1 shows the flow diagram for the cycle of the combination of the two materials

FIG. 1.



to produce a heat output from exothermic chemical reaction and a resultant electrolytic separation of the reaction product resulting from this. Recombination to produce the original materials for recycling is effected by the electrical energy input.

Fig. 2 shows the basic "circuit". Two stainless steel vessels, 1, 2 contain sodium and sulphur respectively. These raw materials are fed through valves to reaction vessel 5 which is of heat and corrosion-resistant material. Copper conduit 6 for a fluid to be heated (for instance water or gas) is coiled round the vessel 5.

The sodium and sulphur react together to form sodium polysulphide with the release of considerable quantities of heat energy. This energy is taken up by the fluid in the coil 5 and led off to a load.

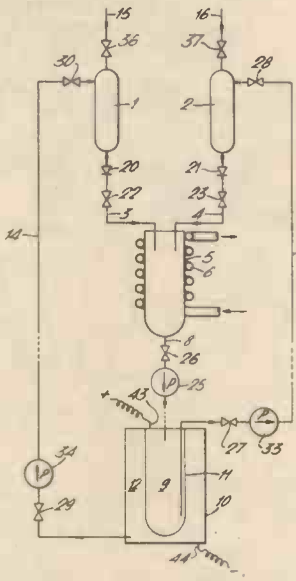
The load is a heating stage for an electric turbine or vapour engine for a vehicle, such as a Stirling cycle heat engine.

The spent polysulphide is fed to recovery cell 10 which has a blind-end tube of solid beta-alumina electrolyte. This tube defines a cathode 9 inside an anode 12. A 3 volt d.c. supply is fed through the electrodes to the polysulphide, and sodium ions are conducted through solid electrolyte 11 to the anode while the sulphur remains in the cathode 9.

Regenerated sodium and sulphur are then recycled to the containers 1 and 2. Thus the patented energy storage system has a capacity limited only by the size of the storage containers.

Supplies of polysulphide can be converted to sulphur and sodium throughout the entire period when there is excess power available, for instance during low-load night conditions on the national grid, and supplies of sodium and sulphur recombined to provide heat and generate power during the

FIG. 2



entire period when there is a heavy load on the grid. In this way large quantities of electrical energy can be stored at far more economical price than with conventional batteries and without recourse to exotic alternative energy storage techniques, such as pumping water up a hill, lifting weights up a slope or compressing gas into vast reinforced cylinders or underground caves.

The fact that the British government has patented the invention suggests that its practical use is under serious consideration. The idea could perhaps also be applicable to domestic central heating. The chemicals would be separated on night storage rates and combined during the day to produce hot water for central heating.

PE/LEKTROKIT PRIZES

The following prizes were awarded as a result of the PE/Lektrokit competition run in our September 1979 issue.

1st Prize a Lektrokit Powerace 102, a jumper wire kit and 16 pin Test Clip goes to *Mr. D. J. Speakman* of Braintree for his dual timebase submission.

Runners up prizes have been awarded to *Mr. T. Johansson* of Sweden for a l.e.d. logarithmic level meter; *Mr. I. M. Crann* of Brecon for a novel tone generator for electronic organs and to *Mr. T. Davies* of Swansea for a combined voltmeter/logic scope.

Due to the very limited number of entries, first, third, fourth and seventh prizes only have been awarded.

POINTS ARISING

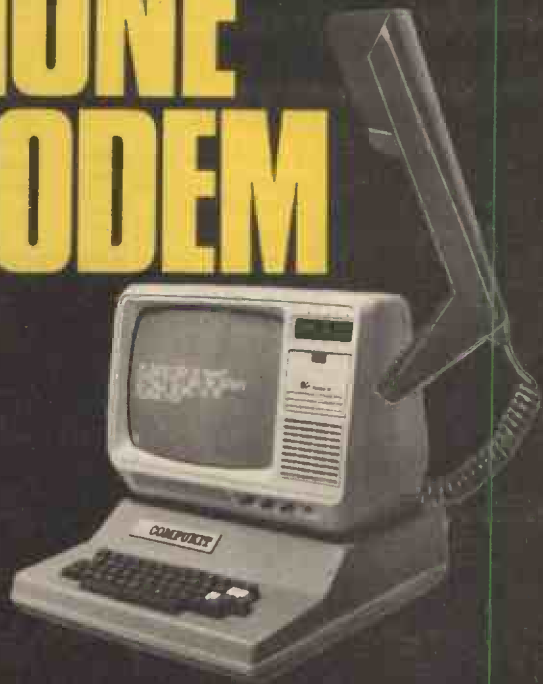
ULTRASONIC CLEANER *(January 1980)*
The value of C2 should be 150pF and not 15µ.

ULTRASONIC BURGLAR ALARM *(December 1979)*
The 18V battery voltage should be wired through the keyswitch instead of the neutral lead.

DIGITAL TEMPERATURE CONTROLLER *(October 1979)*
The wiper and top end of VR1 should go to +9V and not to IC1/14 (p.c.b. is correct).

ACOUSTICALLY COUPLED TELEPHONE MODEM

Kenneth Amor



THIS article outlines the methods used to send and receive digital information, and shows in detail an inexpensive method of accomplishing this using conventional telephone facilities. The Acoustic Modem allows data and software exchange almost instantly, over any distance.

Data to be transmitted over varying distances has been standardised in its format, known as the American Standard Code for Information Interchange, and is abbreviated to ASCII. The ASCII Code format is shown in Fig. 1.

ASCII CODE

Every Alphanumeric character to be transmitted differs in bit pattern, and even the number of bits varies. It is possible to identify the whole of the ASCII character set using only seven bits, plus the start and stop bits. Fig. 2 shows this set of characters with their respective logic levels.

A code can be obtained for every Alphanumeric character, *and* many other characters to be found on certain keyboards.

THE MODEM

The acoustic modem is able to deal directly with the waveform shown in Fig. 1, because it is in serial form. A typical period for one bit is ten milliseconds, thus allowing one character to be transmitted in approximately 100 milliseconds. The bit period may be varied depending upon whether electromechanical or all electronic data transmission/receiving equipment is being used.

Having applied data to the Modem we now wish to transmit same over many miles to a fellow computer user, and it is a question of sending and receiving this digital information over long distances without tampering with post office equipment. The answer is, of course, the acoustically coupled telephone modem. By inserting the handset of a domestic telephone into this device, data may be transmitted and received at will, albeit somewhat slowly.

The principle of operation employs frequency modulation techniques involving the phase locked loop principle. A full explanation of how the complete system works is given in conjunction with the circuit diagrams of Figs. 5, 6 and 7.

Constructional dimensions are given for both the standard telephone handset and the trimphone version. Of course, two such acoustic modems will be required to set up a data link, but it is assumed that each enthusiast would construct just one modem.

THE FREQUENCY SHIFT KEYED TRANSMITTER

The voltage controlled oscillator section of the phase locked loop (IC2) is utilised for the 1000Hz tone. The capacitor C1 and resistors VR2, VR3 are responsible for setting this initial frequency. This 1000Hz tone would be present for the logic level "0" on the input of the transmitter. This situation is so when TR1 is turned off. If now a logic level "1" is applied to the data input, IC1, using double negation, follows the input voltage level and therefore turns on TR1, effectively connecting R3, VR2 in Parallel with R4, and VR3. The new resistance value produced by this resistor combination produces a new VCO frequency of 1200Hz which is the frequency representing logic level "1". Pin 4 on IC2 (4046) contains the frequency shifting signal that is applied as base current to TR2 via R6. TR2 drives the miniature loudspeaker producing the two audible tones which represents the corresponding logic levels of input data. When the modem is in the "Send" mode the 1000Hz tone can clearly be heard from within the modem.

SETTING UP THE FSK TRANSMITTER

(a) Switch the Modem to SEND.
(b) Apply a short circuit to the data input.
(c) Connect a frequency meter to TP.
(d) Adjust VR3 until 1000Hz is shown on frequency meter.
(e) Now remove the short circuit from the input and apply +5V with respect to the common connection.
(f) Adjust VR2 until the new frequency becomes 1200Hz i.e. 200Hz *change* between "0" and "1".
(g) An audible indication will verify that all is well as these two frequencies are trimmed.

When this has been carried out it is worth applying a low frequency square wave to the data input of the transmitter to ensure that the frequency shift operation follows the logic levels being applied. A circuit suitable to carry out this test is shown in Fig. 4.

THE RECEIVER SECTION

Let us assume we are receiving the transmitted signal from a distant modem. The modem at our end picks up from the telephone handset the faint signals and applies them to an audio amplifier (IC3). A gain of approximately 100 was found to be sufficient to provide a working signal for the phase locked loop (IC4). C2 couples the FSK (Frequency-Shift Keying) signal to pin 2 of IC4. Diodes D5, D6, across R16 serve to provide some degree of limiting, as well as protection to IC4's input. Limiting by D5, D6 prevents amplitude modulation interference. The timing components VR1, C3, determine the frequency that the phase locked loop will free run at. This frequency should be adjusted to be 1100Hz, i.e. between the two FSK frequencies to be received. When a logic "0" is received (1000Hz) at pin 2 of IC4, the phase locked loop will lock onto this causing the voltage controlled oscillator of the PLL to suddenly shift from 1100Hz to 1000Hz. As this happens, the output signal from the phase comparator (pin 7 of IC4) becomes negative with respect to the reference potential at pin 6 of IC4. This potential difference will force the d.c. comparator IC5 to swing negative and this output signal will be caught at approximately −0·5V by D7 when the logic "0" is received. If now we receive a logic "1" signal (1200Hz) at pin 2 of IC4, the PLL will lock with its VCO frequency at 1200Hz, resulting in the phase comparator output becoming greater than the d.c. reference on pin 6 of IC4. Thus the voltage comparator IC5 responds with an output voltage positive going. It will in fact saturate in the positive direction at about 4·4 volts, providing an adequate logic level to become our Data output. C5 is chosen for determining the lock range of PLL, while R19, C6, R20, C7, R21, C9 form a filter network preventing the possibility of the VCO frequency, or harmonics, upsetting the output comparator.

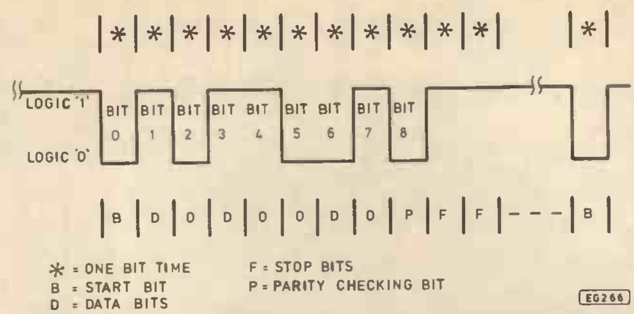
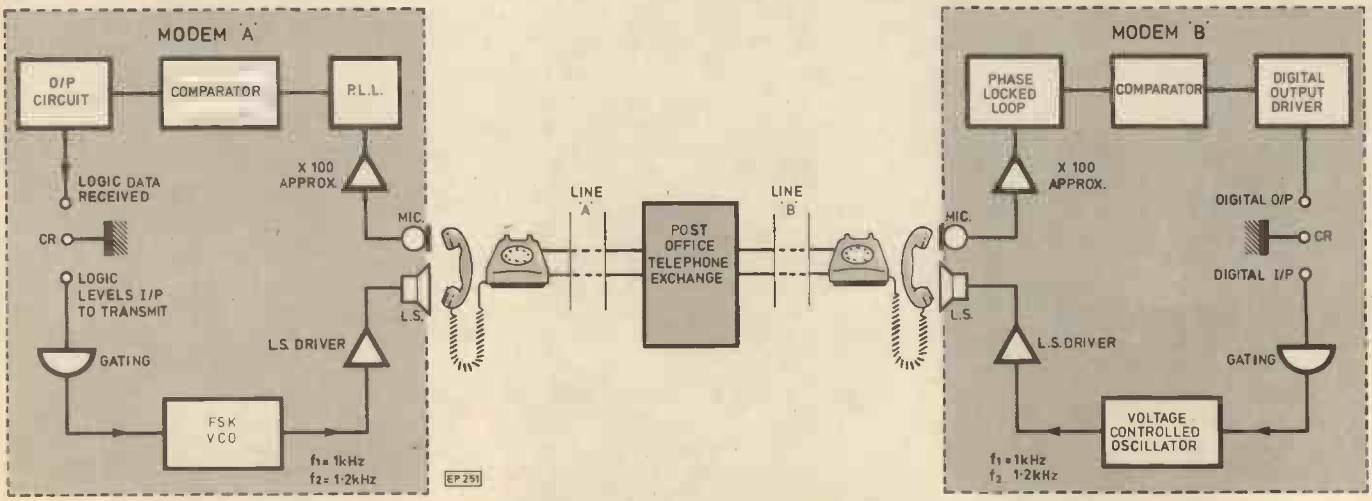


Fig. 1. ASCII code format, in this case representing the character "M"

b7→b5 / b4→b1	000	001	010	011	100	101	110	111
0000	NUL	DLE	SP	0	@	P		p
0001	SOH	DC1	!	1	A	Q	a	q
0010	STX	DC2	"	2	B	R	b	r
0011	ETX	DC3	#	3	C	S	c	s
0100	EOT	DC4	$	4	D	T	d	t
0101	ENQ	NAK	%	5	E	U	e	u
0110	ACK	SYN	&	6	F	V	f	v
0111	BEL	ETB	'	7	G	W	g	w
1000	BS	CAN	(	8	H	X	h	x
1001	HT	EM	)	9	I	Y	i	y
1010	LF	SUB	*	:	J	Z	j	z
1011	VT	ESC	+	;	K	[	k	{
1100	FF	FS	,	<	L	\	l	|
1101	CR	GS	—	=	M	]	m	}
1110	SO	RS	period	>	N	∧	n	~
1111	SI	US	/	?	O	—	o	DELete

Fig. 2. The ASCII code, showing the binary equivalents of each character

Fig. 3. Block schematic of the Modem link-up. The system is half-duplex. Serial pulse repetition rates should be no higher than the VCO Tx frequency. Input levels are TTL. Applications might include micro' link-ups at 110 Baud, VDU communication using a 20mA loop, facsimile transfer etc. Trials with the Modem included a link-up with a teletype from Bebington (Merseyside) to Luton



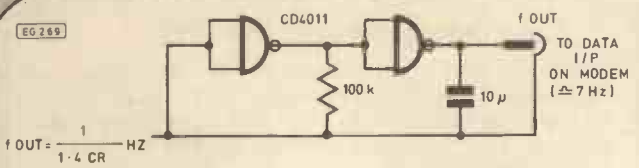


Fig. 4. Test oscillator for FSK transmitter

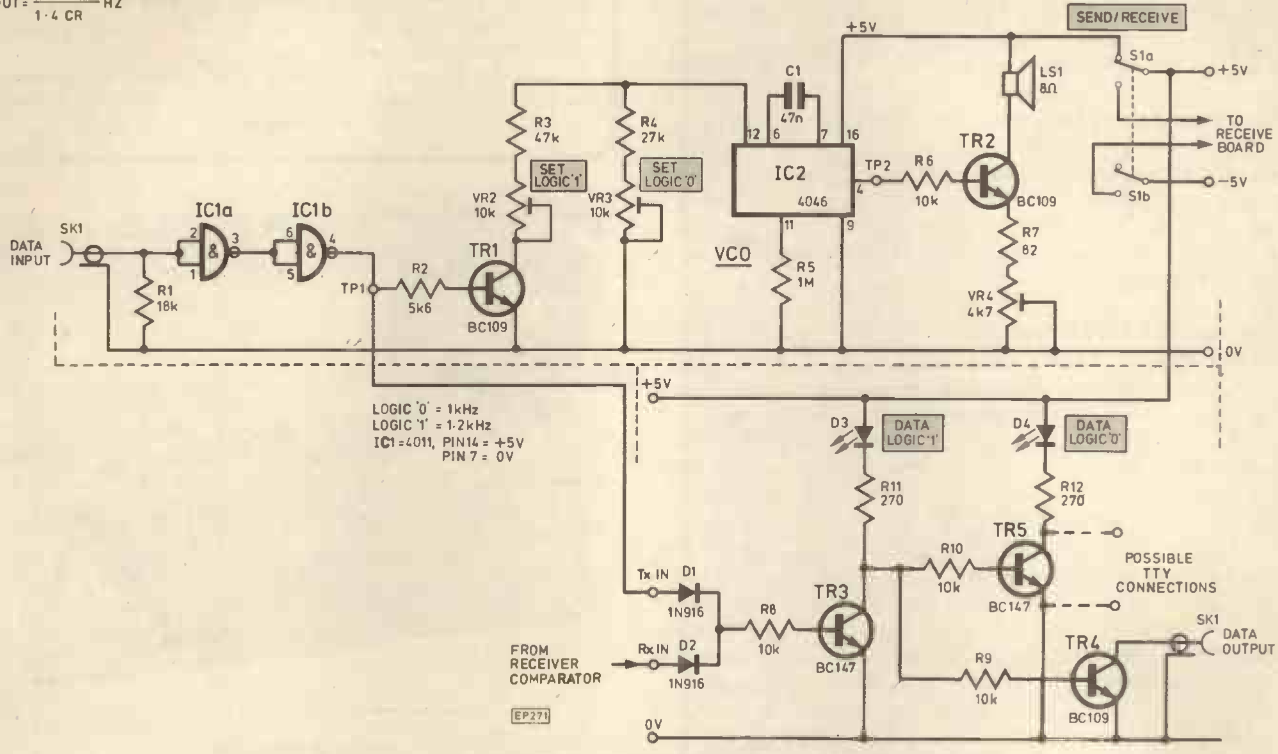


Fig. 5. FSK transmitter of Acoustic Modem

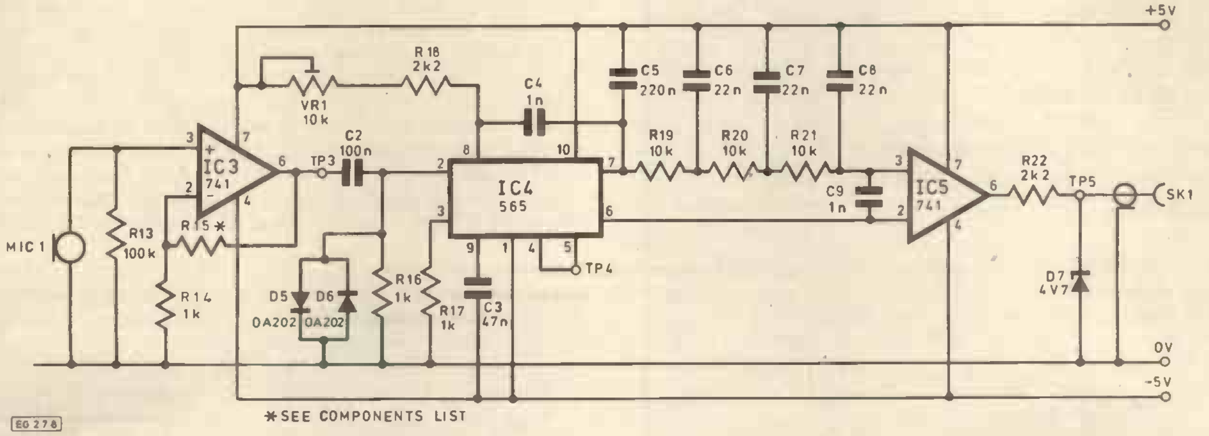


Fig. 6. FSK receiver section

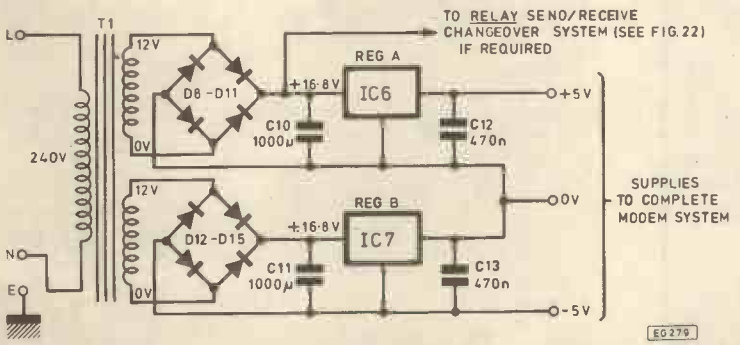


Fig. 7. PSU. ±5V at 100mA

COMPONENTS . . .

