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SEPT 1984 95p

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PLUS

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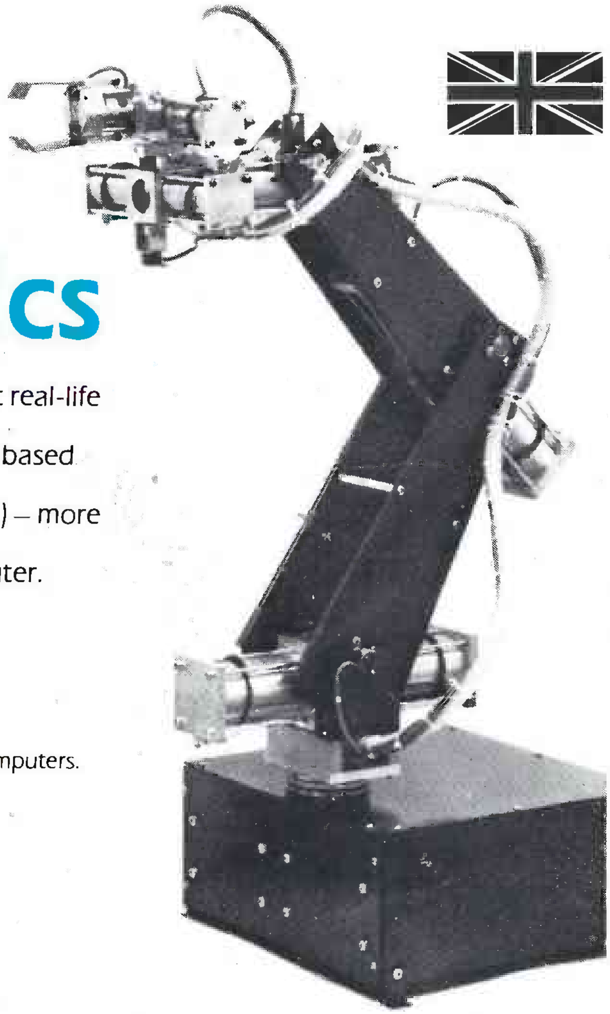
- The outs and ins of batteries

..AUDIO....COMPUTING....MUSIC....RADIO....ROBOTICS..

neptune

for low-cost training in

real-life robotics



The advanced design of the Neptune 2 makes it the lowest cost real-life industrial robot.
It is electro-hydraulically powered, using a revolutionary water based system (no messy hydraulic oil!)
It performs 7 servo-controlled axis movements (6 on Neptune 1) – more than any other robot under £10,000.
Its program length is limited only by the memory of your computer.
Think what that can do for your BASIC programming skills!

And it's British designed, British made.

Other features include:

- Leakproof, frictionless rolling diaphragm seals.
- Buffered and latched versatile interface for BBC VIC 20 and Spectrum computers.
- 12 bit control system (8 on Nuptune 1).
- Special circuitry for initial compensation.
- Rack and pinion cylinder couplings for wide angular movements.
- Automatic triple speed control on Neptune 2 for accurate 'homing in'.
- Easy access for servicing and viewing of working parts.
- Powerful – lifts 2.5 kg. with ease.
- Hand held simulator for processing (requires ADC option).

Neptune robots are sold in kit form as follows:

Neptune 1 robot kit (inc. power supply)	£1250.00
Neptune 1 control electronics (ready built)	£295.00
Neptune 1 simulator	£45.00
Neptune 2 robot kit (inc. power supply)	£1725.00
Neptune 2 control electronics (ready built)	£475.00
Neptune 2 simulator	£52.00
ADC option (components fit to main control board)	£95.00
Hydraulic power pack (ready assembled)	£435.00
Gripper sensor	£37.50
Optional extra three fingered gripper	£75.00
BBC connector lead	£12.50
Commodore VIC 20 connector lead and plug-in board	£14.50
Sinclair ZX Spectrum connector lead	£15.00

All prices exclusive of VAT and valid until the end of 1984.

mentor

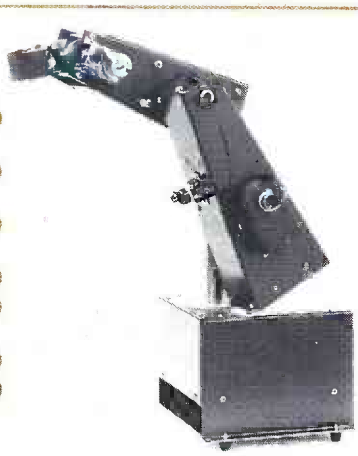
desk-top robot

This compact, electrically powered training robot has 6 axes of movement, simultaneously servo-controlled. It gives smooth operation, and its rugged construction makes it ideal for use in educational establishments. Other features include long-life bronze and nylon bearings, integral control electronics and power supply, special circuitry for inertial compensation, optional on-board ADC, and hand-held simulator as the teaching pendant. Like Neptune, Mentor's program length is limited only by your computer's memory. Programming is in BASIC.

Mentor is all-British in design and manufacture and comes in kit form at an astonishingly low price:

Mentor robot kit (inc. power supply)	£345.00
Mentor Control electronics (ready built)	£135.00
Mentor Simulator (requires ADC option)	£42.00
ADC option (Components fit to control electronics board)	£19.50
BBC connector lead	£12.50
Commodore VIC 20 connector lead and plug-in board	£14.50
Sinclair ZX Spectrum connector lead	£15.00

All prices exclusive of VAT and valid until the end of 1984.



Cybernetic Applications

CYBERNETIC APPLICATIONS LIMITED

electronics today INTERNATIONAL

SEPTEMBER 1984 VOL 13 NO 9

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Telex 8811896.

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100V 100n, 120n 10p; 150n, 180n 12p; 220n, 270n 15p; 330n, 390n 20p; 470n, 560n 26p; 680n 30p; 1uF 34p 2u2 50p

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200, 220, 250, 270, 300, 330, 360, 390, 470, 500, 600, 820 21p each
1000, 1200, 1800, 2200 30p each
3300, 4700pF 80p

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256K DRAM £59

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BY126	12
BY127	14
CRO33	250
OA9	40
OA47	12
OA70	12
OA79	15
OA81	20
OA85	15
OA90	8
OA91	8
OA95	8
OA200	8
OA202	8
1N914	4
1N916	5
1N4001/2	5
1N4003	6
1N4004/5	6
1N4006/7	7
1N4148	4
1N5401	15
1N5404	16
1N5406	17
1N5408	19
1S44	9
1S921	9
6A/100V	40
6A/400V	50
6A/800V	60

VARICAPS

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BB105B	40
BB106	40
BB109B	45
MVAM2	105

BRIDGE RECTIFIERS

1A/50V	18
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1A/400V	25
1A/600V	34
2A/50V	30
2A/200V	40
2A/400V	46
2A/600V	66
6A/100V	83
6A/400V	96
10A/200V	215
10A/600V	296
25A/200V	240
25A/600V	396
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3A400V	56
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8A400V	69
8A800V	115
12A100V	78
12A400V	82
12A800V	136
16A100V	103
16A400V	106
16A800V	220
25V500V	220
25A800V	296
T2800	125

75 SERIES

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75110	90
75114/5	150
75121/2	130
75150	125
75154	125
75158	150
75159	195
75182/4	99
75188/9	100
75322	140
75324	360
75325	00
75361/3	150
75365	00
75450	86
75451/2	52
75454	70
75491/2	65

SCR THYRISTORS

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5A400V	40
5A600V	48
8A300V	60
8A600V	90
12A100V	78
12A400V	96
12A800V	188
BT106	150
BT116	180
C106D	36
TIC44	24
TIC45	29
TIC47	36
2N5062	32
2N5064	38
2N4444	130

DIAC

ST2	25

COMPUTER ICs

2102L	160
2114	200
2147	395
2516	350
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6845SP	750
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6850	175
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8131	475
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81LS97	140
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AM26LS32A	125
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AM7910	£32
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DS3647	00
DS3691N	POA
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DS8820	110
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FD1791	£22
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MC1488	100
MC1489	100
MC14411	675
MC14412	725
MC3242	590
MC3446	250
MC3447P	315
MC3486	225
MC3487	225
IM6402	350
MC6845	625
MC6846	625
MK3886-2M	£7
MM5280D	696
MM5303	636
MM5307	1275
MM5387A	475
MM58174	875
MM74C922	420
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SAA5050	875
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SPO256AL2	950
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TMS4047	100
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TMS4500	£14
TMS4500	£14
TMS4532-3	350
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710	48
741 8 pin	16
747C 14 pin	70
748C 8 pin	30
735 8 pin	185
810	158
9400CJ	375
ADC0808	885
AY-1-1320	225
AY-1-5050	99
AY 1-5051	160
AY-1-6720	210
AY-3-1270	730
AY-3-1350	350
AY 3 8910	400
Booklet for AY-3-8910	400
AY-3-8912	500
AY-5 1317A	630
AY-5-1350	366
CA3011	130
CA3012	175
CA3014	275
CA3018	85
CA3019	90
CA3020	210
CA3023	210
CA3028A	130
CA3035	255
CA3036	270
CA3043	275
CA3045	385
CA3046	70
CA3048	220
CA3059	325
CA3075	213
CA3080E	75
CA3081	180
CA3085	160
CA3086	60
CA3089E	200
CA3090AO	375
CA3123E	165
CA3130	90
CA3140	55
CA3160	95
CA3161	160
CA3162	450
CA3189	275
HA1336W	175
HA1388	235
ICL7106	690
ICL7107	975
ICL7611	99
ICL7660	248
ICL8038CC	360
ICL8211A	750
ICM7205A	1150
ICM7207	475
ICM7215	1050
ICM7216AJ	£22
ICM7216C	£22
ICM7217A	750
ICM7224	785
ICM7240	300
ICM7555	105
ICM7556	150
LA3550	250
LA4031P	340
LA4032	295
LA4400	350
LA4422	320
LC7130	320
LC7120	300
LC7137	350
LF347	150
LF351	70
LF353	90
LF355	95
LF356	99
LF357	110
LF398	495
LM10	325
LM301A	30
LM307	45
LM308T	95
LM311	65
LM318N	175
LM319	195
LM324A	75
LM334Z	115
LM335Z	135
LM337	275
LM339	40
LM348	64
LM349	125
LM358	60
LM377	215
LM379	495
LM380	120
LM381N	175
LM382	200
LM384	225
LM386	110
LM387	135
LM389	145
LM393	85
LM394CH	385
LM558	170
LM725CN	300
LM733	70
LM1458	35
LM1871	300
LM1889	350
LM2907	395
LM2917	325
LM3900	70
LM3909N	85
LM3911	185
LM3914	445
LM3915	350
LM3916	350
LM13600	150
LS7220	280
M706B1	150
MS1513L	230
MS1515L	320
MS1516L	475
MB3712	200
MB3756	440
MC1204	250
MC1301	90
MC1303	96
MC1304P	260
MC1310P	150
MC1445	250
MC145106	695
MC1455	50
MC1458	35
MC1469	300
MC1494	694
MC1495	350
MC1496L	70
MC1596	225
MC1648	290
MC1709G	90
MC3302	75
MC3401	50
MC3403	95
MC3404	85
MC3405	150
MC3422	00
MC3423	80
MC3442	00
MC3487	00
MC4016	00
MF10	350
MFC6040	75
ML924	275
NE515	275
NE529	225
NE531	140
NE543K	225
NE544	200
NE555	25
NE556	65
NE558	170
NE560	350
NE562B	410
NE564	420
NE565A	120
NE566	155
NE567V	140
NE570	410
NE571	400
NE5532	175
NE5534A	160
OM335	750
RC4136D	60
RC4558	60
S566B	225
SAB3209	425
SAB3210	325
SAB3271	485
SAB4209	585
SG3402	295
SL490	350
SL6270CD	150
SN76013	350
SN76023ND	240
SN76227N	95
SN76477	470
SN76488	525
SN76489	495
SP8629	350
SP0256AL	799
TA7120	140
TA7204	150
TA7205	90
TA7222	150
TA7310	125
TAA621AX1	296
TAA661A	190
TAA700	275
TAA900	395
TAB1042	110
TAD100	159
TBA120S	70
TBA900	395
TAB1042	110
TAD100	159
TBA120S	70
TBA920Q	200
TBA990Q	350
TCA220	350
TCA270Q	350
TCA280A	220
TCA940	175
TCA965	180
TDA1004	350
TDA1008	310
TDA1010	235
TDA1022	499
TDA1024	115
TDA1034	350
TDA1490	350
TDA2002	325
TDA2003	250
TDA2004	300
TDA1490	350
TDA2002	325
TDA2003	250
TDA2004	300
TL170	50
TL430C	90
TL507	110
TL509	110
TL061CP	40
TL062CP	65
TL064CN	98
TLO71CP	40
TLO72CP	76
TL074CN	150
TL081CP	35
TL082CP	60
TL083CP	75
TL084CN	120
TL091CP	60
UA2240	120
UA78540	230
ULN2003	90
ULN2004	90
ULN2283	100
ULN2803	190
UPC575	275
UPC1025H	375
UPC1156H	295
UPC1182	425
UPC1366	195
XR2206	375
XR2207	400
XR2211	575
XR2216	675
XR2266	380
ZN414	80
ZN419E	180
ZN423E	130
ZN424E	130
ZN425E	345
ZN426E	300
ZN427E	600
ZN428E	450
ZN429E	245
ZN459	290
ZN1034E	200
ZN1040E	665
ZNA234E	925

TTL74

7400	60
7401	30
7402	30
7403	30
7404	75
7405	30
7406	180
7407	170
7408	30
7409	25
7410	45
7411	45
7412	30
7413	50
7414	70
7416	150
7417	150
7420	30
7421	80
7422	40
7423	40
7425	40
7426	65
7427	40
7428	45
7430	80
7432	60
7433	40
7437	50
7438	95
7440	45
7441	65
7442	95
7443	155
7444	155
7445	175
7446	170
7447	130
7448	130
7450	30
7451	30
7453	30
7454	30
7460	48
7470	55
7472	40
7473	55
7474	65
7475	75
7476	55
7480	65
7481	185
7482	100
7483	122
7484	140
7485	150
7486	50
7489	225
7490	125
7491	55
7492	75
7493	75
7494	120
7495	95
7496	115
7497	230
74100	170
74104	70
74105	70
74107	45
74109	75
74110	165
74111	80
74112	170
74116	175
74118	110
74119	160
74120	90
74121	60
74122	70
74123	120
74125	60
74126	60
74128	60
74132	80
74136	40
74141	105
74142	260
74143	280
74144	280
74145	115
74147	180
74148	145
74150	190
74151	90
74153	90
74154	190
74155	90
74156	95
74157	105
74159	195
74160	125
74161	125
74162	125
74163	125
74164	155
74165	125
74166	170
74167	250
74170	215
74172	430
74173	135
74174	140
74175	105
74176	105
74177	105
74178	125
74179	125
74180	115
74181	320
74182	115
74184	170
74185	170
74190	175
74191	175
74192	175
74193	149
74194	113
74195	80
74196	180
74197	115
74198	257
74199	257
74221	117
74246	130
74247	132
74248	175
74249	175
74251	92
74259	220
74263	75
74265	60
74273	212
74276	144
74278	159
74279	85
74283	130
74284	446
74285	446
74290	120
74293	84
74297	900
74298	159
74351	208
74365	85
74366	85
74367	85
74368	85
74376	116
74390	139
74393	140
74490	134

74C

74C244	195
74C245	195
74C373	240
74C374	245
74C922	750
74C923	645
74C925	775

74S

S00	70
S02	60
S03	60
S04	60
S05	60
S08	60
S09	60
S10	40
S11	50
S15	60
S20	40
S22	50
S32	70
S37	70
S38	90
S40	45
S51	45
S64	45
S65	45
S74	85
S85	295
S86	115
S112	80
S113	90
S114	80
S124	300
S132	110
S133	60
S134	60
S135	110
S138	195
S139	195
S140	60
S151	180
S153	182
S157	225
S158	210
S163	300
S174	250
S175	320
S188	320
S189	320
S194	320
S197	400
S201	250
S225	525
S240	430
S241	430
S244	520
S251	270
S257	250
S258	250
S260	70
S262	£12
S287	225
S288	210
S289	200
S301	350
S365	250
S373	400
S374	490
S412	380
S470	325
S471	620
S472	1150
S474	400
S475	800
S571	820
S573	950