Resistors

R1	18k
R2	5k6
R3	47k
R4	27k
R5	1M
R6, R8–R10, R19–R21	10k (7 off)
R7	82
R11, R12	270 (2 off)
R13	100k
R14, R16, R17	1k (3 off)
R15	100k nom. (subject to trimming)
R18, R22	2k2 (2 off)

All resistors 5% $\frac{1}{4}$W unless otherwise stated

Capacitors

C1, C3	47n WIMA FKC-3 temp. stable or equiv. (2 off)
C2	100n
C4, C9	1000p (2 off)
C5	220n
C6–C8	22n (3 off)
C10, C11	1000µ/25V (2 off)
C12, C13	470n (2 off)

Ratings and types not critical unless specified

Potentiometers

VR1, VR2, VR3	10k preset (3 off)
VR4	4k7 preset

Transistors and Diodes

TR1, TR2, TR4	BC109 (3 off)
TR3, TR5	BC147 (2 off)
D1, D2	1N916 (2 off)
D3	l.e.d. (red)
D4	l.e.d. (green)
D5, D6	OA202 (2 off)
D7	4V7 Zener (BZY 88)
D8–D11, D12–D15	1A 50V rectifier bridge (2 off)

Integrated Circuits

IC1	CD4011
IC2	4046
IC3, IC5	741
IC4	565
IC6, IC7	5V 1A regulator (plastic)

Miscellaneous

Crystal microphone insert
Miniature loudspeaker 8Ω 100mW
Transformer 0–12V: 0–12V: 3VA
I/O d.i.n. socket (3-pin)
Double-pole, double-throw switch (send/receive)
Veroboard 137 x 64mm (5 x 2·5ins.)
I.c. board type: PCB421 available from **West Hyde Developments Ltd.**

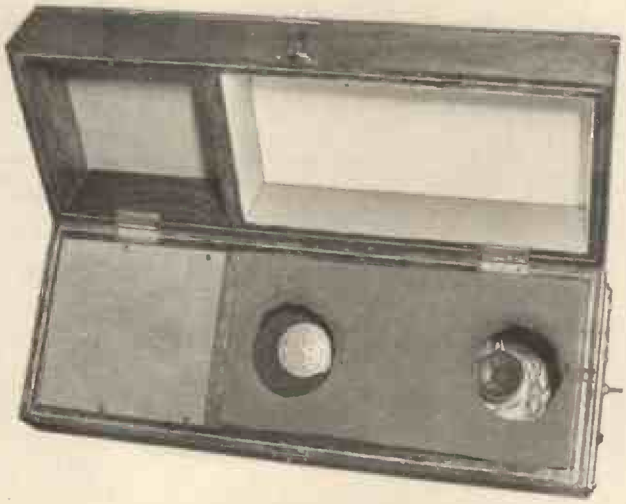
CONSTRUCTOR'S NOTE

A complete set of components for the Acoustically Coupled Telephone Modem is available from Watford Electronics (see advertisers' index).

MODEM OWNERS' REGISTER

Having got you to build the modem, your computer will be on the look-out for other machines to talk to, and so it is our endeavour to compile a list of all PE Modem owners who wish to "ASCIImunicate". We hope response will be sufficient to provide a useful list on request, so send us your details (listed below) and a S.A.E.

Suggested details: *Name, address, telephone number, system, micro' used, peripherals and reason for incorporating the modem (in brief please).*



PO REGULATIONS

We believe the specification of the PE Acoustic Modem conforms to the Post Office regulations governing the use of devices acoustically coupled via the Public Switched Telephone Network. However, it should be noted that under the Post Office Act 1969 accoustically coupled devices should not be used with Post Office maintained plant without the prior consent of the Post Office.

Applications for the evaluation of private equipment (for which a charge in excess of £50 will be payable) may be made to the Post Office once the supplier is satisfied that the equipment meets the requirements given in Technical Guide No. 32, available from: **Post Office Telecommunications Headquarters, Service Department Sv 1.1.3.3, Tenter House, 45 Moorfields, London EC2Y 9TH.**

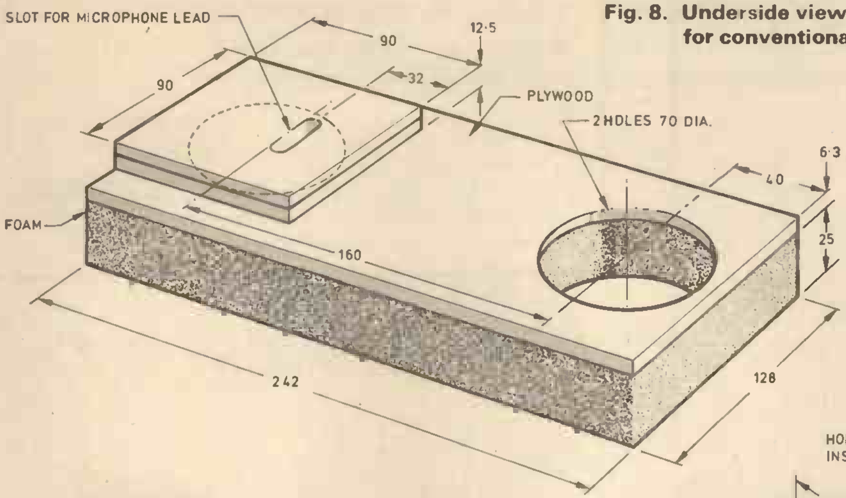


Fig. 8. Underside view of handset mount for conventional telephone

DIMENSIONS IN mm.

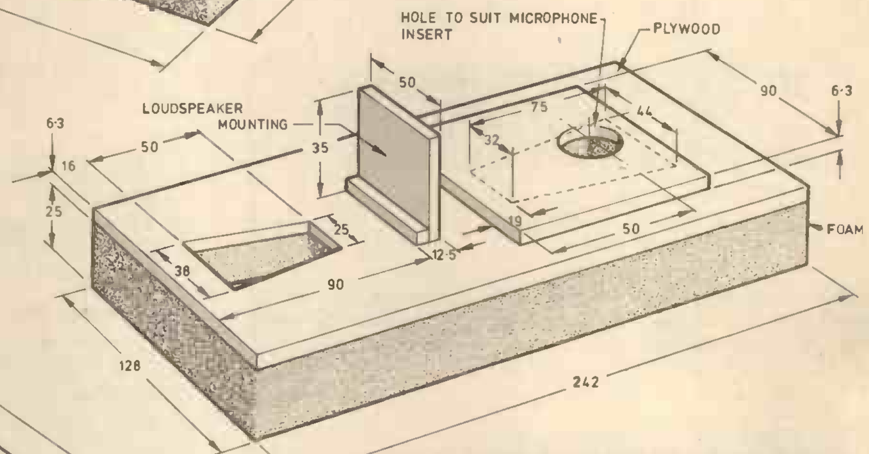


Fig. 9. Underside view of handset mount for the Trimphone

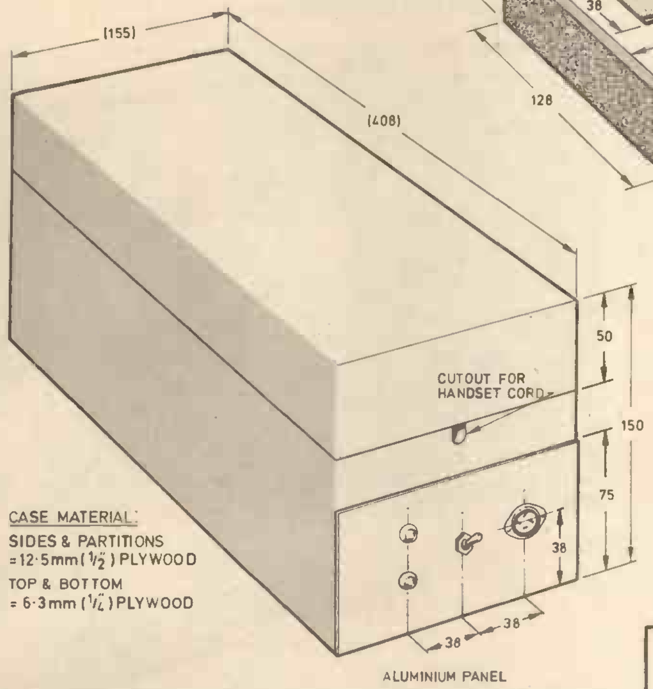
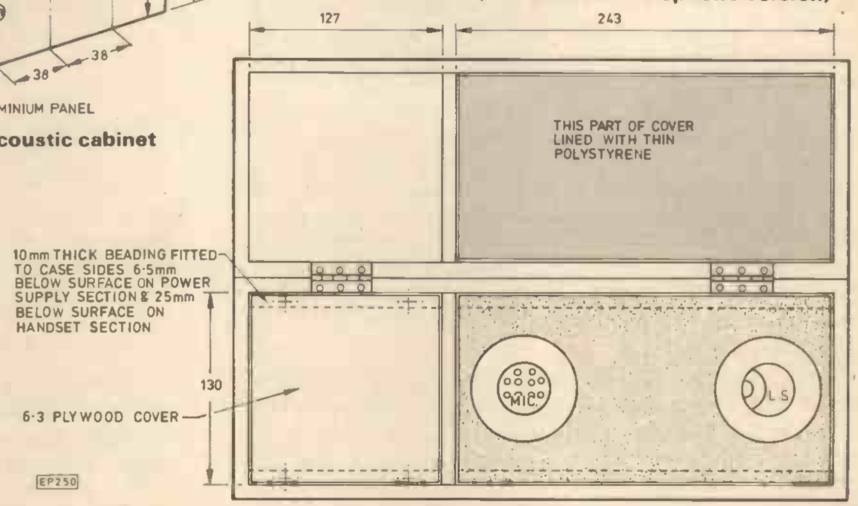


Fig. 10. Overall dimensions of the acoustic cabinet

Fig. 11. Top view of cabinet with lid fully open (Conventional telephone version)



ACOUSTIC MODEM

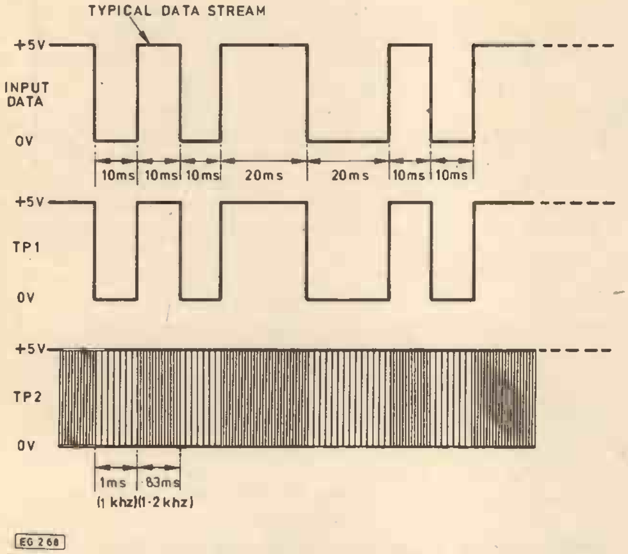


Fig. 12. Transmitter Test Point waveforms. When no input is applied and the Modem is switched to Transmit, the 1Ms square wave will appear continuously at Test Point 2

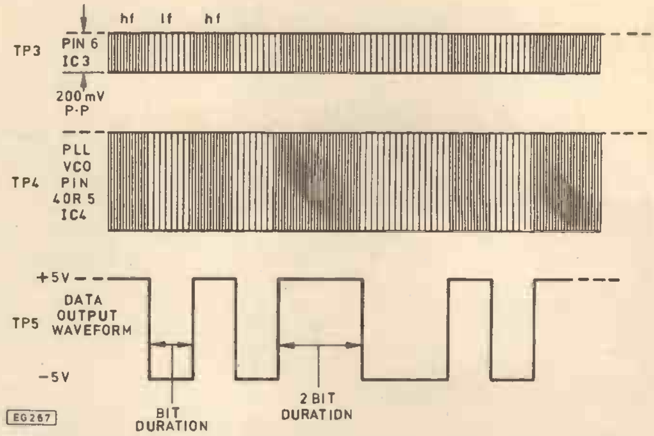


Fig. 13. Receiver waveforms. Example shown is the ASCII character "M". The l.f. pulses, i.e. logic 0, are a burst of 1ms pulses for the duration of the bit. The h.f. burst (logic 1) contains bit blocks 0·83ms wide. For Teletype operation the output bit duration is about 10ms

RECEIVER CHECK

(a) Look at signal on TP3 to ensure it is at least 250mV peak to peak when receiving from distant modem.

(b) If not, the gain of IC3 may have to be raised by increasing R15 (100k).

(c) With no signal being received, adjust VR1 until the frequency meter placed on TP4 reads 1100Hz.

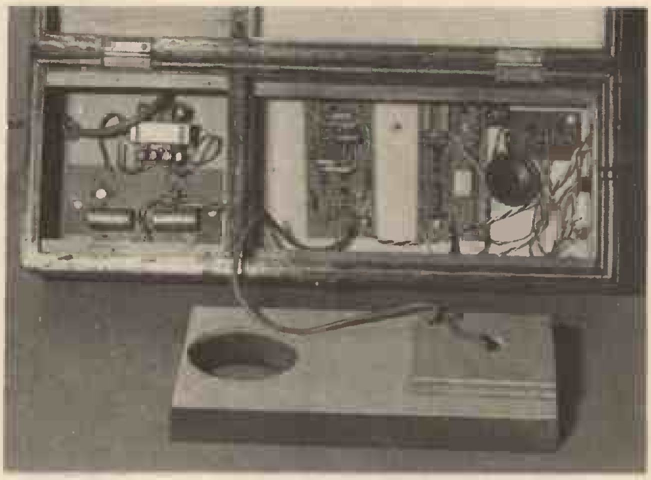
(d) With Data being received observe TP5 and refer to receiver waveforms information.

DATA INDICATOR AND OUTPUT OPTIONS

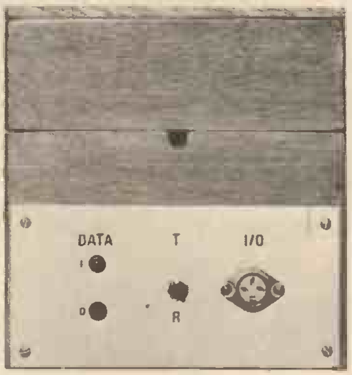
Signals from both the transmitter and receiver are fed to l.e.d.s D3 and D4. This allows us to monitor the data both when we are sending and also receiving. It should be made clear that the modem will not be doing both at once, being *half*-duplex.

TR3 switches on when the output of gate (IC1) goes high (Transmit Mode) or when Pin 6 of IC5 goes positive (Receive Mode). This will result in (D3) turning on and indicating a logic "1" level being present. As TR3 is turned on, R12 is virtually connected to ground, thus turning off TR5. The transistors TR3 and TR5 form a "see-saw" stage. When one is off the other is on, so that when no base current flows in TR3 it is a sure sign that a logic "0" is being received or transmitted, thus TR5 will be turned on and the "0" l.e.d. will be illuminated.

TP5 would normally be the receiver output point. It might be that a 180° signal is required to drive the device coupled to the modem. If this is so, connect the output of the modem to the open collector of TR4. i.e. TR4 will be turned on when "0" is being received. This is suitable for coupling to a teletypewriter.