74LS

LS00	75
LS01	28
LS02	32
LS03	28
LS04	82
LS05	35
LS08	48
LS09	30
LS10	65
LS11	30
LS12	30
LS13	35
LS14	78
LS15	25
LS19	45
LS20	45
LS21	25
LS22	25
LS24	78
LS26	30
LS27	38
LS28	30
LS30	35
LS32	92
LS33	25
LS37	25
LS38	90
LS40	45
LS42	85
LS47	99
LS48	99
LS49	60
LS51	25
LS52	25
LS54	25
LS55	25
LS63	55
LS73	50
LS74	85
LS75	50
LS76	30
LS78	40
LS83	90
LS85	115
LS86	75
LS90	65
LS91	130
LS92	65
LS93	65
LS95	78
LS96	155
LS107	55
LS109	55
LS112	55
LS113	45
LS114	45
LS122	75
LS123	120
LS124	150
LS125	55
LS126	55
LS132	75
LS133	60
LS135	28
LS136	45
LS138	75
LS139	75
LS145	120
LS147	195
LS148	150
LS151	110
LS153	110
LS154	195
LS155	75
LS156	75
LS157	68
LS158	60
LS160	75
LS161	75
LS162	75
LS163	65
LS164	110
LS165	130
LS166	195
LS168	140
LS169	90
LS170	225
LS173	110
LS174	130
LS175	90
LS181	110
LS183	245
LS190	110
LS191	75
LS192	110
LS193	110
LS194	80
LS195	80
LS196	110
LS197	110
LS221	105
LS240	140
LS241	130
LS242	135
LS243	135
LS244	250
LS245	250
LS247	115
LS248	115
LS249	115
LS251	80
LS253	80
LS256	175
LS257	80
LS258	80
LS259	175
LS260	80
LS261	150
LS266	45
LS273	180
LS275	380
LS279	75
LS280	195
LS283	95
LS290	85
LS292	900
LS293	85
LS294	999
LS295	140
LS298	140
LS299	290
LS320	230
LS322	360
LS323	360
LS324	150
LS325	150
LS326	290
LS327	290
LS347	130
LS348	125
LS352	125
LS353	125
LS355	220
LS356	220
LS363	175
LS365	75
LS366	75
LS367	75
LS368	75
LS373	220
LS374	220
LS375	80
LS377	145
LS378	120
LS379	150
LS380	310
LS382	310
LS384	475
LS385	330
LS386	50
LS390	110
LS393	120
LS395	135
LS396	300
LS398	195
LS399	150
LS445	125
LS447	80
LS465	155
LS490	160
LS540	145
LS541	145
LS624	150
LS629	150
LS640	200
LS641	200
LS645	200
LS668	90
LS669	90
LS670	225
LS673	000
LS674	800
LS678	275
LS682	250

TRANSISTORS

AC126/7	35
AC141/2	35
AC176	35
AC187	35
AC188	35
ACY19/21	75
ACY22/41	75
AD142	120
AD149	79
AD161	42
AD162	42
AF115/6	80
AF188	80
AF124/26	70
AF139	40
AF178	75
AF186	70
AF239	55
BC107	12
BC107B	14
BC108	12
BC108B	14
BC108C	14
BC109	12
BC109B	14
BC109C	14
BC114/5	30
BC117/8	25
BC137/9	40
BC140	38
BC142/3	38
BC147	12
BC147B	15
BC148	12
BC148B	15
BC149	12
BC149C	15
BC182L	10
BC183L	10
BC184	10
BC184L	10
BC186/7	28
BC188 6/7	25
BC12	10
BC212L	12
BC213	10
BC213L	12
BC214	10
BC214L	12
BC237/8	15
BC256B	35
307B	15
BC308	16
BC318	80
BC327	15
BC337/8	15
BC441/61	34
BC477	40
BC516/7	40
BC547/8	12
BC549C	15
BC556/7	15
BC558/9	15
BCY39/40	85
BCY41/42	30
BCY45	50
BCY58/59	36
BCY70/71	18
1BCY72	25
BCY78	30
BD114	190
BD121	95
BD124	115
BD131/32	65
BD133	70
BD135	45
BD136/37	40
BD138/39	40
BD140	40
BD144/45	198
BD158	68
BD205/6	110
BD245	65
BD378	70
BD434	70
BD517	75
BD645	80
BD695A	150
BD696A	150
BF115	45
BF154/8	30
BF167	35
BF173	35
BF177	35
BF178	35
BF179	40
BF184/5	38
BF194/5	15
BF198/9	18
BF200	80
BF224A	40
BF224B	40
BF245	50
BF256A	45
BF256B	50
BF257/8	32
BF259	40
BF275	55
BF336/7	35
BF394	40
BF451	40
BF494/5	40
BF594/5	30
BFR39/40	30
BFR41/79	25
BFR80/81	25
BFR98	105
BFX29	35
BFX81	45
BFX84	35
BFX85/6	35
BFY50/51	30
BFY52	30
BFY53	30
BFY55/56	56
BFY64	40
BFY81	120
BFY90	80
BRY39	50
BSX20	30
BSX26/29	45
BSX36	35
BSY95	35
BU105	180
BU205	180
BU206	200
BU208	200
BUY69C	225
MD8001	250
MJ2955	90
MJE170	150
MJE180	150
MJE340	54
MJE370	100
MJE371	100
MJE520	85
MJE521	96
MJE2955	98
MJE3055	70
MPF102	40
MPF103	30
MPF104	30
MPF105	30
MPF106	40
MPSA05	30
MPSA08	30
MPSA12	32
MPSA55	30
MPSA56	30
MPSA70	40
MPSU02	58
MPSU05	60
MPSU06	60
MPSU52	65
MPSU55	60
MPSU56	60
OC26	170
OC28	220
OC35	50
OC36/41	75
OC42/75	75
OC71/72	50
OC75/76	55
OC81/82	50
OC83/84	70
OC170/71	75
OC70	40
OC200	75
TIP29A	32
TIP29C	38
TIP30A	35
TIP30C	37
TIP31A	38
TIP31B	39
TIP31C	45
TIP32A	43
TIP32C	45
TIP33A	70
TIP33C	75
TIP34A	85
TIP34C	105
TIP35A	120
TIP35C	130
TIP36A	130
TIP36C	140
TIP41A	50
TIP41B	52
TIP42B	58
TIP120	70
TIP121/2	73
TIP141/2	120
TIP147	120
TIP2955	70
TIP3055	70
TIS43	50
TIS44/5	45
TIS88A	50
TIS90/91	30
UC	65
VK1010	99
VN10KM	70
VN46AF	95
VN66AF	110
VN88AF	120
VN89AF	120
ZTX107/8	12
ZTX109	12
ZTX212	28
ZTX300	13
ZTX302	16
ZTX303	25
ZTX304	17
ZTX326	30
ZTX451	23
ZTX500	14
ZTX501/2	15
ZTX503	18
ZTX504	25
ZTX531	125
ZTX550	25
2N697	23
2N698	40
2N699	48
2N706A	25
2N708	25
2N918	40
2N1131/2	40
2N1302	45
2N1307	70
2N1671B	160
2N2160	325
2N2219A	28
2N2220A	28
2N2221A	25
2N2222A	25
2N2368	25
2N2369A	18
2N2483/4	27
2N2646	46
2N2904/5	28
2N2906/7	28
2N2907A	28
2N2926G	10
2N3053	25
2N3054	55
2N3055	50
2N3252	46
2N3441/2	140
2N3614/5	180
2N3663	20
2N3702/3	10
2N3704/5	10
2N3706/7	10
2N3708/9	10
2N3713	140
2N3771	179
2N3772	195
2N3773	210
2N3819	35
2N3820	60
2N3822/3	60
2N3866	90
2N3903/4	18
2N3905/6	18
2N3906	17
2N4037	60
2N4058	15
2N4061/2	15
2N4264	30
2N4286	25
2N4289	25
2N4314	78
2N4400	25
2N4427	80
2N4871	55
2N5135/6	30
2N5138	25
2N5172	25
2N5179	45
2N5180	45
2N5190/1	75
2N5194	80
2N5305/8	30
2N5457/8	30
2N5459	30
2N5777	45
2N5879	180
2N6027	32
2SA671	250
2SA715	75
2SC495	85
2SC496	85
2SC1061	250
2SC1096	85
2SC1162	45
2SC1173	125
2SC1306	100
2SC1307	150
2SC1449	95
2SC1678	140
2SC1679	180
2SC1923	65
2SC1945	225
2SC1963	80
2SC1957	80
2SC1969	160
2SC2028	85
2SC2029	200
2SC2078	170
2SC2091	85
2SC2314	86
2SC2166	105
2SC2335	200
2SC2547	40
2SC2612	200
2SD234	74
2SK45	80
2SK288	225
2SJ83	225
2SJ85	225
3N128	115
3N140	115
40315	90
40316	95
40324	100
40326/7	70
40347	90
40348	120
40360	80
40361/2	70
40407/8	75
40411	285
40412	90
40467A	130
40468	85
40594	105
40603	110
40673	75
40871/2	90

RF CHOKES Miniature PCB type
1uH, 2u2, 4u7, 10u, 22u, 33u, 47u, 100u, 220u, 330u, 470u 30p
1mH, 1m5, 2m2, 4m7, 10mH 35p
22m, 33m, 43m 60p
100m 75p

SWITCHES

TOGGLE: 2A, 250V
SPST 35p
DPDP 48p

SUB-MIN TOGGLE
SPST on/off 58p
SPDT c/over 64p
SPDT centre off 85p
SPDT biased both ways 105p
DPDT 6 tags 80p
DPDT centre off 88p
DPDT biased both ways 145p
DPDT 3 positions on/on/on 185p
4-pole 2 way 220p

SLIDE 250V:
DPDT 1A 14p
DPDT 1A c/off 15p
DPDT ½A 13p

PUSHBUTTON 6A
with 10mm Button
SPDT latching 150p
DPDT latching 200p
SPDT moment 150p
DPDT moment 200p

Mini Non Locking
Push to Make 15p
Push to Break 25p

DIGITAST Switch
Assorted Colours
75p each

GAS/SMOKE DETECTORS

TGS812 or TGS813

£6 each

DIP SWITCHES

(SPST) 4 way **65p**; 6 way **80p**; 8 way **85p**; 10 way **125p** (SPDT) 4 way **190p**

ROTARY SWITCHES

(Adjustable Stop type)
1 pole/2 to 12 way; 2 pole/2 to 6 way; 3 pole/2 to 4 way; 4 pole/2 to 3 way **48p**

ROTARY: Mains DP 250V 4 Amp on/off **68p**

ROTARY: (Mak-a-switch)
Make a multiway switch. Shafting assembly has adjustable stop. Accommodates up to 6 wafers (max. 6 pole/12 way + DP switch). Mechanism only **90p**

WAFERS: (make before break) to fit the above switch mechanism. 1 pole/12 way; 2 pole/6 way; 3 pole/4 way; 4 pole/3 way; 6p/2 Way **65p**
Mains DP 4A Switch to fit **45p**
Spacers **4p**. Screen **6p**.

ROCKER SWITCHES

ROCKER: 5A/250V SPST **28p**
ROCKER 10A/250V SPDT **38p**
ROCKER: 10A/250V DPDT c/off **95p**
ROCKER: 10A/250V DPST with neon **85p**

THUMBWHEEL Mini front mounting switches
Decade Switch Module **275p**
B.C.D. Switch Module **298p**
Mounting Cheeks (per pair) **75p**

JUMPER LEADS (Ribbon Cable Assembly)

Length	14 pin	16 pin	24 pin	40 pin
Single ended DIP (Header Plug) Jumper				
24 inches	145p	185p	240p	380p
Double ended DIP (Header Plug) Jumper				
6 inches	185p	205p	300p	485p
12 inches	198p	215p	315p	480p
24 inches	210p	235p	345p	540p
36 inches	290p	370p	480p	525p

IDC Female Header Socket Jumper Leads 36"

	20 pin	26 pin	34 pin	40 pin
Single ended	160p	200p	260p	300p
Double ended	290p	370p	480p	525p

VEROBOARD 0.1in

2½ x 3¼ 95p
2½ x 5 110p
3¾ x 3¾ 110p
3¾ x 5 125p
3¾ x 17 420p
4¾ x 17 590p
Pkt of 100 pins 55p
Spot face cutter 150p
Pin insertion tool 185p

VA Board 195p
DIP Board 395p
Vero Strip 95p

PROTO DECs
Veroblock 480p
S-Dec 395p
Eurobreadboard 590p
Bimboard 1 575p
Superstrip SS2 1350p

VERO WIRING PEN
+ spool 380p
Spare spool 75p
Combs 8p

DALO ETCH RESIST PEN
Plus spare tip 100p

FERRIC CHLORIDE
1 lb bag Anhydrous
195p + 50p p&p

ULTRASONIC TRANSDUCER
40KHz 475 pr

COPPER CLAD BOARDS

	Fibre glass Single-sided	Fibre glass Double sided	S.R.B.P. S/Speed
6" x 6"	100p	125p	9.5" x 8.5"
6" x 12"	175p	225p	110p

DILL SOCKETS

	Low Prof	Wire Wrap
8 pin	8p	25p
14 pin	10p	35p
16 pin	10p	42p
18 pin	16p	52p
20 pin	20p	60p
22 pin	22p	65p
24 pin	25p	70p
28 pin	28p	80p
40 pin	30p	90p

EDGE CONNECTORS

2x6 way	—	111p
2x12 way	—	160p
2x15 way	—	165p
2x18 way	210p	175p
2x22 way	215p	250p
2x23 way	175p	—
2x25 way	285p	275p
2x28 way	190p	—
2x30 way	310p	—
2x36 way	360p	—
2x40 way	380p	—

SIL SOCKET 0.1" Pitch 20 way **65p**

ANTEX SOLDERING IRONS

C15W 525p; C18W 550p; Spare Bits 85p; Iron Stand 175p;
CS17W 545p
XS25W 570p
Elements 230p
Heat Shunt 30p

IDC CONNECTORS

	PCB with Pins Strt	Plugs latch Pins Angle	Female Header Plug	Female Card Edge Conct
10 way	90p	99p	85p	120p
16 way	130p	150p	110p	—
20 way	145p	166p	125p	195p
26 way	175p	200p	150p	240p
34 way	205p	236p	160p	320p
40 way	220p	250p	180p	340p
50 way	235p	270p	200p	395p
60 way	—	—	230p	495p

EURO CONNECTORS

Gold Flashed Contacts	Female Strt Pins	Socket Angle Pins	Male Strt Pins	Plug Angle Pins
DIN41617 31 way	170p	—	—	175p
DIN41612 2 x 32 A + B	275p	320p	220p	285p
DIN41612 2 x 32 A + C	295p	340p	240p	300p
DIN41612 3 x 32 A + B + C	360p	385p	280p	395p

DIL PLUG (Header)

	Solder	IDC
14 pin	40p	90p
16 pin	48p	105p
24 pin	88p	178p
28 pin	290p	295p
40 pin	250p	255p

RIBBON CABLE

price per foot

	Grey	Color
10 way	15p	28p
16 way	25p	40p
20 way	30p	50p
24 way	40p	65p
28 way	55p	80p
34 way	60p	85p
40 way	70p	90p
50 way	100p	135p
64 way	120p	160p