NEXT MONTH



In the concluding article next month we shall give stripboard layout diagrams for the three boards, plus a considerable amount of applications information and device data showing how the modem can be improved and/or adapted to suit particular link-up requirements

Strictly Instrumental

by K. Lenton-Smith

A NEW instrument was presented at the recent Trade Fair—the Sharma HX80. The manufacturers, Keith Hitchcock, have been mentioned previously in this column in connection with their Doppler-effect speaker systems. Early last year I heard the prototype in action and had an opportunity to examine its very compact circuitry. Played through a rotary speaker, it was a Hammond tone-wheel organ recreated.

At first sight, the HX80 is a fairly conventional portable organ, drawbar controlled with 49 notes on the upper and 37 notes on the lower manual. The 18-note pedal clavier has either 8′ or 10′ pitch available. Generation is by digital pulse trains and, by splitting the waveform into segments at differing voltage levels, versatile tone synthesis is achieved. The sine waves produced by this means are mixed (Fourier synthesis) in the normal way.

The group of nine drawbars on the upper manual has been arranged so that 5-1/3′ is replaced by 1-1/7′—which is a very odd frequency in relation to the chromatic compass but is possible because of the tone generator used. It is seven times the fundamental frequency and if the latter is taken as A 440Hz, 3080Hz falls between F and G! Use of the seventh harmonic is not new (one of the overtones in a square wave in fact) but this unusual mutation drawbar provides extra tone colouring.

Other drawbars control 8′ and 4′ string tone, variable sustain, attack, decay and ambience (a form of reverberation). A single switch alters the compass of the manuals down one octave so that 32′ to 2′ pitches are substituted. The lower manual has no mutations but separate sustain covers the 16′ 8′ 4′ 2′ and 1′ pitches. Presets, three vibrato controls and a transposer also feature. Priced at under £700 including VAT, the HX80 will interest those looking for a comprehensive but fully portable instrument (though a tone cabinet is required). Basically this is a 'straight' organ without too many gimmicks and is made in the UK.

PIANOCORDER

The Pianola is a rarity these days and, like the fairground organ, uses punched paper rolls. The Kemble Piano Co. has the UK marketing rights for the first electronic version—the Pianocorder. Using cassette tape, digital pulses are recorded as a pianist plays the original. On playback, pulses from the tape are decoded and applied to solenoids on playing key or expression pedal. For teaching purposes, this could be a most useful aid as, unlike hearing a magnetic tape recording of the conventional type, the Pianocorder's keys are seen to move—and the playback speed can be varied at the teacher's will.

As this article goes to press, the Pianocorder is being demonstrated at the Chappell Music Centre, New Bond Street, London W1.

NO GO

An interest in electronic music can have its problems as friends may ask for your help in sorting out a small problem caused by transportation or rough usage. Of course, the cause is always obscure, inspection lighting inadequate and time is of essence! If the reader is inadvertently involved, a few guidelines may help:

Modern instruments, and organs in particular, have circuitry that is far more complex than a decade ago. A service manual (or at least block diagram) is essential as CMOS devices are often the order of the day—and it is wise to know what you are dealing with. Instruments in the home are often on nylon carpeting so circuit boards should not be treated with abandon. Although protection diodes are normally employed, the board should be considered as an extension to the i.c. Some special purpose devices are difficult to find so if in doubt earth yourself and obviously use a low leakage iron, also earthed.

If the instrument has been moved without its back panel in place, printed circuit boards can easily get damaged. Equally, forcing it into position over misaligned guides can split the board. If a crack is diagnosed, remove p.c.b. sockets with great care as solid conductors are often used. Run a little cyanoacrylate adhesive into the crack and clamp the board flat for the few minutes it takes to set. After removing the clamp, broken tracks can be patched: clean the copper strip locally with a small, sharp blade (a scalpel is ideal) and solder small bridges of tinned copper across the breaks.

Commercial instruments are designed for easy replacement of sub-assemblies and thus contain many connectors and a wiring harness similar to those used in the car industry. Slide-on tags for multiple connection to a common point are often used and are also reminiscent of BL products. They may be perfectly good for cars, but can cause noise and breakthrough in organs if used for signal earth purposes. Vibration from internal speakers or in transportation can cause them to get noisy or to simply disconnect themselves: remedies being either to tighten to the maximum or risk the wrath of the professional serviceman by chopping off the tags and making a really sound job by soldering!

TESTING

Digital meters can be very useful at times but, due to the time taken to sample, are not satisfactory for reading moving voltages/currents, e.g. percussion circuits. Although this also applies to analogue meters to some degree, the reaction of a pointer gives a much better idea of the circuit's action. Incidentally, I would suggest that any prospective purchaser takes a good look at a detailed specification of the digital meter in mind as advertisements often omit essential points. Despite claims of high accuracy, current readings are often subject to voltage burdens which, in some models, will cause errors of 25 per cent or so. My own digital meter, which is widely advertised, often refuses to auto-zero itself (and it's no fluke!). At least these meters normally have very high input impedance, but analogue meters should be capable of 20kΩ/V.

A box containing an i.c. amplifier, speaker and battery is a useful tool for tracing audio paths. My version has a switched jack socket so that the battery is connected when the test lead jack is inserted: I don't need to remember to switch off before putting it back on the shelf. The connecting cable has a longer earth wire, terminated by a croc clip, so that the probe (inner of the screened lead) can be taken from end to end of an instrument without having to find a new signal earth point repeatedly.

An oscilloscope is perhaps something of a luxury for fault-finding and more useful at the design stage. Assuming that there is no intention of checking the waveform supplied to a top octave synthesiser, which will be in the MHz range and a simple square wave, the timebase range needs to be modest only. Vibrato will call for about 7Hz as the slowest trace, though unless there is good persistence, flicker makes the display's usefulness questionable. About 15kHz will be just about the maximum required for the X plate, but a simple 'scope will show whether the waveform is what it is supposed to be and if tone filters are having the required effect. Be careful where the 'scope is connected into the instrument, that the input coupling capacitor is above suspicion and if it should be earthed for that particular application. If in doubt with expensive CMOS devices, test elsewhere!

I have not mentioned a CR bridge as most meters can cope with resistor measurement fairly well. Some can also handle capacitors but if not, a single 4001 package and a few discrete components can be assembled into a direct reading capacitor adaptor. Where valve circuitry is concerned—and plenty still exist and work well—it pays to check values of discrete components. Resistors can change their values alarmingly when age and high voltages come into play, so don't always believe the colour of the multiplier band: 10k resistors can easily become 100k in the course of time.

ELECTROSTAT

P. DAKIN

THERE are many types of thermostat in use around the home and in industry. The majority make use of the bimetal strip or bar and for general use there is nothing wrong with them. However, where a wide range, close tolerance, or economical use of energy is required an electronic thermostat is far superior.

The advantage of the circuit to be described here is that the temperature of a body can be held, if necessary, to within 0·1°C (ideal for photographic and similar uses) and the economic value is that it does not overheat the body wasting energy in the process. (Fig. 1).

The circuit is designed to give bursts of full power, of sufficient duration to overcome heat losses, and maintain a constant temperature.

The circuit is built around the SGS-ATES L121 i.c. This device incorporates a zero voltage detector, amplifier, comparator, internal power supplies with reference voltages, output stage for triggering triacs or thyristors, and will work from any single phase 50-60Hz supply.

CIRCUIT DESCRIPTION

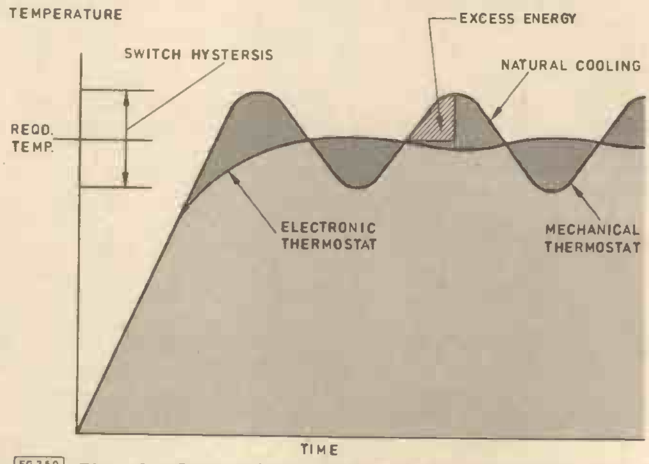
The block diagram of the L121 is shown in Fig. 2. The supply to the i.c. is via Rs which limits the supply current to approximately 30mA. The mains frequency signal is clipped to ±12V at the clipping and rectification stage. Pins 8 and 10 are the i.c.s dual internal supply smoothing. This smoothed supply is regulated by the voltage regulating stage, and used to supply the other internal functions, and also produce a 1·5 volt reference at pin 4, and a positive supply output at pin 6.

The zero cross detector determines when the supply on pin 9 crosses zero volts relative to pins 12 and 13, and whether it is positive, or negative going. Signals from this detector are fed to the ramp generator, control logic and output logic stages. The ramp generator produces a linear rising voltage, the rate of which is determined by C1 (pin 1) and R1 (pin 16). This is referred to as the time base. The voltage of this ramp is from less than 1V to approximately 6V, and is fed directly to the comparator.

The amplifier is a high gain d.c. operational amplifier, which is used to amplify the sensor output voltages to a suitable level for the comparator.

The comparator compares the relative levels of the amplifier output (pin 2) with the time base signal (pin 1) and will enable the chopper and control logic when the ramp voltage exceeds that of the amplifier output, as shown in Fig. 3. This has the effect of turning the heater on and off at a rate set by the time base.

The output logic stage determines the gate pulse polarity



EG 260 **Fig. 1. Comparison between an electrical and a mechanical thermostat**

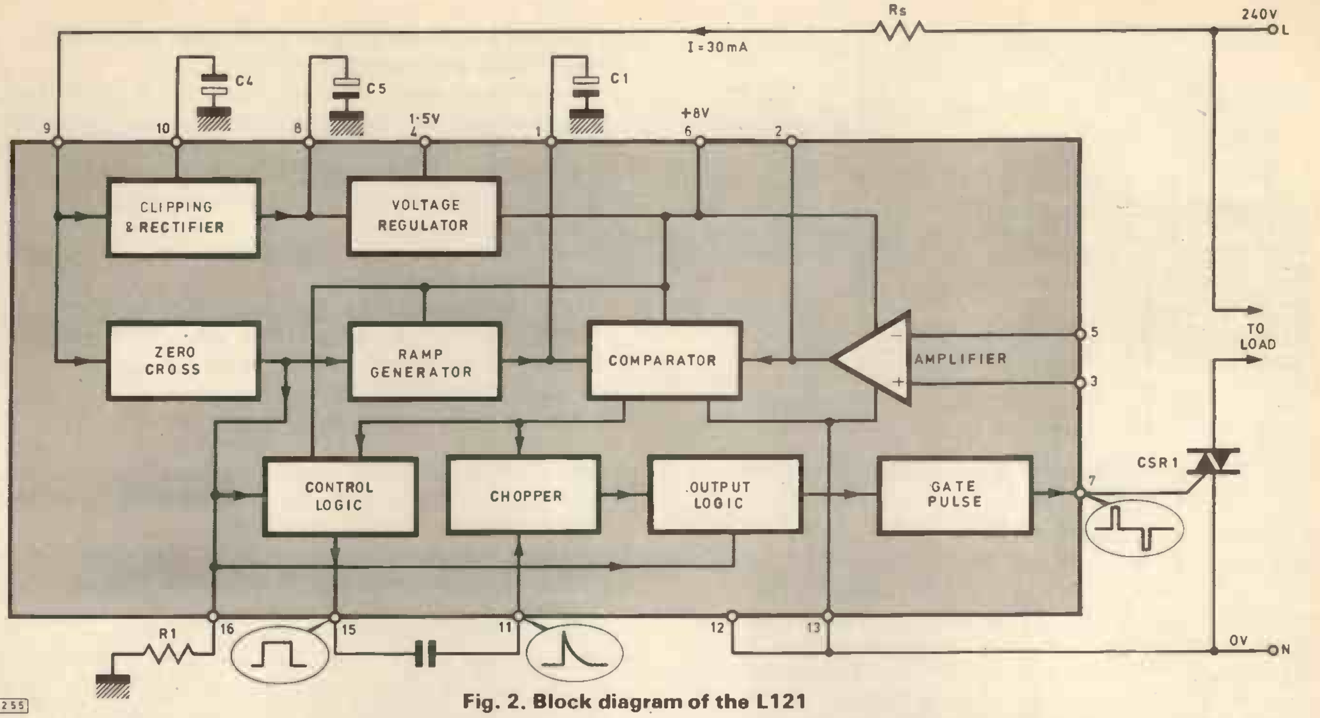


Fig. 2. Block diagram of the L121

and also synchronises it with the zero voltage of the mains (zero cross detector signal), and this reduces radio frequency interference (R.F.I.) produced by the triac to a very low level.

The control logic is such that it triggers the chopper stage when the voltage from the ramp exceeds the voltage at pin 2, and for a time dependent on C2, which means that the triac switches at a mains voltage of approximately ±10V.

To eliminate this transistor TR2 can be included, as in Fig. 4. TR2 inverts the control logic output and feeds it directly to the chopper. This has the effect of triggering the triac while the mains voltage is between zero and ±10V, which will reduce R.F.I. to an absolute minimum.

Fig. 4 shows the circuit diagram of the Electrostat with a range of 20°C to 80°C, and a variable time base of 1 second to 1 minute. The minimum time base of the system is set by R1 and C1, with TR1 increasing the value of C1 by a factor dependent on the gain of the transistor as the resistance of VR1 is increased.

Diodes D2 and D3 are extra clipping diodes so that under fault conditions, no high voltages can appear on pin 9 of the L121. The sensor of the system is a thermistor connected to the inverting input of the amplifier as shown in Fig. 5. The 1·5 volt reference from pin 4 is compared with the potential difference across the thermistor, the difference amplified, and fed to the comparator as described earlier. If the amplifier gain is high i.e. 50 or more, any small change in

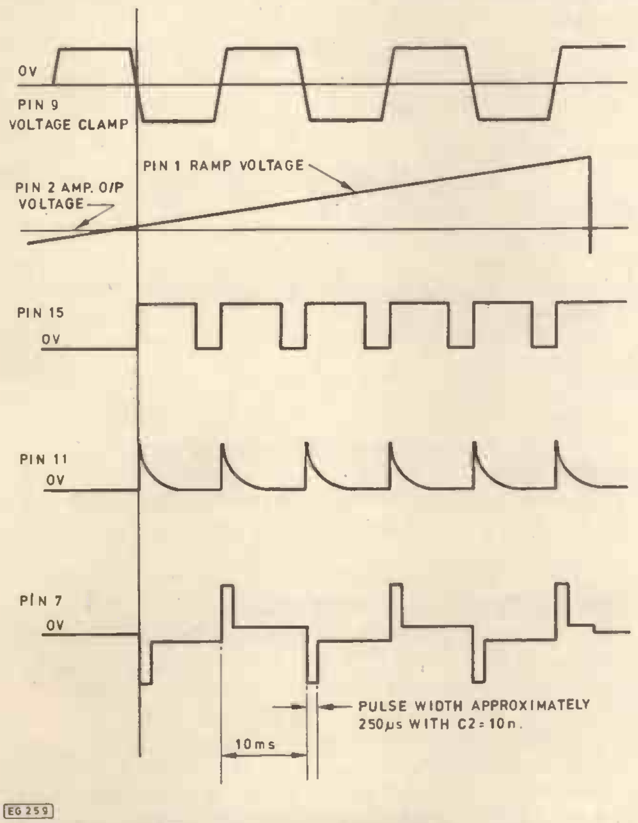


Fig. 3. Waveforms and phase relationships

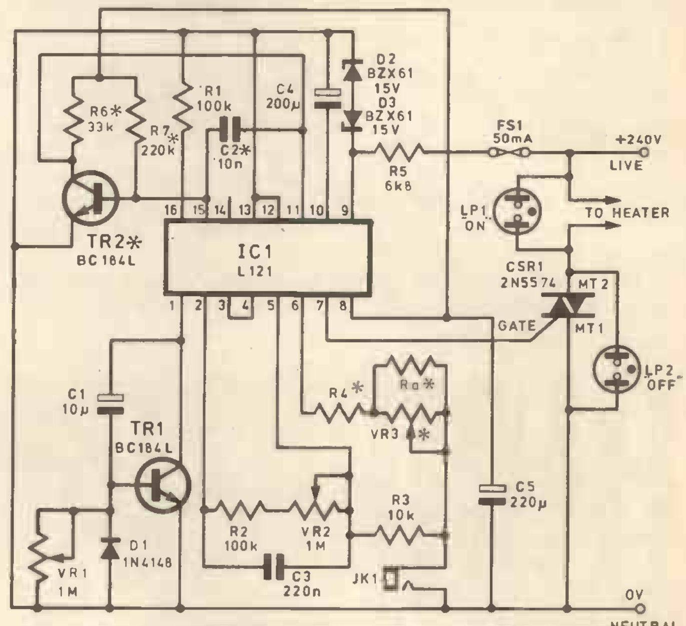
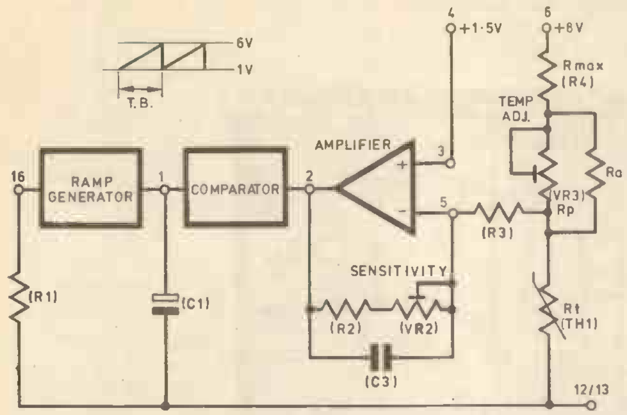


Fig. 4. Circuit diagram of the Electrostat (*see text)



EG 256 **Fig. 5. Block diagram of the amplifier, comparator and ramp generator**

thermistor potential will result in a large change in output from the amplifier, which will be acted upon by the other circuit functions, to return the sensor voltage near to the reference level. This situation is ideal for photographic work where a temperature can be controlled to within 0·1°C or better, depending upon the location of the sensor, and the thermal resistance of the object being heated.