ZIF DIL SOCKETS

24 pin 565p
28 pin 750p
40 pin 845p

'D' CONNECTORS

	9 way	15 way	25 way	37 way
Male				
Solder lugs	80p	105p	160p	250p
Angle pins	150p	210p	250p	355p
PCB pins	120p	130p	195p	295p
Female				
Solder lugs	105p	160p	200p	335p
Angle pins	165p	215p	290p	440p
PCB pins	150p	180p	240p	420p
COVERS	80p	75p	75p	90p

IDC 25 way 'D' Plug **385p**; Socket **450p**

25 way 'D' CONNECTOR (RS232)

Jumper Lead Cable Assembly
18" long, Single end, Male 475p
18" long, Single end, Female 510p
36" long, Double Ended, M/M 995p
36" long, Double Ended, F/F £10
36" long, Double Ended, M/F 995p

AMPHENOL PLUGS

	IDC	Solder
24 way IEEE	475p	470p
36 way Centronix	450p	475p
24 way Female	525p	490p

PANEL METERS

FSD
60 x 46 x 35mm
0–50mA
0–100mA
0–500mA
0–1mA
0–5mA
0–10mA
0–50mA
0–100mA
0–500mA
0.aA
0.2A
0.25V
0.50V AC
0.300V AC
"S"
"VU" **490p each**

CRYSTALS

32.768KHz	100
100KHz	235
200KHz	265
455KH	370
1MHz	275
1.008M	275
1.28MHz	390
1.6MHz	395
1.8MHz	515
1.8432M	250
2.0MHz	225
2.4576M	200
3.12MHz	240
3.278M	150
3.5794M	98
3.6864M	300
4.0MHz	150
4.032MHz	290
4.19430M	200
4.433619M	100
4.608MHZ	200
4.80MHz	200
5.0MHz	160
5.185MHz	300
5.24288M	390
6.0MHz	140
6.144MHz	150
6.5536MHz	225
7.0MHz	150
7.168MHz	250
7.7328MHz	250
7.68MHz	200
8.0MHz	150
8.089333M	395
8.86723M	220
9.00MHz	200
10.0MHz	175
10.24MHz	200
10.5MHz	250
10.7MHz	150
12.0MHz	175
12.528M	300
14.31814M	170
15.0MHz	240
16.0MHz	220
18.0MHz	180
18.432M	150
19.968MHz	150
20.0MHz	200
24.0MHz	170
24.930MHz	325
26.69M	150
27.648M	170
27.145M	180
38.6667M	240
48.0MHz	240
100.0MHz	295
116.0MHz	300

RELAYS

Miniature, enclosed, PCB mount.

SINGLE POLE Changeover
RL-91 205R Coil, 12V DC, (10V5 to 19.5V), 10A at 30V DC or 250V AC **195p**

DOUBLE POLE Changeover, 6A 30V DC or 250V AC
RL-100 53R Coil, 6V DC (5V4 to 9V9) **190p**
RL6-111 205R Coil, 12V DC (10V7 to 19V5) **195p**
RL6-114 740R Coil, 24V DC (22V to 37V) **200p**

ASTEC UHF MODULATORS

Standard 6MHz **375p**
Wideband 8MHz **550p**

BUZZERS

miniature, solid-state 6V, 9V & 12V **70p**
PIEZO TRANSDUCERS PB2720 **70p**

LOUDSPEAKERS

Miniature, 0.3W- 8 **80p**
2in, 3¼in, 2½in, 3in
2½in 40, 64 or 80 **80p**

MONITORS

- ZENITH — 12" Green, Hi-Resolution Popular **£75**
- MICROVITEC 1431. 14" Colour RGB input. Connecting cable incl. **£174**
- KAGA 12". Med-res. RGB Colour. Has flicker-free characters. Ideal for BBC, Apple, VIC, etc **£195** (car £7)
- KAGA 12". As above but Hi-Resolution **£259** (car £7)
- Connecting Lead for KAGA **£5**

Carriage £7 Securicor

BROTHER HR15 PRINTER

A high quality Daisy Wheel printer at the price of a Dot Matrix printer.

Price £349

TRANSFORMERS

3-0-3V; 6-0-6V, 9-0-9V; 12-0-12V; 15-0-15V @ 100mA **98p**
pcb mounting. Miniature, Split Bobbin
3VA: 2x6V-0.25A; 2x9V-0.15A; 2x12V-0.12A; 2x15V-0.1A **235p**
6VA: 2x6V-0.5A; 2x9V-0.3A; 2x12V-0.25A; 2x15V-0.2A **280p**
Standard Split Bobbin type:
6VA: 2x6V-0.5A; 2x9V-0.4A; 2x12V-0.3A; 2x15V-0.25A **250p**
12VA: 2x4.5V-1.3A; 2x5V-1A; 2x9V-0.6A, 2x12V-0.5A; 2x15V-0.4A; 2x20V-0.3A **345p** (35p p&p)
24VA: 2x6V-1.5A; 2x9V-1.2A; 2x12V-1A; 2x15V-0.8A; 2x20V-0.6A **385p** (60p p&p)
50VA: 2x6V-4A; 2x9V-2.5A; 2x12V-2A; 2x15V-1.5A; 2x20V-1.2A; 2x25V-1A; 2x30V-0.8A **520p** (60p p&p)
Specially wound for Multirail computer PSUs
50VA: Outputs +5V/5A; +12V, +25V, −5V, −12V at 1A **620p** (60p p&p)
100VA: 2x12V-4A; 2x15V-3A; 2x20V-2.5A; 2x25V-2A; 2x30V-1.5A; 2x50V-1A **965p** (75p)

P&P charge to be added over and above our normal postal charge

VOLTAGE REGULATORS

1A TO220 Plastic Casing

	+ ve		− ve	
5V	7805	50p	7905	50p
12V	7812	50p	7908	60p
15V	7815	45p	7912	50p
18V	7818	45p	7915	50p
24V	7824	50p	7918	50p
			7924	50p
100mA TO92 Plastic package				
5V	78LO5	30p	79LO5	50p
6V	78LO6	30p	—	—
8V	78LO8	30p	—	—
12V	78L12	30p	79L12	50p
15V	78L15	50p	79L15	60p

ICL7660 248p
RC4194 375p
RC4195 160p
LM309K 135p
LM317K 250p
LM317KP 450p
LM323K 450p
LM337 175p
LM723 Var 30p
TAA550 50p
TDA1412 150p
78H05 +5V/5V 550p
78H12+12V/5A 640p
78HG + 5V to + 25V 5A 585p
79HG − 2.25V to −24V; 5A 685p

SOLDERCON PINS

Ideal for making SIL or DIL Sockets
100 pins 75p
500 pins 350p

ALUM BOXES

3 x 2 x 1"	85p
4 x 2½ x 2"	100p
4 x 2½ x 2½"	103p
4 x 4 x 2"	105p
4 x 4 x 2½"	120p
5 x 4 x 1½"	99p
5 x 4 x 2½"	120p
5 x 2¾ x 1½"	90p
5 x 2¾ x 2½"	130p
6 x 4 x 2"	120p
6 x 4 x 3"	150p
7 x 5 x 3"	180p
8 x 6 x 3"	210p
10 x 4 x 3"	240p
10 x 7 x 3"	275p
12 x 5 x 3"	280p
12 x 8 x 3"	295p

CMOS

4000	20	4072	25	4536	275
4001	25	4073	26	4538	80
4002	25	4075	25	4539	90
4006	75	4076	68	4541	95
4007	25	4077	25	4543	70
4008	60	4078	25	4544	150
4009	45	4081	25	4548	40
4010	60	4082	25	4549	400
4011	25	4085	60	4553	245
4012	25	4086	60	4554	180
4013	60	4089	125	4555	35
4014	60	4093	37	4556	55
4015	60	4094	70	4557	250
4016	40	4095	95	4558	120
4017	60	4096	100	4559	395
4018	60	4097	275	4560	180
4019	58	4098	80	4561	104
4020	90	4099	110	4562	350
4042	43	4160	95	4566	165
4021	58	4161	96	4568	250
4022	67	4162	96	4569	175
4023	30	4163	96	4572	45
4024	50	4174	96	4580	255
4025	22	4175	105	4581	125
4026	90	4194	105	4582	99
4027	43	4408	850	4583	100
4028	45	4409	850	4584	60
4029	75	4410	725	4585	70
4030	35	4411	750	4597	330
4031	130	4412	805	4599	155
4032	70	4415	590	40085	90
4033	130	4419	280	40097	45
4034	146	4422	770	40098	42
4035	70	4435	850	40100	215
4036	275	4440	900	40101	130
4037	115	4450	360	40102	140
4038	75	4451	350	40103	412
4039	280	4490	450	40104	120
4040	60	4500	395	40105	220
4041	57	4501	38	40106	60
4042	50	4502	60	40107	55
4043	42	4503	40	40108	325
4044	50	450-	99	40109	100
4045	110	4505	385	40110	235
4046	60	4506	100	40114	240
4047	60	4507	45	40161	194
4048	55	4508	130	40163	75
4049	38	4510	55	40174	75
4050	35	4511	55	40175	75
4051	45	4512	55	40181	220
4052	60	4513	150	40182	80
4053	60	4514	115	40192	75
4054	85	4515	115	40193	95
4055	85	4516	55	40194	70
4056	85	4517	275	40195	75
4057	1000	4518	48	40244	196
4059	435	4519	32	40245	196
4060	68	4520	53	40257	196
4061	500	4521	115	40373	220
4062	986	4522	125	40374	220
4063	85	4526	60	45106	586
4066	45	4527	65	**OPTO**	
4067	245	4528	68	OCP71	120
4068	25	4529	150	ORP12	85
4069	25	4530	90	ORP61	86
4070	25	4531	130	BPX25	250
4071	25	4532	65	BPW21	320
		4534	400	TIL139	225

OPTO ELECTRONICS

LEDs with clips
TIL209 10
TIL211 GRN 14
TIL212 Yel. 14
TIL220 2" Red 12
2" Green, Yellow or Amber 14
0.2" Bi colour Red/Green 65
Green/Yellow 78
0.2" Tri colour Red/Green/Yellow 85
Hi-Brightness Red 58
High-Bri Green or Yel 68
Flashing red 0.2" red 55
Square LEDs, Red, Green, Yellow 30
Rectangle Stackable LEDs Red, Green or Yellow 18
Triangular LEDs Red 18
Green or yellow 22
LD271 Infra Red 48
SFH205 Detector 118
TIL32 Infra Red 52
TIL78 Detector 55
TIL38 50
TIL100 75
BARGRAPH, Red 10 segments 275

ISOLATORS
ILD74 145
ILQ74 275
TIL111/2/4 70
ILCT6 Darlington 135
4N33 Photo Darlington 136

7 Segment Displays
TIL312 .3" CA 120
TIL313 .3" CC 120
TIL321 .5" CA 140
TIL322 .5" CC 140
TIL729/730 140
DL704 .3" CC 125
DL707 .3" CA 125
FND357 Red 120
FND500 130
.3" Green CA 150
.6" Green CA 215
.3" ± 1 Red CA 150
.3" ± 1 Green CA 150
LCD 3½ Digits 496
LCD 4 Digits 530
LCD 6 Digits 625
Reflective Switch 170
SLOTTED Optical Switch similar to RS Comp.'s 195

COMPUTER CORNER

- **EPSON RX80 PRINTER: 100 CPS**, 9 x9 matrix, dot addressable graphics, condensed & double width printing, Normal, Italics & Elite Char., Tractor Feed, Bidirectional, Logic seeking **£235**
- **RX80 F/T Epson Printer.** As above but has both Tractor and Friction feed facilities **£259**
- **EPSON FX80 PRINTER 10"** Tractor & Friction Feed, 160 CPS, bi-directional Logic seeking, 9 x 11 matrix, hi-res bit image, Normal, Italic & Elite Char. Super & Subscript. Proportional spacing **£325**
- **SEIKOSHA GP100A.** 10" Tractor Feed, 80 Colmn. 30CPS, Normal and Double width Char. Dot Res Graphics **£138**
- Printer Cable for our printers and BBC MICRO **£8**
- **TEX EPROM ERASER** with a safety switch **£30**
- **SPARE** 'UV' Lamp bulb **£8**
- **C12** COMPUTER GRADE CASSETTES in library cases **36p**
- 8½" & 9½" Fan Fold paper (1000 sheets) .... **£7 + 150p carr**

Call in at our shop for demonstration. Be satisfied before you buy or write in for our descriptive Micro Peripherals Leaflet.

DISC DRIVES

(BBC Compatible)

- **CS100** — Single Cased with PSU, 40 track, 5¼" S/S 100K **£143**
- **CD200** — Twin Cased with PSU, 40 Track, 5¼" S/S 200K **£269**
- **CS200** — Single Cased with PSU, 80 Track, 5¼" S/S 200K **£205**
- **CD400** — Twin Cased with PSU, 80 track, 5¼" S/S 400K **£365**
- **MITSUBISHI 5¼" SLIM LINE DISC DRIVES** Double Sided, Double Density, Track Density 96 TPI, Track to track access time 3msec.
- **MITSUBISHI Single Slimline**, 5¼" Cased with PSU, DSDD, 1 Megabyte (400 K with BBC) **£225**
- **MITSUBISHI Twin Slimline**, 5¼" Cased with PSU, DSODD, 2 Megabyte, (800 K with BBC) **£425**

5¼" DISKETTES (Lifetime Warranty)

- **10 3M Diskettes Single side Double density** **£17**
- **10 3M Diskettes Double side Double density** **£27**

N.B. Carriage on Drives £7 securicor

SPECTRUM 32K UPGRADE

Upgrade your 16K Spectrum to full 48K with our RAM Upgrade Kit. Very simple to fit. Fitting instructions supplied.

£18

SPECTRUM CENTRONICS/RS232 PRINTER INTERFACE

★ It was the first! It is still the best!
★ Centronics and BI-DIRECTIONAL RS-232 with full hand-shaking.
★ Obeys SPECTRUM LLIST and LPRINT.
★ Split-Speed Operation for RS-232.
(Use it to communicate with the BBC MICRO or OTHER PERIPHERALS)
★ Interface 1, Interface * & Microdrive compatible.
★ Configuration program creates customised M/C driver to suit your printer.
★ HI-RES screen dumps in 2 sizes on EPSON, SEIKOSHA, STAR, SHINWA, MANNESMAN TALLY, NEC, RITEMAN, KAGA, etc. This is a STANDARD FEATURE! Not an extra.
★ Compatible with TASWORD TWO and most professional programs.

£29.95

BBC & MICROCOMPUTER & ACCESSORIES

Model A .... **£299** Model B **£399** (incl VAT)
We stock the full range of BBC Micro peripherals, Hardware & Software like, Disc Drives (Top quality Cumana & Mitsubishi), Diskettes, Printers, printer, Paper, Interface Cable, Dust Covers, Cassette Recorder & Cassettes, Monitors, Connectors (Ready made Cables, Plugs & Sockets), Plotter (Graphic Tablet) EPROM Programmer, Lightpen Kit, Joysticks, Sideways ROM Board, EPROM Eraser, Machinecode ROM. The highly sophisticated Watford's 16K BEEB DFS, WORDWISE, BEEB-CALC, Software (Educational Application & Games), BOOKs, etc, etc, Please send SAE for our descriptive leaflet.