The exact value of time base and temperature setting components depends upon every particular application. Table 1 lists some possible uses and suggested values.

Application	Temp. Range Centigrade	Time Base and C1 Value	Amplifier Gain R4 & VR3 Value
Photographic	20-40	1s-5s	50-100
Heater		10µ-47µ	500k-1M
Fermentation	15-30	1s-30s	20-50
Heater		10µ-330µ	200k-500k
Fish Tank	20-30	30s-120s	20-50
Heater		330µ-1200µ	200k-500k
Room	15-25	60s-180s	20-50
Heater		600µ-1800µ	200k-500k
Immersion	40-80	15s-120s	20-70
Heater		150µ-1200µ	200k-700k

TABLE 1

TIME BASE SELECTION

The time base is set by R1 and C1. This time must be shorter than the time it takes for the heat to travel through the medium to the thermistor (thermal time constant). Transistor TR1 is used to increase the effective value of C1 to several hundreds of times its true value when long time bases are required, and where a large capacitor would be impractical. Typical time bases range from 1 second to several minutes.

The manufacturers of the i.c. recommend that R1 be set at 100k and C1 selected to give the required time using the formula:

$$C1=\frac{1{\cdot}2\ TB}{R1}$$

where; VR1=0Ω
R1=100k
C1 in Farads
TB in seconds (1 second minimum)

When the time base needs to be 1 minute or more, T1 is used to magnify C1:

C1 (effective)=C1 (true value) X TR1 hfe

where TR1 is a BC 184L
hfe =250 to 900
and VR1 value is greater than 1M or omitted.

THERMISTOR AND TEMPERATURE SETTING RESISTOR SELECTION

A thermistor similar to the types GM 473 or VA 3410 is recommended as their operating range is −60°C to +200°C, and their resistance is fairly large at mid-range (approximately 47k at 25°C). The range of resistances at various temperatures is given in Table 2. Referring to Fig. 5, it can be shown that:

$$R(max)=5{\cdot}33Rt\ (max\ temp) \quad (1)$$

and Rp paralleled with Ra

$$Rp//Ra=(5{\cdot}33 \times Rt\ (min\ temp)\ )-R\ (max) \quad (2)$$

If Rp parallel with Ra is a preferred value ±20 per cent, use the preferred value. If not use the next biggest preferred value and calculate Ra:

$$Ra=\frac{(Rpv//Ra) \times Rpv}{Rpv-(Rpv//Ra)} \quad (3)$$

Select the range of temperature required and substitute in the equations the relevant values of thermistor resistances from Table 2.

Temperature (Centigrade)	Approx Resistance (Ohms)
−60	10M
−30	1M
0	159k7
10	100k
20	59k
25	47k
30	37k7
40	24k8
50	16k7
60	11k5
70	8k1
80	5k9
90	4k3
100	3k2
150	1k0

TABLE 2

Example

Photographic Heater

Preferred range 20°C to 40°C

R(max)=5·33 x Rt(max)
=5·33 x 24·8k
=132·2k

Nearest preferred value 120k

Rp//Ra=(5·33 x Rt(min)—R(max)
=(5·33 x 59k)—120k
=194·5k

Nearest preferred value 220k

$$Ra=\frac{(Rpv//Ra) \times Rpv}{Rpv-(Rpv//Ra)}$$

$$Ra=\frac{194{\cdot}5k \times 250k}{250k-194{\cdot}5k}$$

=876k

Nearest preferred value 1MS

Amplifer Gain

The amplifier gain is set by the ratio of R2, VR2, and R3:

$$Gain=\frac{R2 + VR2}{R3} \quad (4)$$

CONSTRUCTION AND TESTING

The p.c.b. design and component layout for the Electrostat are shown in Figs. 6 and 7. Triac CSR1 should be of an adequate rating and mounted on a heatsink using a suitable insulating kit.

Care must be taken when assembling the triac on to the heatsink, and ensure the neutral is connected to the MT1 terminal. For 110V supplies R5 must be reduced to 3·3k 4W. Fuse FS1 is 50mA, and the load should be fused at a suitable value.

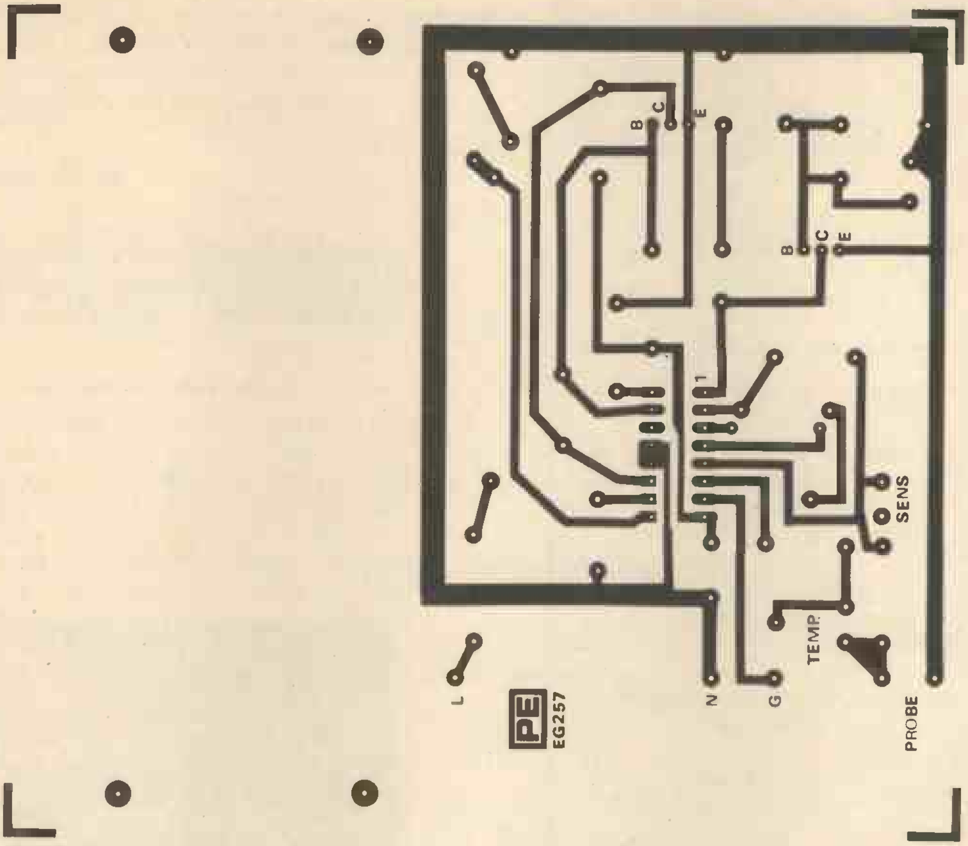


Fig. 6. P.c.b. design

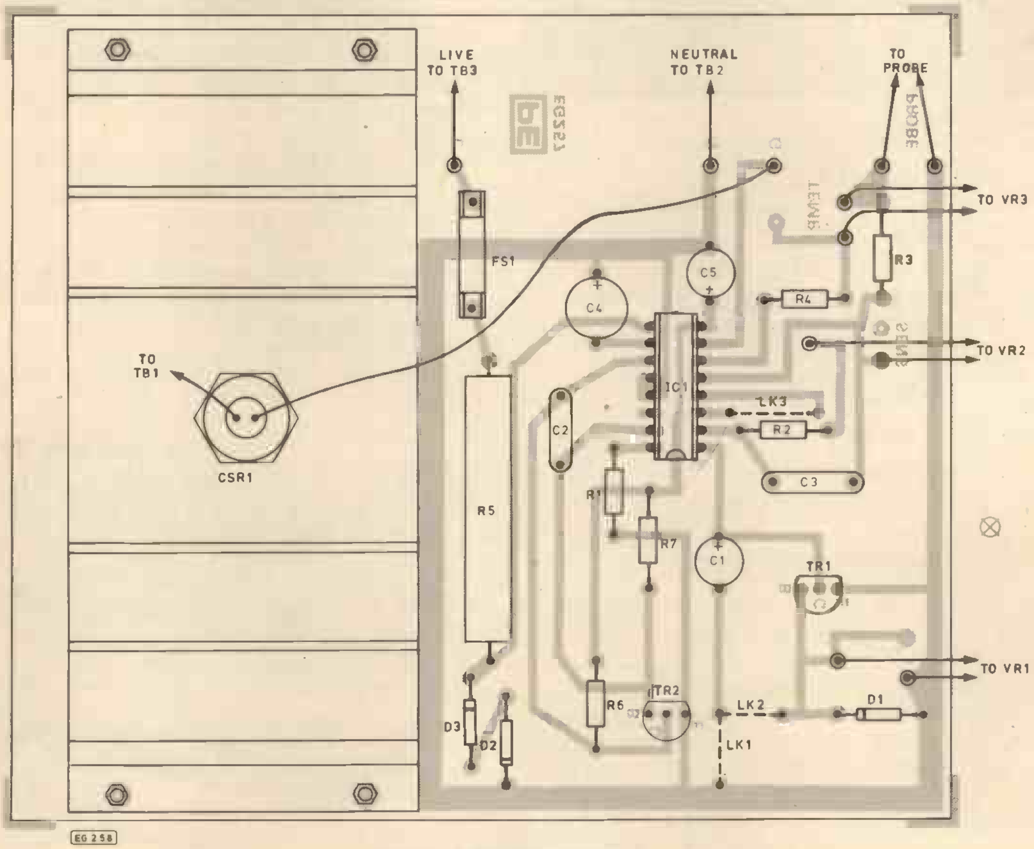


Fig. 7. Component layout

COMPONENTS . . .

Resistors

R1, R2	100k (2 off)
R3	10k
*R4	
R5	6k8 7W (3k3 4W for 110V)
R6	33k
R7	220k
*Ra	

All resistors $\frac{1}{4}$W 10% except otherwise stated.

Potentiometers

VR1, VR2	1M Lin. (2 off)
*VR3	

Capacitors

*C1	
C2	10n
C3	220n
C4, C5	220µ 16V (2 off) elect.

Semiconductors

D1	1N4148
D2, D3	BZX61 15V (2 off)
TR1, TR2	BC184L (2 off)
CSR1	2N5574 (or any 400V triac with a suitable current rating for the load)
TH1	VA3410
IC1	L121 (Quarndon Electronics, Slack Lane, Derby.)

Miscellaneous

LP1, LP2	Mini mains neon (2 off)
FS1	50mA fuse

P.c.b.
Connector block
Heatsink to suit triac
Suitable case
JK1 3·5mm jack socket
*See text

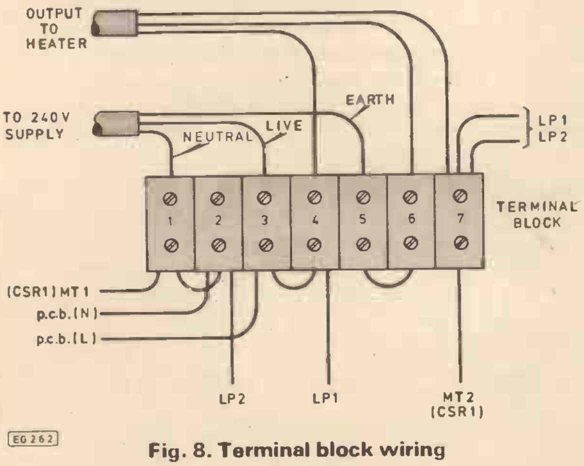


Fig. 8. Terminal block wiring

The wiring for the terminal block is shown in Fig. 8. The thermistor can be built into a probe as suggested in Fig. 9 and is connected to the circuit via JK1.

Having checked the circuit for correct placing of components, carefully examine around the i.c. for solder splashes and joined tracks. When all is satisfactory, connect the load and the supply, and switch on. If the thermistor is "cold", relative to the temperature setting, the "off" neon indicator LP2 will light immediately. If the "on" neon LP1 lights adjust VR3 to minimum, and check the "off" neon lights.

If neither neon lights, turn off and check all connections. Also check pin 8 for +12V, and pin 10 for −12V, with respect to pins 12 and 13. Next check pin 1 for ramp voltage. If satisfactory check pin 2 for voltage swing by adjusting VR3. If an oscilloscope is available, check pins 11 and 15 for control pulses, and pin 7 for output pulses.

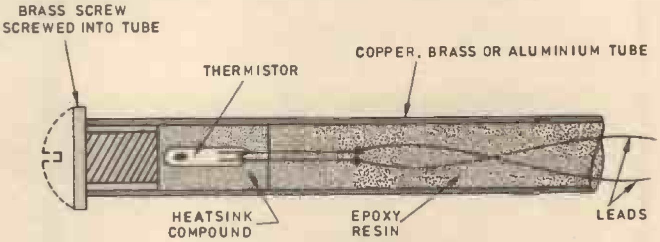
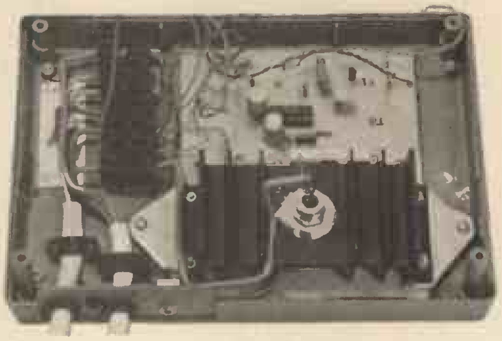


Fig. 9. Probe construction

The setting of the sensitivity resistor VR2 will depend on the thermistor location within the medium and the time base. For maximum sensitivity, a time base much shorter than the thermal time constant of the body is preferable.

The sensitivity is best set by trial and error, or if a storage oscilloscope is available, monitor pin 2 for several minutes and adjust VR2 until a still flat trace is obtained.



If the sensitivity is set too high, the system will be under damped and the temperature could vary by a large amount around the required value. Similar results will be seen if the sensitivity is set far too low.

If in use R.F.I. is present, try adding TR2, R6 and R7. as shown in Fig. 4, and omit capacitor C2.

Having checked that the unit works, it can now be built into a unit to suit your own application. If a metal case or front panel is used ensure it is earthed. Remember, for safety DO NOT connect the earth to the neutral.

Where calibration of VR3 is required, it should be against a digital thermometer, or a laboratory standard mercury thermometer, located in the same area of the body as the units sensor. ★

STEVENSON
Electronic Components

CMOS

		4020	50p	4050	25p
		4022	50p	4060	80p
		4023	13p	4066	30p
		4024	40p	4068	13p
4001	13p	4025	13p	4069	13p
4002	13p	4026	90p	4070	13p
4007	13p	4027	28p	4071	13p
4009	30p	4028	45p	4072	13p
4011	13p	4029	50p	4081	13p
4012	13p	4040	55p	4093	36p
4013	28p	4041	55p	4510	60p
4015	50p	4042	55p	4511	60p
4016	28p	4043	50p	4518	65p
4017	47p	4046	90p	4520	60p
4018	55p	4049	25p	4528	60p

FULL DETAILS IN CATALOGUE!

TTL

		7473	20p	74141	55p
		7474	22p	74145	55p
7400	10p	7475	25p	74148	90p
7401	10p	7476	20p	74150	55p
7402	10p	7485	55p	74151	40p
7404	12p	7486	20p	74154	65p
7406	22p	7489	135p	74157	40p
7408	12p	7490	25p	74164	55p
7410	10p	7492	30p	74165	55p
7413	22p	7493	25p	74170	100p
7414	39p	7494	45p	74174	55p
7420	12p	7495	35p	74177	50p
7427	20p	7496	45p	74190	50p
7430	12p	74121	25p	74191	50p
7432	18p	74122	35p	74192	50p
7442	38p	74123	38p	74193	50p
7447	45p	74125	35p	74196	50p
7448	50p	74126	35p	74197	50p
7454	12p	74132	45p	74199	90p

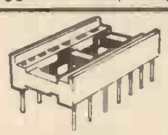
OPTO

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

DISPLAYS

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

SKTS



Low profile by Texas

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

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

PCBS

VEROBOARD

Size in.	0.1in.	0.15in.	
2.5 x 1	14p	–	Vero Cutter 80p.
2.5 x 3.75	45p	45p	
2.5 x 5	54p	54p	Pin insertion tool 108p
3.75 x 5	64p	64p	
3.75 x 17	205p	185p	
Single sided pins per 100	40p	40p	

Top quality fibre glass copper board. Single sided. Size 203 x 95mm. 60p each.
'Dalo' pens. 75p each.
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	each	100+	1000+
0.25W	1p	0.9p	0.8p
0.5W	1.5p	1.2p	1p

Special development packs consisting of 10 of each value from 4.7 ohms to 1 Meg-ohm (650 res) 0.5W £7.50. 0.25W £5.70.

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Very high stability, low noise rated at ¼W 1%. Available from 51ohms to 330k in E24 series. Any mix:

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		LM308	60p	NE556	60p
		LM318N	75p	NE567	100p
		LM324	45p	RC4136	100p
709	35p	LM339	45p	SN76477	230p
741	16p	LM378	230p	TBA800	70p
747	45p	LM379S	410p	TBA810S	100p
748	30p	LM380	75p	TDA1022	620p
7106	850p	LM3900	50p	TL081	45p
7107	900p	LM3909	65p	TL084	125p
CA3046	55p	LM3911	100p	ZN414	80p
CA3080	70p	MC1458	32p	ZN425E	390p
CA3130	90p	MM57160	590p	ZN1034E	200p

TRANSISTORS

				ZTX500	16p
				2N697	12p
		BCY72	14p	2N3053	18p
AC127	17p	BD131	35p	2N3054	50p
AC128	16p	BD132	35p	2N3055	50p
AC176	18p	BD139	35p	2N3442	135p
AD161	38p	BD140	35p	2N3702	8p
AD162	38p	BFY50	15p	2N3703	8p
BC107	8p	BFY51	15p	2N3704	8p
BC108	8p	BFY52	15p	2N3705	9p
BC108C	10p	MJ2955	98p	2N3706	9p
BC109	8p	MPSA06	20p	2N3707	9p
BC109C	10p	MPSA56	20p	2N3708	8p
BC147	7p	TIP29C	60p	2N3819	15p
BC148	7p	TIP30C	70p	2N3820	44p
BC177	14p	TIP31C	65p	2N3904	8p
BC178	14p	TIP32C	80p	2N3905	8p
BC179	14p	TIP2955	65p	2N3906	8p
BC182	10p	TIP3055	55p	2N4058	12p
BC182L	10p	ZTX107	14p	2N5457	32p
BC184	10p	ZTX108	14p	2N5459	32p
BC184L	10p	ZTX300	16p	2N5777	50p
BC212	10p				
BC212L	10p				
BC214	10p				
BC214L	10p				
BC477	19p				
BC478	19p				
BC548	10p				
BCY70	14p				
BCY71	14p				

DIODES

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1N4001	4p	1N5401	13p
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	100					8p
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				470		15p
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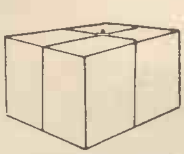

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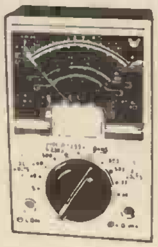

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MICRO-BUS

Compiled by DJD.

Appearing every two months, Micro-Bus will present ideas, applications, and programs for the most popular microprocessors; ones that you are unlikely to find in the manufacturers' data books. The most original ideas will probably come from readers working on their own microcomputer systems, and payment will be made for any contribution featured here. This is also the place to air your views, in general, on this new technology, so let's be hearing from you!

MICRO MAGICIAN

THE following unusual program turns the computer into a magician, enabling it to find a card chosen secretly by a spectator. Two versions of the program are given; one in BASIC, and one in machine code for the 6502.

The presentation of the trick is as follows: only the thirteen cards of one suit are used for the trick. The cards are fanned out face down, and the spectator removes one and remembers its value. The remaining pile of cards is cut once, and the spectator replaces the selected card wherever he likes. The pile is then divided into two, and the two halves are shuffled together. Finally the cards are fanned out face-up on the table, and the order of the cards is typed into the computer. After a brief pause the computer announces which was the chosen card.

Although the trick is based on a simple principle, it leads people to believe that the computer's powers extend to mind-reading, and this belief is strengthened by occasional failures of the computer to guess the card correctly.

By way of illustration, try locating the chosen card in the sequence shown in Fig. 1. The cards were originally in order, ace up to king from left to right, and the sequence shown is the result of following the procedure described above.

HOW THE PROGRAMS WORK

The programs work by comparing the new order of the cards with their previous order; for each card a number is calculated which represents how far the processes of shuffling and cutting have moved that card away from its previous neighbours. The higher this score, the more out of sequence is the card concerned. After calculating this score for each of the 13 cards, the card with the highest score is taken to be the one that was chosen, and in most cases this will be correct. However, in some cases the computer cannot be certain about which card was chosen; for example, if the card is returned to its original position then any card could have been chosen. Also, less obviously, if the card is re-inserted one place to one side of its original position it is impossible to tell whether it, or its neighbour, was the chosen card since the same sequence of cards would result in each case. The reason for cutting the pack before the card is replaced is to encourage the spectator to replace the card in a different position.

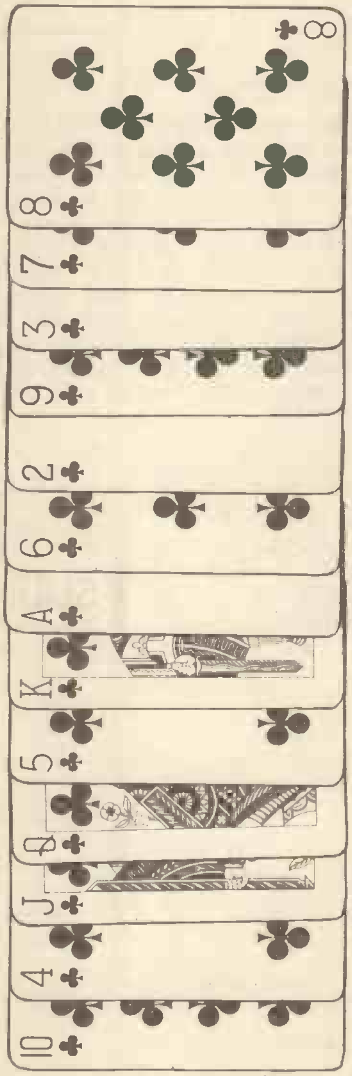


Fig. 1. Find the chosen card in this sequence, which results from a presentation of the trick described in the text

When the programs are first executed they assume that the cards were originally in numerical order, ace up to king. If the cards are not initially in order the program will probably get the first attempt wrong, but in some ways it is more impressive to do the trick without arranging the cards first, and attribute the initial failure to "warming up"! On subsequent operations of the program the initial order is replaced by the new order of the cards, as typed in; the order of the cards should not be disturbed when the trick is repeated.

CARD TRICK PROGRAMS

The two versions of the card-trick program work in comparable ways. The cards are represented internally by the numbers 1 to 13. The programs are divided into three sections. First, the new sequence of cards is read in. Secondly, each of the cards in the previous sequence is searched for in the new sequence, and its position there is subtracted from the positions of each of the cards that were its neighbours in the previous sequence. The sequence is considered to be circular, so if the difference between two positions turns out negative then 13 is added to it. The card's distance from one neighbour, plus its distance from the other neighbour, is saved as that card's score. Finally, the card with the maximum score is found and displayed as the chosen card.

The critical part of the trick is that the cards should only be shuffled once, and the shuffle should be of the sort that divides the packet of cards into two halves and merges the two halves back into one pile (e.g. a riffle shuffle). The cards can be cut at any time, and as many times as wished, but each time the packet of cards should only be cut into two piles.

BASIC VERSION

The BASIC version of the card trick, Fig. 2, closely follows the above description. The subroutine at 500 looks up the card T in the array containing the previous sequence of cards, A, and returns in X the position of T in that array. The program uses only integer arithmetic, and so can work with integer-only BASIC interpreters.

```
0010 REM *** CARD TRICK ***
0020 DIM A(13),B(13),S(13)
0030 FOR J=1 TO 13: A(J)=J: NEXT J
0040 PRINT "ENTER YOUR CARDS"
0050 FOR J=1 TO 13: S(J)=0
0060 INPUT B(J): NEXT J
0070 T=A(13): GOSUB 500
0080 FOR J=1 TO 13: L=X: R=T
0090 T=A(J): GOSUB 500
0100 Q=X-L: IF Q<0 THEN Q=Q+13
0110 S(T)=S(T)+Q: S(R)=S(R)+Q
0120 NEXT J
0130 M=0
0140 FOR J=1 TO 13: A(J)=B(J)
0150 IF S(J)<M GOTO 170
0160 Z=J: M=S(J)
0170 NEXT J
0180 PRINT "YOU PICKED THE "; Z
0190 GOTO 40
0500 FOR K=1 TO 13
0510 IF T=B(K) THEN X=K
0520 NEXT K: RETURN
```

Fig. 2. BASIC version of the card trick enables the computer to find a chosen card

6502 VERSION

The program for the 6502, Fig. 3, was developed on an Acorn system and uses two routines in the Acorn monitor, so if the program is used with another 6502 system these will have to be modified. Subroutine DISPLAY is a display and keyboard-scanning routine which displays the segment patterns from locations 0010–0017, and waits for a keypress (although it can be made to give a single sweep of the display without waiting). It returns with the hex value of the key pressed in the A-register, the X-register is preserved, and the Y-register is zeroed. Subroutine HEXTD generates the segment pattern for the hex number in the lower four bits of the A-register, and stores this in display location Y.

When the program is executed at 0200 the display will go blank. The sequence of cards should then be entered using the hex keys, with ace = 1, ten = A, jack = B, queen = C, and king = D. When the last card is entered the micro will display its guess at the chosen card. The program is then ready to repeat the trick.

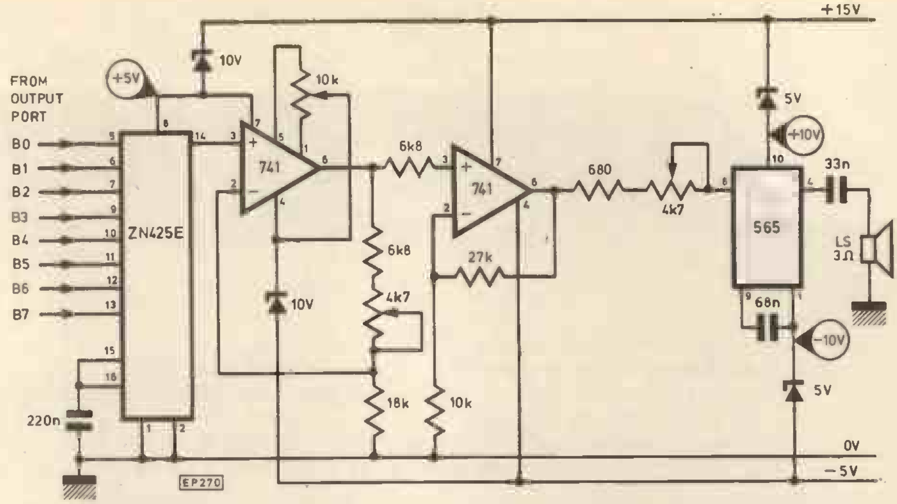


Fig. 4. Programmable frequency generator; the frequency is determined by the number at the output port

For simplicity, 14 bytes are allocated for each of the arrays, the zeroth byte not being used. Subroutine SCAN performs the same function as the subroutine in the BASIC verion.

MODIFICATIONS

The programs can also guess two, or more, chosen cards, though with less reliability; for example, to find two chosen cards the programs should be modified to display the cards with the two highest scores. The programs can also be modified to work with any number of cards, and as the number of cards is increased the likelihood of the computer getting the card wrong diminishes. Thirteen cards is a happy medium; it is not too time-consuming to type in the order, while at the same time the computer's powers are indisputable!

FREQUENCY GENERATOR

The following circuit enables a micro to act as a programmable frequency generator. It uses a low-cost digital-to-analogue converter to drive a voltage-controlled oscillator, and to illustrate its operation a program is given which will play monophonic melodies. The circuit and program were submitted by *Mr. P. V. Bayley* of Newcastle, and what follows is based on his description:

"The circuit, Fig. 4, was designed for use with an 8080 microprocessor, but is suitable for any 8-bit micro. It can generate frequencies covering an overall range of at least three octaves, and incorporates a variable pitch control.

CIRCUIT DESCRIPTION

"Data from an 8-bit output port is fed to the inputs of the ZN425E 8-bit digital-to-

```
                ;       CARD TRICK
                        **** *****
                ;
                DISP    =$0010          ACORN DISPLAY BUFFER
                DISPLY  =$FEOC          DISPLAY ROUTINE
                HEXTD   =$FE7A          HEX DIGIT TO BUFFER
                ;
0000                    .=$0020         FREE ZERO PAGE
0020            OLD     .=.+14          PREVIOUS SEQUENCE
002E            NEW     .=.+14          NEW SEQUENCE
003C            SUM     .=.+14          VALUES CALCULATED
004A            LAST    .=.+1
004B            POSN    .=.+1
004C            MAX     .=.+1
004D                    .=$0200         START OF PROGRAM
0200  D8        BEGIN   CLD
0201  A0 00             LDY   £0
0203  A2 0D             LDX   £13       ASSUME CARDS ARE
0205  8A        SET     TXA               IN ORDER.
0206  95 20             STA   OLD,X
0208  94 0F             STY   DISP-1,X  CLEAR DISPLAY
020A  CA                DEX
020B  D0 F8             BNE   SET
020D  E8        GET     INX             START AT 1
020E  20 0C FE          JSR   DISPLY
0211  95 2E             STA   NEW,X     GET CARD
0213  94 3C             STY   SUM,X     CLEAR SUM
0215  84 12             STY   DISP+2    CLEAR RESULT
0217  20 7A FE          JSR   HEXTD     KEY TO DISP+0
021A  E0 0D             CPX   £13       ALL DONE?
021C  D0 EF             BNE   GET
021E  A5 21             LDA   OLD+1     FIRST CARD
0220  85 4A             STA   LAST
0222  A0 0D             LDY   £13
0224  B9 20 00  LOOP    LDA   OLD,Y     DO NEXT CARD
0227  20 6A 02          JSR   SCAN
022A  86 4B             STX   POSN      SAVE POSITION
022C  A5 4A             LDA   LAST
022E  20 6A 02          JSR   SCAN
0231  8A                TXA
0232  38                SEC
0233  E5 4B             SBC   POSN
0235  B0 02             BCS   OK
0237  69 0D             ADC   £13       MAKE IN RANGE 0-12
0239  48        OK      PHA
023A  18                CLC
023B  A6 4A             LDX   LAST
023D  75 3C             ADC   SUM,X
023F  95 3C             STA   SUM,X     ADD TO SUM
0241  B6 20             LDX   OLD,Y
0243  86 4A             STX   LAST      REPEAT FOR OTHER
0245  68                PLA               NEIGHBOUR.
0246  75 3C             ADC   SUM,X
0248  95 3C             STA   SUM,X
024A  88                DEY
024B  D0 D7             BNE   LOOP      DO FOR ALL 13 CARDS.
024D  A2 0D             LDX   £13       LOOK FOR MAX
024F  A9 00             LDA   £0
0251  B4 2E     FIND    LDY   NEW,X     TRANSFER NEW ORDER
0253  94 20             STY   OLD,X       TO OLD.
0255  D5 3C             CMP   SUM,X
0257  10 04             BPL   NOTGT
0259  86 4C             STX   MAX       GREATEST SO FAR
025B  B5 3C             LDA   SUM,X     UPDATE WITH VALUE
025D  CA        NOTGT   DEX
025E  D0 F1             BNE   FIND      DO FOR ALL 13 CARDS.
0260  A5 4C             LDA   MAX       BEST CARD
0262  A0 02             LDY   £2        DISPLAY IN
0264  20 7A FE          JSR   HEXTD       POSITION 2.
0267  4C 0D 02          JMP   GET       REPEAT WITH NEW ORDER
                ;
                ; SUBROUTINE SCAN
026A  A2 0D     SCAN    LDX   £13
026C  D5 2E     SCAN1   CMP   NEW,X     LOOK FOR A
026E  F0 03             BEQ   RETN        IN ARRAY NEW.
0270  CA                DEX
0271  D0 F9             BNE   SCAN1
0273  60                RTS             POSITION IS X
                ;
                        .END
```

Fig. 3. Card trick program for the 6502 micro

```
                ;       MUSIC PROGRAM
                ;
0000 010001     MUSIC   LXIB 0100H      ;SET ADDRESS PTR.
0003 110008     LOOP    LXID 0800H      ;TEMPO FACTOR
0006 0A                 LDAX B
0007 D300               OUT  0          ;OUTPUT TO PORT
0009 C600               ADI  0          ;TEST ACC.
000B CA1800             JZ   STOP
000E AF                 XRA  A          ;CLEAR ACC.
000F 1B         DELAY   DCX  D
0010 BA                 CMP  D
0011 C20F00             JNZ  DELAY
0014 03                 INX  B          ;POINT TO NEXT
0015 C30300             JMP  LOOP
0018 76         STOP    HLT
```

Fig. 5. Program for the 8080 micro which, with the circuit of Fig. 4, plays tunes stored in memory

```
C8,C8,C4,C4,C2,C2,BC,BC,08,BC,08,BC,08,BC,C2,C2,08,C2,08,C2,08.
C8,C8,C4,C4,C2,C2,C4,C4,BF,BF,08,BF,08,BF,08,BF,C4,C4,CC,CC.
C8,C8,C4,C4,C2,C2,BC,8C,08,BC,08,BC,08,BC,C2,C2,08,C2,08,C2,08.
C8,C8,C4,C4,C2,C2,C4,C4,BF,BF,08,BF,08,BF,08,BF,08,BF.
C8,C8,C4,C4,C2,C2,BC,BC,08,BC,08,BC,08,BC,BC,BC,08,08.
C8,C8,D4,D4,08,D4,08,D4,08,D4,08,D4,D1,08,D4,E0,E0,DA,DA,D4,D4.
D1,D1,08,D1,08,D1,08,D1,08,D1,DA,DA,D4;D4,D1,D1.
D4,D4,08,D4,08,D4,08,CC,CC,08,CC,08,CC,08,C8,C8,08,C8,08,C8,08,C2,C2.
08,C2,C2,C3,C3,BE,BE,08,BE,08,BE,C8,C8,C4,C4,C2,C2,BC,BC,08,BC,08.
                                          BC,BC,BC,08,08.
```

Fig. 6. Data for a simple tune to illustrate how the frequency generator can be controlled by a micro

```
                ;       TWO BYTE JUMP ROUTINE
                ;
0030 E3         RST6    XTHL            ;TOP OF STACK TO HL
0031 6E                 MOV  L,M        ;L = DESTINATION
0032 E3                 XTHL            ;RESTORE HL, STACK
0033 C9                 RET             ;JUMP TO DESTINATION
```

```
                ;       TWO BYTE CONDITIONAL JUMP
                ;       ON NO CARRY.
                ;
0038 E3         RST7    XTHL            ;TOP OF STACK TO HL
0039 23                 INX  H          ;SKIP ADDRESS BYTE
003A E3                 XTHL            ;RESTORE HL
003B D8                 RC              ;RETURN IF NOT MET
003C E3                 XTHL            ;GET ADDRESS BACK
003D 2B                 DCX  H          ;GET JUMP ADDRESS
003E 6E                 MOV  L,M        ;L = DESTINATION
003F E3                 XTHL            ;RESTORE HL, STACK
0040 C9                 RET             ;JUMP TO DESTINATION
```

Fig. 7. (7a above, 7b right) Routines for the 8080 which implement two-byte jump instructions

analogue converter. The output feeds the non-inverting input of a 741 op-amp used as a buffer amplifier, and this should be calibrated as follows: first VR1 is used to give an output of OV at pin 6 when OOH is output to the port; then VR2 is used to adjust for an output of 3·6V when FFH is output to the port.