MARCO TRADING

TRANSISTORS + DIODES

Type	Price (£)
AC127	0.30
AC128	0.30
AC128K	0.34
AC132	0.55
AC141	0.26
AC141K	0.40
AC142	0.26
AC142K	0.48
AC151	0.45
AC152	0.45
AC176	0.28
AC176K	0.48
AC187	0.26
AC187K	0.40
AC188	0.28
AC188K	0.40
ACY40	0.88
AD142	1.10
AD143	1.10
AD149	0.96
AD161	0.42
AD162	0.42
AD161/AD162	0.96
AF106	0.48
AF114	2.10
AF115	2.10
AF116	2.10
AF117	2.10
AF118	0.85
AF121	0.62
AF124	0.48
AF125	0.48
AF126	0.48
AF127	0.48
AF139	0.68
AF178	0.68
AF239	0.68
AF279S	0.75
AL100	2.50
AL102	1.88
AL113	2.20
ASY80	1.75
AU110	1.40
AY102	4.32
BA102	0.34
BA110	0.67
BA121	0.40
BA129	0.38
BA148	0.16
BA154	0.06
BA155	0.10
BA156	0.06
BA157	0.28
BA164	0.14
BB104B	0.52
BB105B	0.30
BB105G	0.48
BB110B	0.42
BC107	0.10
A or B	0.12

Type	Price (£)
BC108	0.10
A,B or C	0.12
BC113	0.14
BC114	0.12
BC115	0.12
BC116	0.15
BC117	0.22
BC118	0.17
BC119	0.30
BC125	0.12
BC140	0.28
BC141	0.42
BC142	0.30
BC143	0.30
BC147	0.08
A or B	0.10
BC148	0.08
A or B	0.10
BC149	0.09
BC157	0.10
BC158	0.10
BC159	0.10
BC160	0.30
BC161	0.30
BC168B	0.10
BC169C	0.10
BC170	0.14
BC170B	0.12
BC171	0.10
BC171	0.10
A or B	0.10
BC172	0.08
A or B	0.08
BC177	0.20
BC178A	0.22
BC182	0.09
A,B or C	0.09
BC182L	0.09
A,B or C	0.09
BC183	0.09
A,B or C	0.10
BC183L	0.08
A,B or C	0.10
BC184L	0.10
A,B or C	0.10
BC207	0.15
BC208	0.16
BC212	0.09
A,B or C	0.10
BC212L	0.08
A,B or C	0.10
BC213	0.09
A or B	0.10
BC213L	0.10
A or B	0.10
BC237	0.11
BC238	0.12
BC239C	0.14
BC251	0.12
A,B or C	0.14
BC301	0.30

Type	Price (£)
BC302	0.32
BC303	0.32
BC307	0.10
BC308A	0.10
BC323	0.99
BC327	0.14
BC328	0.14
BC337	0.12
BC338	0.12
BC350	0.14
BC440	0.30
BC441	0.32
BC461	0.32
BC547	0.12
BC548	0.12
BC549	0.12
BC550	0.18
BC550C	0.18
BC557	0.12
BC558	0.12
BCX34	0.27
BCY70	0.15
BCY71	0.17
BCY72	0.18
BCZ10	1.58
BCZ11	1.45
BD124P	0.80
BC130Y	0.68
BD131	0.34
BD132	0.34
BD131/BD132	0.95
BD135	0.32
BD136	0.36
BD137	0.36
BD138	0.38
BD139	0.38
BD140	0.38
BD144	1.80
BD145	1.82
BD150A	0.51
BD159	0.65
BD160	1.65
BD165	0.45
BD175	0.60
BD182	1.00
BD183	1.10
BD184	1.20
BD201	0.72
BD202	0.87
BD204	0.80
BD222	0.80
BD225	0.86
BD232	0.63
BD233	0.60
BD234	0.62
BD235	0.63
BD236	0.63
BD237	0.65
BD238	0.56
BD241	0.60
BD243A	0.80

Type	Price (£)
BD244A	0.65
BD375	0.32
BD410	0.76
BD434	0.68
BD436	0.68
BD437	0.76
BD438	0.75
BD439	0.68
BD507	0.48
BD508	0.53
BD509	0.54
BD510	0.48
BD517	0.59
BD520	0.66
BD699	1.25
BD707	0.88
BDX18	2.35
BDX32	2.10
BF115	0.32
BF117	0.54
BF119	0.82
BF120	0.38
BF123	0.40
BF125	0.42
BF127	0.38
BF152	0.16
BF154	0.23
BF157	0.40
BF158	0.22
BF159	0.24
BF160	0.23
BF167	0.30
BF173	0.25
BF177	0.42
BF178	0.30
BF179	0.32
BF180	0.35
BF181	0.35
BF182	0.32
BF183	0.32
BF184	0.32
BF185	0.32
BF194	0.08
BF195	0.10
BF196	0.10
BF197	0.10
BF198	0.14
BF199	0.16
BF200	0.26
BF222	0.48
BF224	0.20
BF224J	0.16
BF240	0.20
BF241	0.20
BF244	0.26
BF244A	0.28
BF244C	0.24
BF245A	0.28
BF254	0.15
BF256	0.40
BF257	0.32

Type	Price (£)
BF258	0.30
BF259	0.32
BF262	0.30
BF263	0.30
BF270	0.30
BF271	0.26
BF273	0.18
BF274	0.32
BF323	0.92
BF336	0.26
BF337	0.28
BF338	0.26
BF355	0.42
BF363	0.82
BF367	0.24
BF371	0.27
BF422	0.38
BF450	0.38
BF457	0.33
BF458	0.36
BF459	0.44
BFR39	0.22
BFR40	0.22
BFR41	0.22
BFR51	0.30
BFR61	0.32
BFR62	0.28
BFR88	0.34
BFR90	1.72
BFT41	0.38
BFT43	0.38
BFW10	0.79
BFW44	0.76
BFX29	0.28
BFX30	0.30
BFX80	3.56
BFX84	0.24
BFX85	0.26
BFX86	0.26
BFX87	0.26
BFX89	0.65
BFY50	0.21
BFY51	0.21
BFY52	0.21
BFY57	0.40
BFY90	0.90
BFY90S	1.34
BR100	0.20
BR101	0.44
BR103	0.58
BRC4443	1.78
BRY39	0.38
BRY56	0.42
BRY61	0.86
BSS17	0.56
BSS27	0.92
BSX19	0.34
BSX20	0.34
BSX59	0.62
BSX76	0.29
BT100A/02	0.94

Type	Price (£)
BT101/300	1.15
BT101/500	1.25
BT102/300	1.35
BT102/500	1.65
BT106	1.50
BT108	1.30
BT109	1.18
BT116	1.25
BT119	3.62
BT120	3.60
BT121	3.02
BT138/600	1.30
BT151/560R	0.90
BT151/300R	1.15
BTY79/400R	2.80
BU100A	2.30
BU104	2.00
BU105	1.20
BU105/02	1.56
BU108	1.80
BU124	1.75
BU126	1.25
BU133	1.80
BU204	1.35
BU205	1.30
BU206	1.70
BU208	1.55
BU208A	1.63
BU208/02	2.05
BU326S	1.75
BU407	1.65
BU407D	1.80
BUX80	3.70
BUY20	1.75
BUY69A	2.60
BUY69B	1.98
BY101	0.48
BY118	1.10
BY122	0.68
BY126	0.12
BY127	0.12
BY133	0.16
BY135	0.25
BY164	0.44
BY179	0.66
BY182	0.87
BY184	0.40
BY187	0.72
BY189	4.75
BY198	0.44
BY199	0.47
BY206	0.24
BY207	0.24
BY210/400	0.25
BY210/600	0.26
BY210/800	0.30
BY223	1.20
BY227	0.26
BY229	0.30
BY238	0.68
BYX10	0.24

Type	Price (£)
BYX36/150	0.22
BYX36/600	0.28
BYX48/300	0.72
BYX49/300	0.47
BYX55/350	0.29
BYX55/600	0.33
BYX71/600	1.18
BYZ12	0.42
C106D	0.80
E1222	0.40
E5024	0.30
GET872	0.48
ITT44	0.04
ITT2002	0.11
ME0402	0.20
ME0404/2	0.24
MEU21	0.60
MJ400	1.25
MJ2955	0.90
MJ3000	1.98
MJE240	0.60
MJE340	0.54
MJE370	0.88
MJE520	0.48
MJE2955	0.99
MJE3055	0.70
MPSLO1	0.28
OA47	0.10
OA90	0.08
OA91	0.06
OA95	0.18
OA200	0.06
OA202	0.15
OC25	2.10
OC26	1.70
OC28	1.50
OC29	2.47
OC35	1.75
OC36	1.75
OC42	0.72
OC42K	1.40
OC44	0.72
OC45	0.58
OC71	0.50
OC72	0.52
OC81	0.68
OC200	2.46
OC202	2.20
ORP12	0.85
R2008B	1.50
R2010B	1.52
SHG1.5	0.40
TAG1/100	1.40
TAG3/400	1.78
TIC44	0.40
TIC45	0.45
TIC46	0.48
TIC47	0.70
TIC106A	0.70
TIP30A	0.46
TIP31C	0.54