"A second 741 amplifier drives a voltage-controlled oscillator; this is the oscillator section of a 565 phase-locked loop. VR3 is used as an overall pitch control and can be adjusted to provide a maximum frequency of over 6kHz. At a mid-range setting the circuit will cover the range 200Hz to 2400Hz with good linearity. Note that the 565 operates from ± 10V supplies, derived from ± 15V with two zener diodes.

MUSIC PROGRAM

"The circuit was used with the program shown in Fig. 5, which produces simple tunes. The values required to produce a musical scale are first determined, and then the tune is written as a sequence of these values, stored in memory starting at 0100H. Different note durations can be obtained by repeating the same note code, and blank intervals are obtained by any low-value code, such as 08H. A zero byte denotes the end of the tune.

"The program was run on a Limrose Electronics MPT8080 microtutor, and to enter data for the tune it is necessary to change the first instruction of the program to C3H (jump), and then single-step the first three bytes. After entering the data for the tune make sure that the next location contains OOH, and then change the first instruction back to 01H.

"The data in Fig. 6 are for a lively tune which should be fairly well known."

TWO-BYTE JUMP FOR 8080

Jumps in the 8080, whether conditional or unconditional, are all three bytes long: one byte for the op-code, and a two-byte destination address. The following programs, submitted by *M. R. Reynolds* of Surrey, show how to implement two-byte jump instructions which can be used to save memory in a small system. The second byte of the instruction gives the low-order byte of the destination address.

"The program of Fig. 7a uses just four bytes of memory to implement a two-byte unconditional jump instruction. It makes use of one of the eight restart instructions, which are one-byte subroutine calls to fixed addresses. They have the format '11AAA111' (binary) and cause the return address, the address after the restart instruction, to be pushed onto the stack, and control passed to the subroutine starting at 'OOAAAOOO' (binary). The program in Fig. 7a uses the F7 instruction which jumps to a subroutine at 0030H, and the routine simply substitutes the byte following the F7 instruction for the low-order byte of the return address. The return instruction then causes a transfer to that address. Note that this is not a relative jump, although one could be implemented with a longer subroutine.

"A conditional jump can be implemented as shown in Fig. 7b. The extra increment and decrement are needed to skip the address byte if the condition is not met. This example uses the FF instruction, which causes a jump to 0038H. The condition in the conditional return instruction is the inverse of the condition required for the overall jump; for example, RNZ would be required for a 'jump if zero' instruction."

News Briefs

45,000 ICs for £52.50

The 1980 edition of the IC Master contains more IC data than ever before. Even though some 5,000 redundant parts have been deleted, it nevertheless provides details of more than 45,000 different ICs including 5,000 new devices.

Included in the price of £52.50 is postage and packing and comprehensive up-dates which are issued automatically at 3-monthly intervals. The 1980 IC Master is available from Paterson Steadman and Partners Ltd., 34/36 High Street, Saffron Walden, Essex CB10 1EP.

GIRL OF THE YEAR

The 1979 Girl Technician Engineer of the Year is Mrs Ann Cox-Horton, age 26, an electrical contracts engineer from Chertsey, Surrey. At a recent ceremony in London she was presented with the prize of £250 and an inscribed rose bowl by Sir Montague Finniston, FRS, Chairman of the Committee of Inquiry into the Engineering Profession.

Sponsored by The Caroline Haslett Memorial Trust and the IEETE, this award aims to focus attention on electrical and electronic engineering as a worthwhile professional career for women.

Ann Cox-Horton is employed by T Clarke & Co Limited, a London firm of electrical contractors. She is responsible for contracts valued at up to £1½ million, including the work of up to 50 people.

The runner-up, Mrs Barbara Needham, 27, a senior research engineer from Harlow, Essex, received a special award of £150.

Barbara Needham works for Standard Telecommunication Laboratories Limited in Harlow, Essex.

4 CHANNEL MEMORY

C.R. Harding

Experimenter's design for equipping the standard oscilloscope with a charge storage facility so that pulses can be examined at leisure.

WITH the recent advent of microprocessor systems and the availability of cheap digital electronics, more home constructors are using these to replace conventional analogue circuitry. In the design, development and de-bugging of these circuits the need often arises to display a low frequency pulse train, or trains, on an oscilloscope for visual analysis. This is quite difficult on a normal oscilloscope because of the nature of the time base scan, especially if the pulses are narrow. Also charge storage and memory scopes tend to be prohibitively expensive for the amateur.

It was decided therefore to produce a unit which would display pulses of TTL level (+5V) on a normal oscilloscope with no modifications to the oscilloscope. This would include the facility for storing a train of pulses and freezing them on the screen for closer scrutiny. To extend its usefulness further it was designed to display four separate inputs on the oscilloscope as four separate traces.

SPECIFICATION

4 TTL compatible channels
3 ranges of sweep time (1) 0–1s
(2) 0–10s
(3) 0–100s
Manual trigger mode or continuous memory cycling
Trigger output for oscilloscope with l.e.d. indicator
Mains power supply
Frequency response using all channels
(1) Store mode—0–250Hz
(2) Free run mode—0–10MHz

BLOCK DIAGRAM

Fig. 1 shows a block diagram of the complete unit. The four input signals are fed into a quad tri-state buffer the output of which is multiplexed by a four-way data selector. This is clocked by clock 1 via a divide by four counter and the resulting waveform is available from an output stage in a single wire format.

Outputs from the tri-state buffer are also routed to the memory storage section. This consists of a 256 x 4 RAM which is controlled by a fast clock (clock 2) and an eight bit binary counter. Another clock (clock 3) operating at a slow rate steps another eight bit counter. The outputs of the counters are fed to a sixteen bit comparator which produces controlling pulses for the output trigger and the read/write phase of the RAM.

CIRCUIT DESCRIPTION

The input channels (Fig. 2) are fed into a quad tri-state buffer IC1. This is controlled by a signal from the comparator circuitry which enables information to appear at the output of the buffers with a high level. With no enable present the output of the buffers are high impedance and do not interfere with the read phase of the RAM. These outputs are then multiplexed by IC2, a four way data selector. This is controlled by a two stage counter (IC3) and a clock (IC4) which is formed from a Schmitt trigger and runs at approximately 500kHz.

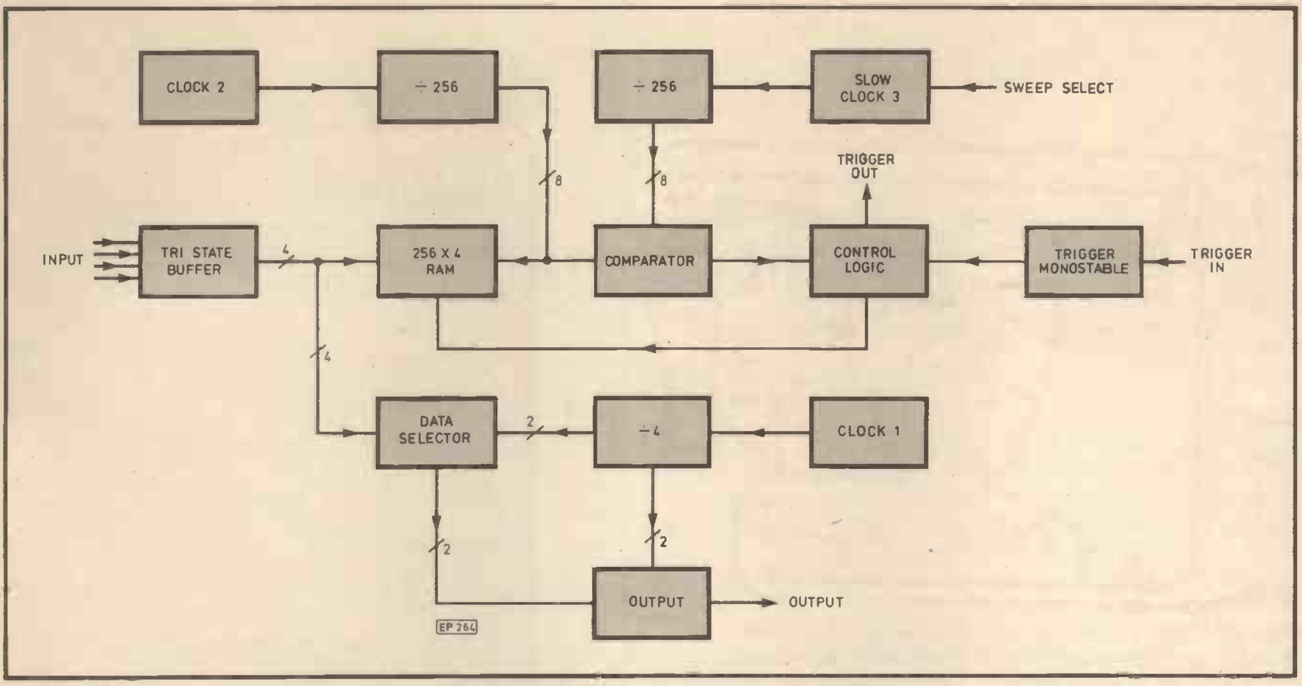


Fig. 1 Block diagram

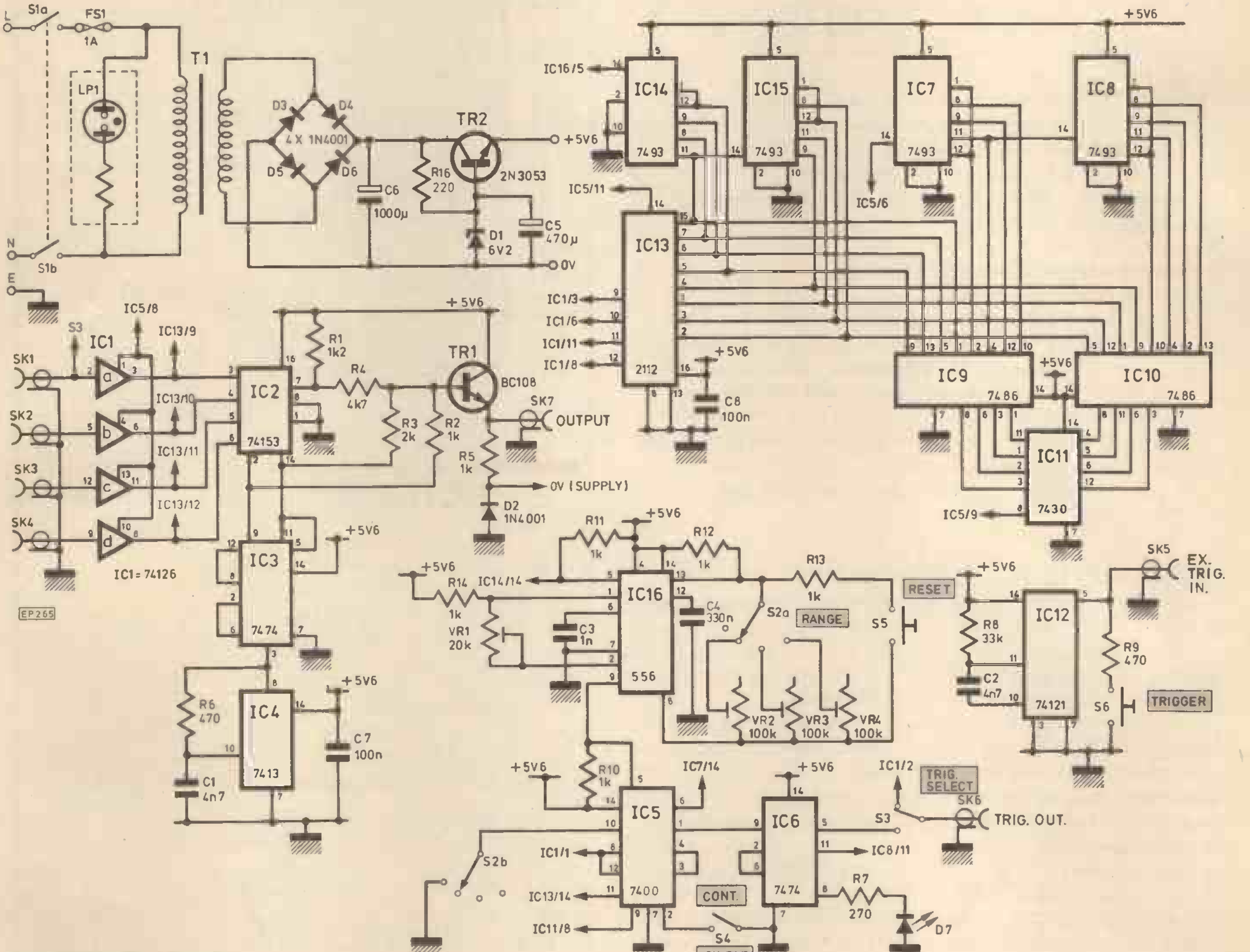


Fig. 2 Complete circuit

TR1 and its associated components form a simple three bit digital to analogue converter. The three inputs to this R2, R3 and R4 are connected to the signal output of IC2 and its two data selector input lines. Information on these last two lines effectively shifts the level of the output from TR1, and gives four distinct traces on the oscilloscope screen. TR1 also provides a buffered, low impedance output and is biased in the emitter follower mode by D2 which has its anode connected to chassis potential (as do the ground connections of the TTL i.c.s) and the cathode to power supply zero volts. This effectively produces a negative bias on the emitter of TR1 and eliminates the need for a negative supply rail.

STORAGE

The storage section of the unit consists of a 256 x 4 RAM IC13, and this is also connected to the outputs of the tristate buffers. The address lines on the RAM are controlled by an eight bit counter IC14 and IC15. These are clocked by a counter running at 256 kHz.

These address lines are also fed into a sixteen bit comparator (IC9 and IC10).

The other eight inputs of the comparator are provided by the outputs of another eight bit counter (IC7 and IC8) which is clocked by a calibrated oscillator. This is the sweep oscillator which provides the scanning times.

Thus the signals from the two eight bit counters are compared and IC11 produces a pulse only when the outputs from these are coincidental. This pulse is then used to produce a write instruction to the RAM which then stores input data.

The frequency of the slow clock (clock 3) is set to values of 256Hz, 25·6Hz to give variation in storage rate. Once the waveform has been stored, at an appropriate scanning rate, the output scanning rate can be increased to expand out the trace to see more detail. Triggering in the unit is provided by IC5 and IC6. This is available in three modes:

1. Single shot
2. External or internal trigger
3. Continuous run

In the first mode the monostable IC12 gives a pulse from push button switch S6 from a manual trigger when desired. In the external or internal trigger mode triggering is achieved from an external pulse or from input channel 1. An l.e.d. is used to indicate correct triggering.

S4 selects the continuous triggering mode which causes the unit to cycle information into the memory continuously. The output trigger pulse is available through S3 via SK6 and is of TTL level.

POWER SUPPLY

This is a conventional transformer derived mains power supply with a full wave diode bridge rectifier.

Zener dioder D1 provides the reference voltage and TR1 supplies the necessary current, which is approximately 300mA, and should have a heatsink attached.

CONSTRUCTION

The prototype was built on two pieces of Veroboard, which were stacked horizontally, one containing the memory and address dividers and the other the oscillators, trigger circuit and power supply. However, the layout of these is not critical and everything could be accommodated on one board.

A case was made for the unit out of aluminium but proprietary cases can be used.

The prototype was made compatible in appearance with

COMPONENTS

Resistors

R1	1k2
R2	1k
R3	2k
R4	4k7
R5	1k
R6	470
R7	270
R8	33k
R9	470
R10	1k
R11	1k
R12	1k
R13	1k
R14	1k
R15	910k
R16	220

0·5W 5% carbon

Capacitors

C1	4n7	mylar
C2	4n7	mylar
C3	1n	mylar
C4	330n	carbonate
C5	470μ	10V elect
C6	1000μ	10V elect
C7	100n	mylar
C8	100n	mylar

Integrated Circuits

IC1	74126	IC9	7486
IC2	74153	IC10	7486
IC3	7474	IC11	7430
IC4	7413	IC12	74121
IC5	7400	IC13	2112
IC6	7474	IC14	7493
IC7	7493	IC15	7493
IC8	7493	IC16	556

Transistors

TR1	BC108
TR2	2N3053

Diodes

D1	BZY88 — 6·2 400 mW Zener
D2–D6	1N4001 (5 off)

Potentiometers

VR1	20k
VR2–VR4	100k (3 off)

Switches

S1	Mains on/off double pole
S2	Two pole four way
S3	Single pole change-over
S4	Single pole on–off
S5–S6	Press to make

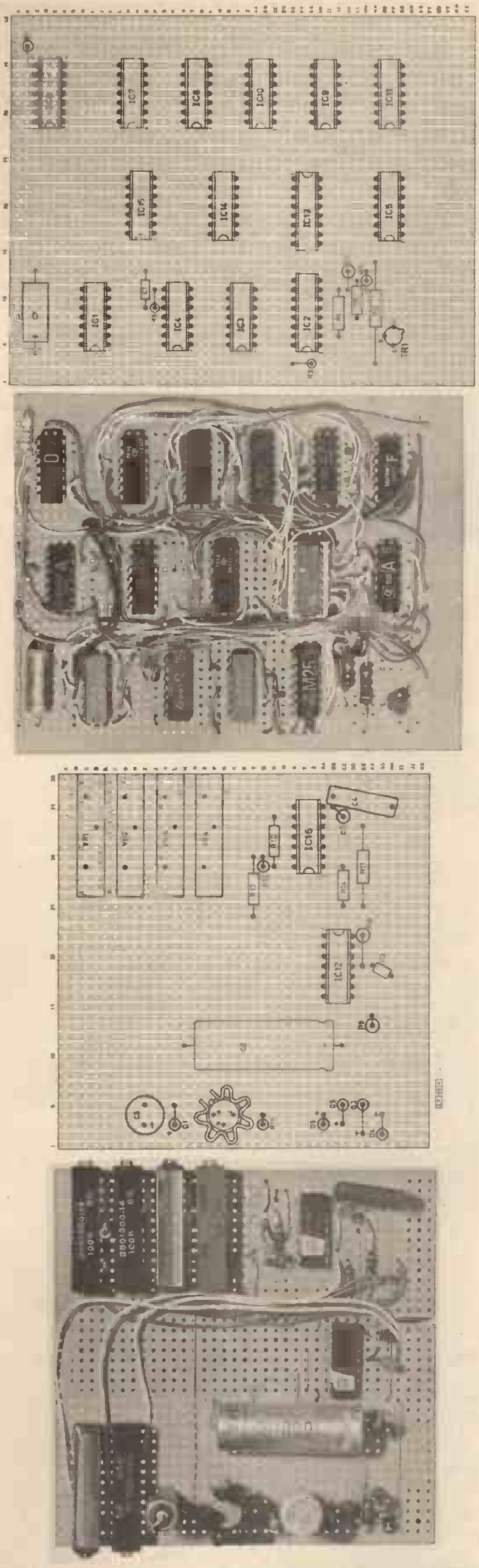


Fig. 3 Component layout for prototype boards. Since the unit is primarily a piece of experimenters test gear which will readily translate for stripboard assembly no cutting or interwiring details are given just a guide for component placement

the author's oscilloscope with the front panel containing input sockets and selection switches. The back panel houses the output and trigger sockets and mains input lead switch and fuse.

SETTING UP AND CALIBRATION

For accurate calibration a digital frequency meter should be used, however, a signal generator can be used for frequency comparison.

The following adjustments should be made:

Adjust	S2 range	Measure	Measurement pins
VR1	—	256 kHz	IC16/5
VR2	1s	256Hz	IC16/9
VR3	10s	25·6Hz	IC16/9
VR4	100s	2·56Hz (390ms)	IC16/9

USING THE UNIT

The unit should be connected to the Y input of one of the oscilloscope's channels (or channel) and the external trigger of the oscilloscope connected to the trigger output of the unit. The Y gain of the oscilloscope should be set to approximately 0·5 volts per centimetre and the timebase to 100 milliseconds per centimetre.

Four traces should appear on the screen with random information on each one. This can be cleared by pressing the sweep trigger button leaving four straight lines.

Connect a low frequency pulse generator (1Hz approximately) to the input (channel 1) and switch the unit to the 10 second sweep range. A trace of 1Hz pulses will slowly be produced on the top trace from left to right and halt when the scan reaches the right-hand margin of the screen.

The input can now be removed and the waveform will remain until the power is removed to the unit.

The unit can also be used in continuous mode where the memory will constantly refresh at the end of each scan. Also the trace can be returned to the time origin by use of the sweep trigger button.

LIMITATIONS

When using the unit care should be taken not to exceed higher frequencies than the maximum stated.

It is useful to note that the trace is actually broken up into 256 sections and at for example 1 second sweep rate the minimum pulse duration that can be recorded is 4ms in 5. If a too high frequency is fed in, depending on its harmonic relationship with the number of bits a lower frequency is produced on the screen, therefore it is useful to know the approximate value of the frequency of the waveform to be measured.

Since the unit writes in all four channels simultaneously one waveform cannot be served while 3 new ones are recorded.

MODIFICATIONS

Although designed for TTL level signals, by using a simple CMOS buffer on the input the usefulness is extended by increasing the input impedance and the level of input. Longer sweep times can be produced by using more ranges with extra capacitance on clock 3. As the sweep time is 256 times longer than the time interval of the 556, sweep periods of up to 100,000 seconds are feasible. ★

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.

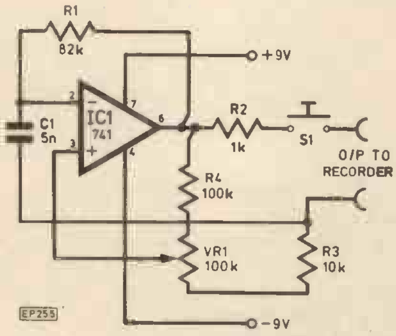
TAPE/SLIDE SYNC

SHOWN are circuits for a Tape/Slide Synchroniser. First of all the commentary is recorded onto the tape in the normal way and whenever it is necessary for the slide projector to advance one slide, S1 is pressed which records a burst of ultrasonic sound onto the tape. When the recorder is played back (connected to the projector via the 'tuned amplifier' Fig. 2) the relay closes and advances the slide projector one slide every time an ultrasonic sound is detected.

The oscillator should be tuned to the right frequency simply by connecting the output to the input of the tuned amplifier, and adjusting VR1 until RLA1 closes. The circuit only amplifies frequencies of about 48·2 kHz.

The output of the 741 is amplified by TR1 and 2 which switches on the relay. The circuit works well despite the fact that the recorders response is very low at 48·2 kHz. A small mono recorder works better than an expensive stereo tape deck because the latter usually have bias oscillators running at about 60-90kHz which might beat with the synchronisers' output.

R.N. Johnson.
Coulsdon
Surrey



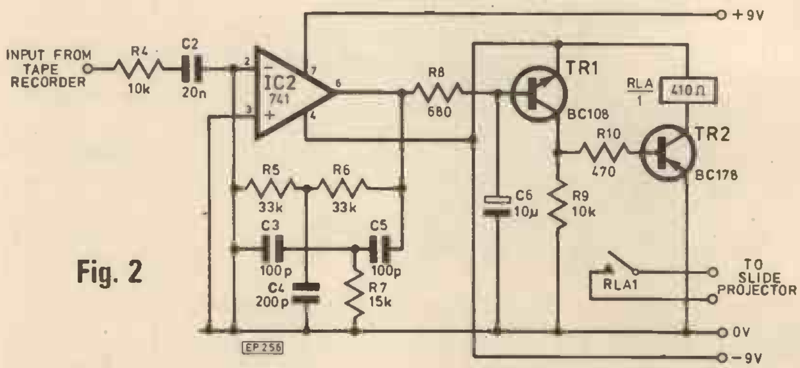


Fig. 2

VOLTAGE SENSITIVE RELAY

The circuit diagram as shown right is an electronic relay with two wires on the input side and three wires at the output. The input leads are connected to the voltage to be sensed. Its range is from 10V a.c./d.c. to 20V a.c./d.c. The relay is a 6 volt/30 ohm coil type with changeover contacts rated for 5A/230V a.c.

The heart of the control system is a general purpose operational amplifier type 741. The control voltage is rectified by diode D1 and filtered and stored by capacitor C1. The non-inverting input (pin 3) is fed with a Zener regulated fixed potential of 3·9 volts, whereas the inverting input (pin 2) is variable and can be set by a preset potentiometer VR1 to any desired voltage. It is only by adjustment of this pot that a control point is achieved.

The output of the 741 changes state with input potential difference of as low as 1 millivolt. The positive going output at pin 6 biases a switching transistor through a diode and 10 kilohm resistor. The transistor in turn energises a relay whose normally open and normally closed contacts could be used in a number of applications. The differential at which the relay is desired to be operated is provided by positive feedback to non-inverting input, by a 10k preset pot VR2 in parallel with C2.

Any desired hysteresis can be set by VR2. An electrolytic is used at the base of switching transistor TR1 to avoid chattering of the relay on a.c. operation.

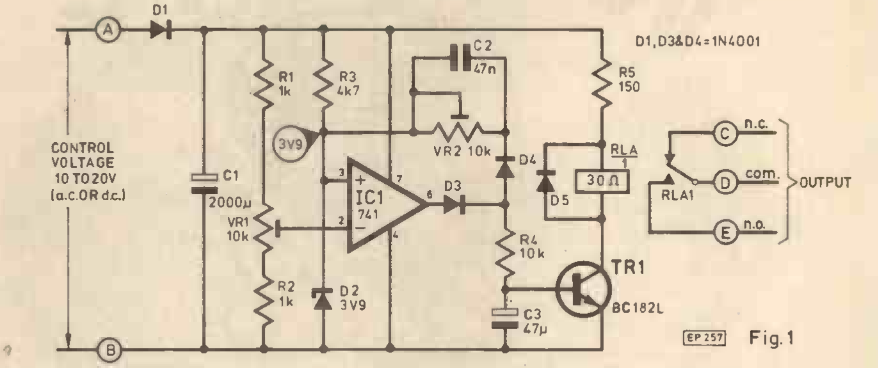


Fig. 1

Automatic Temperature controller

This application is shown below. Here a slight modification in the control circuit of the VSR is needed. R1 is removed and a thermistor with long leads substituted. The thermistor is placed near the heating source. Its resistance will change with heat resulting in control initiation. The preset potentiometer VR1 now can be set for the desired temperature. The n.c. contacts of the relay can be used for opening the heater circuit when desired temperature has reached. In this case the input supply to the VSR is obtained by a low voltage transformer and regulated by a Zener.

Twilight switch

Alternative connections to the VSR (shown in outline) provide a light switch. Here R1 is replaced by an l.d.r. The resistance of this increases with a decrease in ambient light and thus initiates the switching operation. The n.o. (normally open) contacts are connected in series with the load and supply. Thus the lamp load lights up on fall of ambient light at preset value.

M. S. Dhingra.
Chittaranjan.
India.

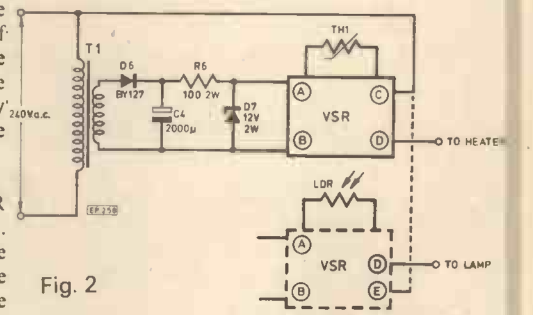


Fig. 2

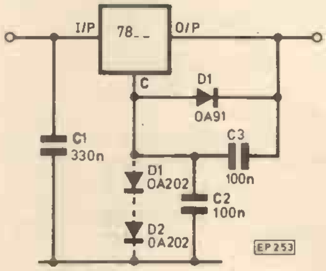
'JACKED UP' REGULATOR

WHEN a precise voltage source is required for a particular application, it is common practice to modify the output voltage of a voltage regulator by "jacking-up" the common, i.e. raising its potential above ground. This useful method has its disadvantages. In the event of a short-circuit the common would become reversed biased and the regulator would loose its protection, thus resulting in its destruction.

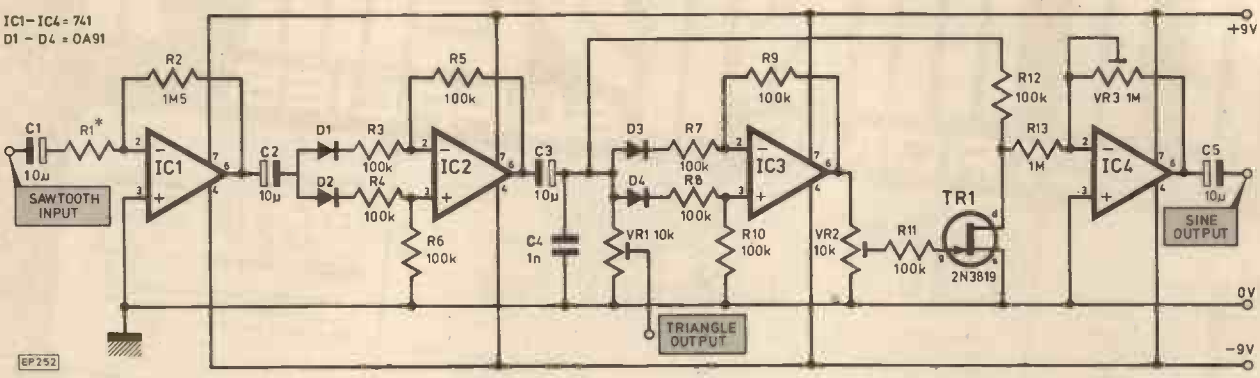
In the circuit shown the germanium diode D1 prevents the common becoming more than 0·2 volt reverse biased under short circuit conditions and thereby protecting the regulator from damage.

The addition of C2 is to ensure stability. Diodes D2 and D3 (as an example) raise the output voltage by about 1·3 volts.

J.A. Barrow
Rugby
Warwickshire



WAVEFORM CONVERTOR FOR MINISONIC



THIS circuit will convert an input of sawtooth shape into a triangle shape and then convert the triangle waveform into a synthesised sine waveform. IC1 amplifies the input signal to a level of 15 V peak to peak. The value of R1 should be chosen according to the input level. R1 should in fact be chosen as (100 × peak-to-peak input voltage) kilohms. For Minisonics 1 and 2, R1 should be 39 kilohms, and 100 kilohms respectively. IC2 is a differential amplifier which inverts the positive going half cycle with respect to the negative going half cycle. With a certain amount of smoothing from C4 this produces an output of about 7·2 V peak-to-peak which is triangular in shape. VR1 should be adjusted to give a triangle output of 1V peak-to-peak for Minisonic 2. Of course the level can be any value up to 7·2 V depending on what suits the constructor's application.

The triangle output is then fed into IC3 which is another differential amplifier and identical to IC2's circuitry. This produces an output of about 3·5 V peak-to-peak which is triangular in shape and twice the frequency of the input triangle waveform. This double frequency triangle wave controls the amount of attentuation in the voltage controlled attentuator built around TR1 and IC4.

As the input triangle wave approaches either its positive or negative peaks the gain of the output stage gradually decreases by the action of the double frequency wave at the gate of the f.e.t. TR1. This has the effect of rounding off the peaks. The shape produced is a very good approximation of a sine wave.

Setting up is quite simple. First the wiper of VR2 must be taken to its 0V end. VR3 is now adjusted to give an output level of around 500 mV r.m.s. VR2 can now be adjusted until the best approximation of a sine wave is produced. An oscilloscope would be useful here but I have found that the adjustment can be made fairly accurately by ear. With the output connected to an audio amplifier VR2 should be adjusted until the sound contains fewest harmonics. Finally VR3 should be readjusted to give an output of about 350 mV r.m.s. (1V peak-to-peak).

The circuit can be used as a triangle to sine convertor quite simply by leaving out IC2 and its associated circuitry.

P.G. Ludgate
High Wycombe,
Bucks.

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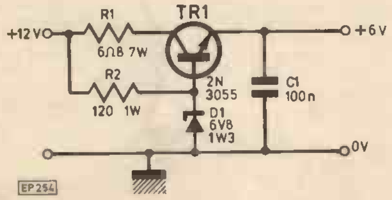

THIS unit enables a 6V cassette player or recorder to be powered from the 12V car battery, while drawing only 100mA in excess of the cassette player's consumption. Short-circuiting the output of the unit does not damage the circuitry, and only 2A flows, whereas the unit can provide 6V at up to 800mA.

R1 limits the short-circuit current to about 2A, and reduces the power dissipation of the series regulator transistor TR1, which acts as an emitter follower with the base voltage provided by R2/D1. (Note that D1 must be rated at 1W or greater.)

The complete unit fits easily into the smallest size of diecast case, which can also act as a heatsink for TR1.

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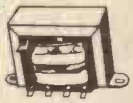

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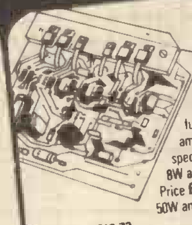

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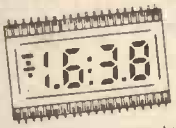

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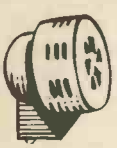

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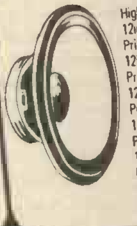

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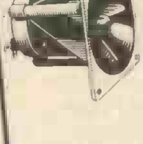

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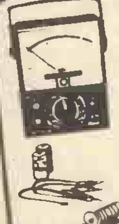

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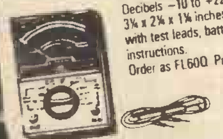

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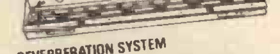

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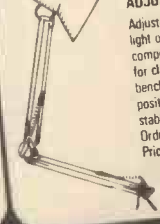

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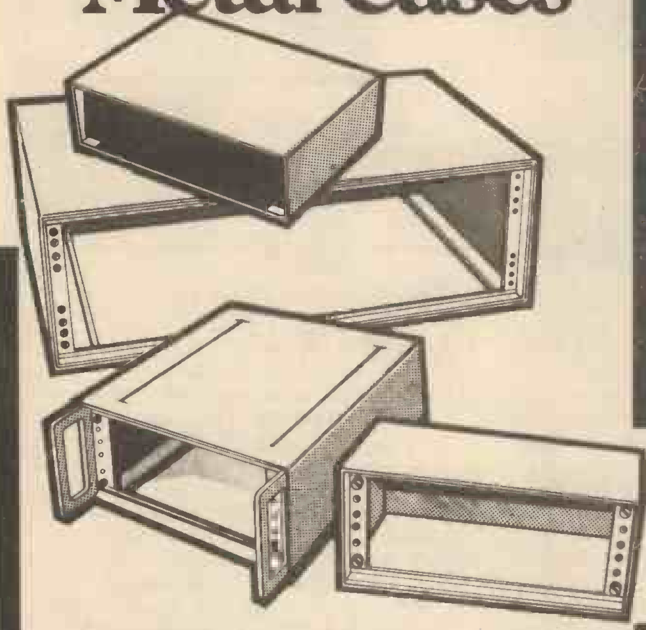

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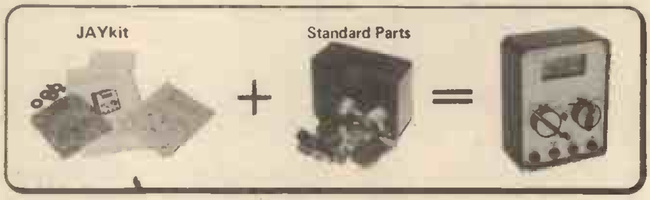

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- ★ Separate TTL output
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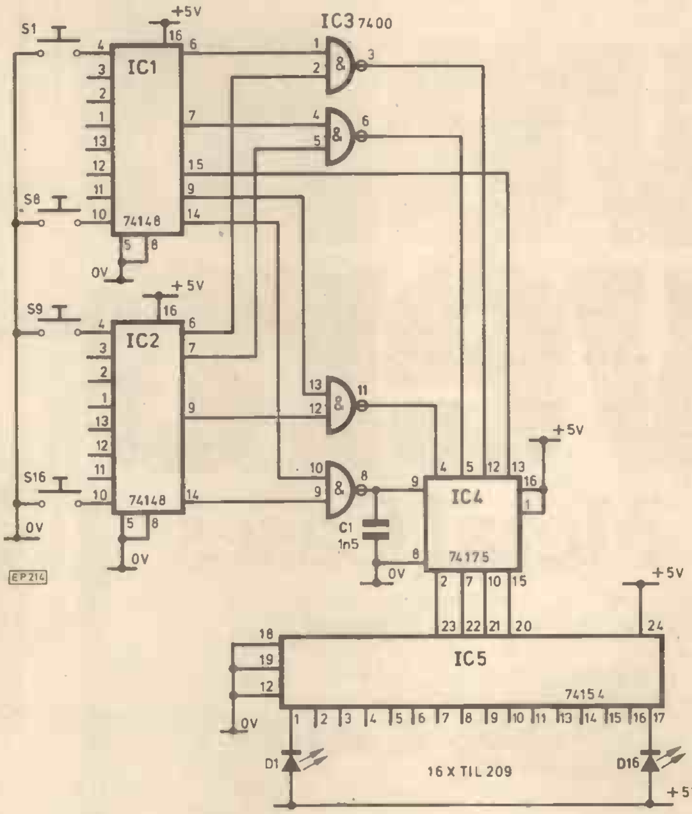
JAYkits

RHYTHM CODE GENERATOR



THE circuit shown was used to generate the 4 bit BCD rhythm select code required by the rhythm generator i.c. M252. It could also be used in any application that requires the generation of a 4 bit BCD word, for example, a hexadecimal keyboard.

If a pushbutton is pressed, the two SN74148 priority encoders code the 16 inputs to a 4 bit BCD word. This word is latched into the SN74175 quad latch by the combined GS outputs (pins 14) of the priority encoders. Capacitor C1 is used to show the edge of the latching signal so that latching takes place when the input data is valid.

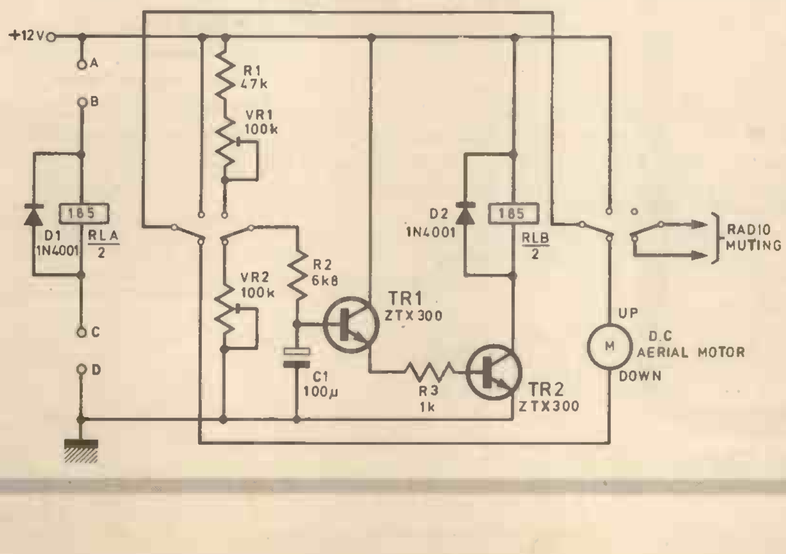
The outputs of the quad latch can be decoded back to 16 bits by a SN74154 and the outputs used to drive l.e.d.s to give a visual indication of the button pressed, or as in this example the rhythm selected.

E. J. Weremiuk,
Brantham,
Essex.

AUTOMATIC CAR AERIAL CONTROL

IN February 1977, a circuit was published in "*Ingenuity Unlimited*" for the automatic control of an electric car aerial. The circuit described here is an alternative approach to the problem. The prototype has been in trouble-free use for over four years. It may be operated by the radio on/off switch so that the aerial is only raised when needed, or, if preferred, by the ignition switch. No additional switch is necessary. The device may be left permanently connected to the car battery, since the leakage current when the radio is switched off is very low.

The main control circuit may be used either by connecting terminal B to the radio on/off switch (or the ignition switch) and shorting C and D, or by shorting A and B and connecting C to an additional control circuit. The main circuit contains two relays, each with two changeover contacts. When the radio is turned on (or the ignition if preferred) RLA switches on, the motor starts to wind up the aerial, C1 charges up and, after a delay (adjusted by the preset VR2), RLB switches on and stops the motor. When RLA switches off, the aerial starts to wind down, C1 discharges and, after a delay (adjusted independently by VR2), RLB 2 switches off and again stops the motor. VR1 and VR2 are adjusted so that the aerial winds completely up and down, the motor making about two revolutions against the slipping clutch for good measure.



If RLB has two changeover contacts, the spare set may be used to mute the radio whilst the aerial is winding up, to prevent crackling from the loudspeaker, e.g. by shorting the volume control. If the radio has a tape recorder socket through which the audio signal passes by means of a shorting plug, that can be used to make the connections to the muting contacts without disturbing the radio internally. A stereo radio would, of course, need a more complex system, or extra contacts in the relay.

D. A. Petty,
Aylesbury,
Bucks.

THERE are many published circuits which enable two lamps to be controlled along two wires giving provision for either lamp or both lamps to be illuminated at any one time.

The circuit described below enables three lamps to be controlled along two wires enabling any one lamp to be illuminated at any one time. It was originally designed for a busy office to convey the instructions of 'Engaged', 'Wait' and 'Enter'.

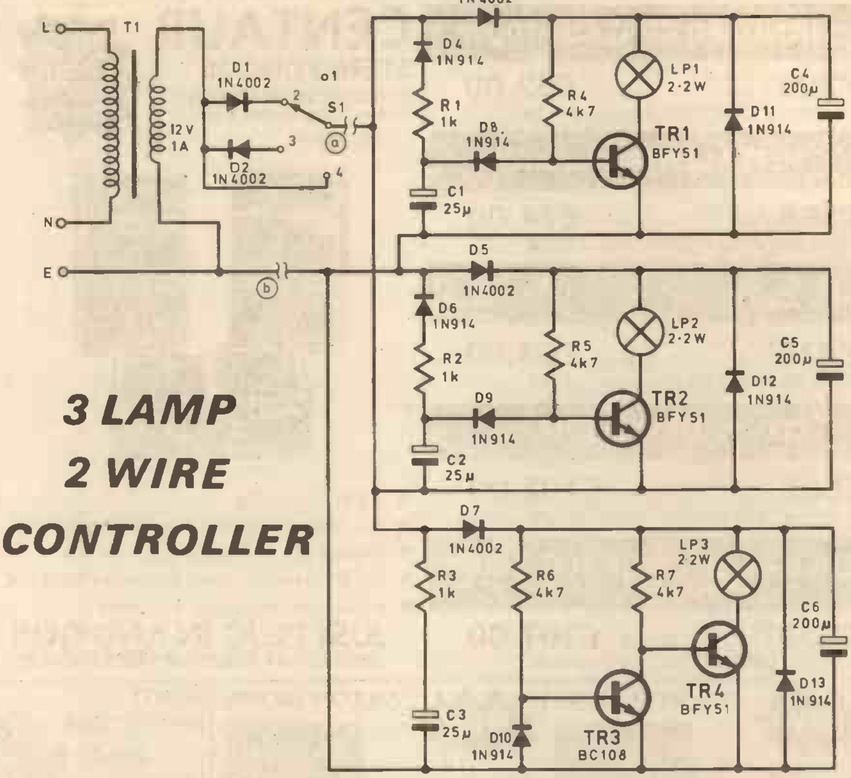
The circuit is powered by 12 volts a.c. which is derived from the mains. The three lamps are controlled by S1 which gives the four possible operations. In position 1 no lamps are on, since no power is being applied to the wires a and b. In position 2, the alternating current from the transformer is half wave rectified by D1, making wire a positive with respect to b. TR1 and its associated components respond to this and so LP1 is illuminated. TR1 is prevented from conducting when S1 is in the a.c. position (position 4) by D4, R1, and D8. These ensure that C1 is charged by the negative half cycles so that TR1 will be made non-conducting.

In position 3 the alternating current is again half wave rectified, but this time wire a is negative with respect to wire b. The circuitry for LP2 is the same as that for LP1 except that it is connected the other way round to the wires a and b.

In position 4 of S1, an alternating voltage is applied to a and b. The circuitry for LP3 works in the following way; with S1 in position 2 (wire a positive) TR3 is conducting so keeping TR4 non-conducting. In position 3 (wire a negative), D7 is reversed biased so that LP3 is again not illuminated. With an alternating voltage, the negative half cycles reduce the voltage across C3 to a sufficiently low level that TR3 is non-conducting. TR4 becomes conducting so allowing LP3 to light.

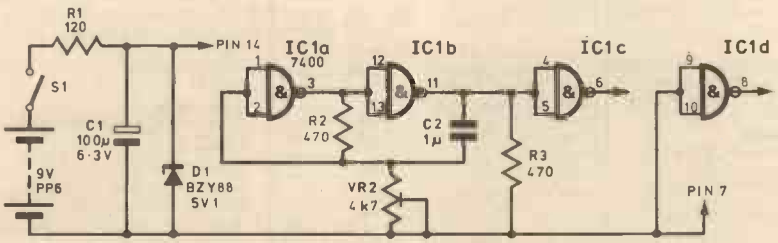
The 200uF electrolytic capacitors in each lamp circuit offers a small amount of smoothing to the half rectified a.c., producing approximately 10 volts d.c. across each lamp when alight.

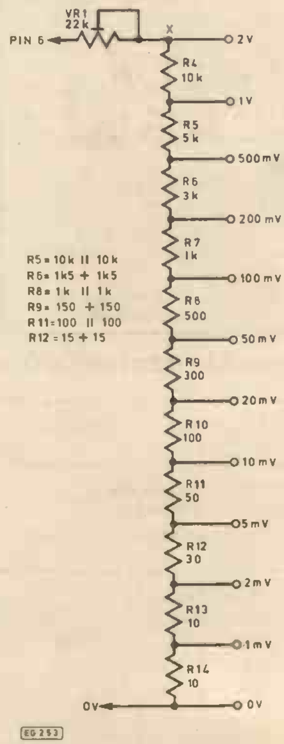
3 LAMP 2 WIRE CONTROLLER



J. P. Kemp,
Kings Norton,
Birmingham.

SCOPE CALIBRATOR





THIS simple circuit can be used to check oscilloscope Y-amplifier Volts/Cm calibration accuracy, and to set the frequency compensation trimmer R4 on a high input impedance oscilloscope probe.

IC1a and IC1b form a simple multivibrator type circuit, and IC1c acts as a pulse shaper. (The unused gate, IC1d, is connected so as to minimise battery current consumption.) The output is an excellent square-wave having fast rise and fall times with flat top and bottom base lines. Frequency is about 1kHz.

The output feeds the simple ladder attenuator (two per cent resistors should be used if high attenuation accuracy is required). VR1 should be set to give 2·0V at point X with respect to 0V.

D1 provides a stabilised 5V for the IC so that the ladder network receives a constant level square wave. Battery current drain is about 25mA.

A. Andrews,
Brighton.

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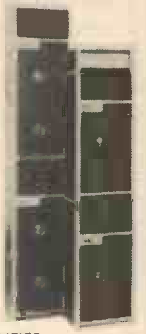

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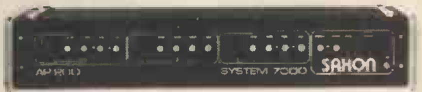

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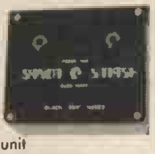

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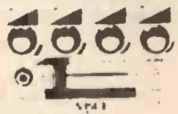

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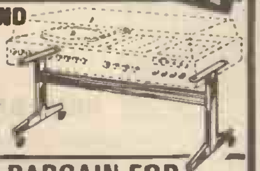

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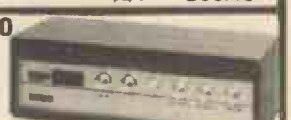

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2N3706	.12
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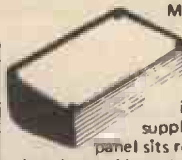

Orange, Blue, Black or Grey ABS body incorporates 1.8mm pcb guides, stand-off bosses in base with 4 BIMFEET supplied. 1mm Grey Aluminium panel sits recessed with fixing screws into integral brass bushes.

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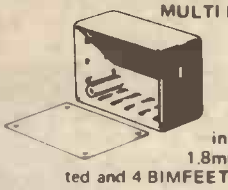

Orange, Blue, Black or Grey ABS with 1mm Grey Aluminium recessed front cover held by screws into integral brass bushes. 1.8mm pcb guides incorporated and 4 BIMFEET supplied.

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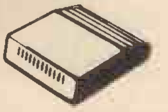

15° Sloping Panel	30° Sloping Panel	
BIM7151 (102x140x51[28] mm)	BIM7301 (102x140x76[28] mm)	£11.36
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BIM7155 (254x211x76[33] mm)	BIM7305 (254x183x102[28] mm)	£16.36
BIM7156 (254x287x76[33] mm)	BIM7306 (254x259x102[28] mm)	£17.71
BIM7157 (356x211x76[33] mm)	BIM7307 (356x183x102[28] mm)	£18.83
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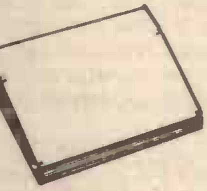

Orange, Blue, Black or Grey ABS body has ventilation slots as well as 1.8mm pcb guides and stand-off bosses in base. Double angle recessed front panel with 4 fixing screws into integral brass bushes. 4 BIMFEET supplied.

BIM 6005 (143 x 105 x 55.5 [31.5] mm) £2.76
BIM 6006 (143 x 170 x 55.5 [31.5] mm) £3.58
BIM 6007 (214 x 170 x 82.0 [31.5] mm) £4.83

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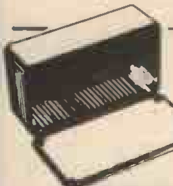

6 sizes in ABS or Diecast Aluminium. ABS moulded in Orange, Blue, Black or Grey. Diecast Aluminium in Grey Hammertone or Natural. All boxes incorporate 1.8mm pcb guides, stand-off supports in base and have close fitting flanged lids held by screws into integral brass bushes (ABS) or tapped holes (Diecast).

	ABS		Diecast	Hammertone	Natural
(50x50x25mm)	N/A		BIM5001/11	£1.54	£1.23
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(112x62x31mm)	BIM2003/13	£1.27	BIM5003/13	£2.24	£1.70
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(190x110x60mm)	BIM2006/16	£2.69	BIM5006/16	£4.94	£3.96

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BIM 2007/17 (112x61x31mm) £1.06

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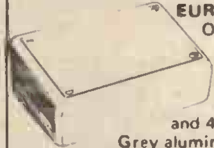

Orange, Blue, Black or Grey ABS body accepts full or ½ size Eurocards, with bosses in the base for direct fixing. 1.8mm wide pcb guides incorporated and 4 BIMFEET supplied. 1mm Grey aluminium lid sits flush with body top and held by 4 screws into integral brass bushes.

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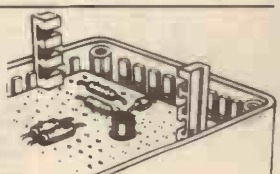

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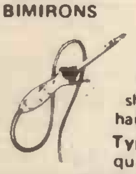

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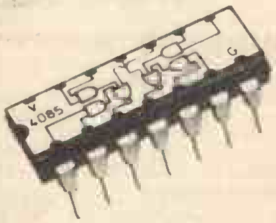

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TIP42A	70p
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TIP54	150p
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ZTX500	15p
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2N706A	20p
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2N918	35p
2N940	18p
2N1131/2	20p
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N1711	25p
2N2102	60p
2N2160	300p
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2N3054	65p
2N3055	48p
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•2N3643/4	48p
•2N3663	20p
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2N3706/7	12p
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Published approximately on the 15th of each month by IPC Magazines Ltd., Westover House, West Quay Road, Poole, Dorset BH15 1JG. Printed in England by Chapel River Press, Andover, Hants. Sole Agents for Australia and New Zealand – Gordon & Gotch (A/sia) Ltd; South Africa – Central News Agency Ltd.
Subscriptions INLAND and OVERSEAS £10.60 payable to IPC Services, Oakfield House, Perrymount Road, Haywards Heath, Sussex.