Type	Price (£)
TIP32	0.40
TIP32C	0.60
TIP33A	0.63
TIP34A	0.72
TIP41C	0.48
TIP42A	0.52
TIP47	0.60
TIP110	0.88
TIP2955	0.60
TIP3055	0.60
TIS43	0.32
TIS88	0.40
TIS90	0.25
TIS91	0.28
ZTX108	0.12
ZTX109	0.12
ZTX212	0.28
IN4001	0.05
IN4003	0.05
IN4004	0.06
IN4006	0.07
IN4007	0.07
IN4148	0.05
IN5400	0.12
IN5402	0.15
IN5405	0.16
IN5406	0.18
IN5408	0.20
IS920	0.08
2N697	0.55
2N706A	0.33
2N2904	0.28
2N2906	0.24
2N2926G	0.10
2N3053	0.22
2N3054	0.56
2N3055	0.45
2N3702	0.10
2N3704	0.10
2N3708	0.10
2N3772	1.90
2N3773	2.70
2N3904	0.16
2N3906	0.16
2N5294	0.48
2N6107	0.71
2N6126	0.68
2SB337	1.60
2SC1172Y	2.90
2SC1173Y	0.82
2SC1302	1.40
2SC1226	0.84
2SC1279	0.50
2SC1306	0.92
2SC1307	1.40
2SC1413A	2.70
2SC1444	1.45
2AC1449	0.63

Type	Price (£)
2SC1507	0.63
2SC1678	1.06
2SC1758	0.68
2SC1909	1.20
2SC1923	0.30
2SC1945	2.88
2SC1953	0.74
2SC1957	0.76
2SC1969	2.88
2SC2028	0.73
2SC2029	1.00
2SC2078	1.05
2SC2091	0.73
2SC2098	2.90
2SC2122A	3.20
2SC2166	1.20
2SC2314	0.80
2SC2335	1.50
2SC2749	2.70
2SC2752	0.60
2SD234	0.64
2SD348	3.30
2SD986	0.62
2SK134	3.80
2SK135	1.90
3N126	1.90
3N211	2.52
3SK45	0.76

ROTARY POTS

0.25W CARBON
LOG: 4K7 — 2M2
IN: 1K — 2M2
32p ea. 10 for £3
Any 100 for £27.50

VEROBOARD

2½ x 3¾	85p
2½ x 5	£1.00
2½x17	£3.07
3¾ x 17	£1.05
3¾ x 5	£1.15
3¾ x 17	£4.10
4¾ x 17¾	£4.95
Pkt of 100 pins	60p
Spot face cutter	£1.48
Pin insertion tool	£1.83
Vero Wiring Pen & Spool	£1.48
DIP board	£3.85
Vero Strip	£1.25

HV Disc Ceramic

1kV 1.5nF	18p
8kV 10, 47, 82, 100, 120, 150, 180, 200, 220pF	30p
270, 300pF	39p
10kV 1nF	67p

VALVES

Type	Price (£)
DY802	0.88
DY86/87	0.75
ECC81	0.95
ECC82	0.65
ECC83	0.75
ECC84	0.85
ECC85	0.90
ECC88	0.95
ECF80	0.95
ECH81	0.75
ECH84	0.75
ECL82	0.75
ECL86	0.98
EF80	0.65
EF86	1.80
EF183	0.75
EF184	0.75
EH90	0.94
EL34	2.50
EL84	0.89
EL509	5.50
EM87	2.55
EY86/87	0.67
EY500A	1.65
PCC84	0.50
PCC85	0.65
PCC89	0.74
PCC189	0.85
PCF80	0.75
PCF86	1.25
PCF200	1.95
PCF801	1.45
PCF802	0.85
PCF806	1.20
PCL82	0.90
PCL83	2.50
PCL84	0.90
PCL86	0.98
PCL805/85	1.35
PD500	3.75
PFL200	1.35
PL33	1.50
PL36	1.45
PL81	0.85
PL82	0.75
PL83	0.65
PL84	0.75
PL95	2.00
PL504	1.20
PL508	2.40
PL509/519	5.95
PY88	1.80
PY500A	2.40
U26	1.90
UCH81	0.90
UCL82	1.70
6J5GT	1.75
6SJ7	2.20
30FL12	1.60

ZENER DIODES

400mW Plastic 3V-75V 8p each 10/75
1.3W Plastic 3V-200V 15p each 10/£1.40
1.5W Flange 4.7-47V £1.26 each
2.5W Plastic 7.5-75V 87p each
20W Stud 7.5-75V £1.31 each

INTEGRATED CIRCUITS (£) EACH

Type	Price	Type	Price
AN240P	3.42	SN76530P	1.40
AN214QQ	3.88	SN76533N	1.60
AN715Q	2.90	SN76650N	1.05
CA3065	1.75	SN76660N	0.75
CA4031P	2.88	SN76666N	0.80
CA4102	3.30	STK015	6.50
CA4250	3.50	TA7108P	3.20
CA4400	2.98	TA7120P	3.20
CA4422	3.07	TA7129AP	3.65
LC7120	5.33	TA7130P	1.65
LC7130	5.26	TA7172	1.80
LC7137	5.16	TA7193	5.50
LM380N	0.80	TA7172P	1.80
LM1303N	2.52	TA7176	2.50
HA1151P	3.12	TA7202P	4.18
MC1307P	1.85	TA7204P	1.86
MC1310P	1.85	TA7205AP	1.50
MC1312P	2.25	TA7208P	3.27
MC1327P	1.25	TA7210P	6.50
MC1330P	0.83	TA7222P	1.88
MC1349P	1.65	TA7223P	3.68
MC1350P	1.20	TA7227P	5.60
MC1351P	2.50	TA7310A	1.80
MC1352P	1.50	TA7609P	4.28
MC1357P	2.88	TA7611AP	2.88
MC1358P	1.30	TAA263	2.46
MC1496P	1.15	TAA310A	2.68
ML231B	2.10	TAA550	0.50
ML232B	2.10	TAA570	1.99
ML237B	2.30	TAA611A12	3.50
NE555	0.25	TAA611B12	2.85
C-mos 555	0.88	TAA630S	3.90
NE556	0.80	TAA661B	1.70
SAA1024	5.35	TAA700	2.80
SAA1025	8.40	TAA840	3.38
SAS560A	2.50	TAD100	2.80
SAS560S	1.85	FM FILTER	1.20
SAS570S	1.65	TBA120A	1.00
SAS580	2.85	AS,S,SA,SB	1.20
SAS590	2.82	Q,T,U,UQ	1.32
SC9503P	1.10	TBA120B	1.30
SL432A	4.00	TBA231	1.45
SL901B	5.20	TBA281	2.65
SL917B	6.25	TBA395	1.20
SL1327Q	1.10	TBA480Q	1.50
SN76003N	2.44	TBA400	2.30
SN76013	1.90	TBA510	2.60
SN76023ND	2.90	TBA510Q	2.60
SN76033N	2.45	TBA520/Q	1.60
SN76110N	1.12	TBA530/Q	1.30
SN76115N	2.00	TBA540/Q	1.40
SN76131N	1.65	TBA550/Q	1.52
SN76226ND	1.80	TBA560C	1.70
SN76227N	1.10	TBA560CQ	1.40

Type	Price
TBA570	1.50
TBA641BX1	4.50
TBA673	2.40
TBA700	2.85
TBA750	2.80
TBA800	1.60
TBA810P	1.10
TBA810S	1.20
TBA820	1.60
TBA890	3.88
TBA920/Q	3.00
TBA940/2A	3.05
TBA970	4.05
TBA990	1.68
TCA160C	3.90
TCA270S	4.00
TCA270SA	4.02
TCA800	3.10
TCA940	1.90
TDA440	3.80
TDA1002	1.90
TDA1003A	6.50
TDA1004A	2.90
TDA1006A	2.40
TDA1035S	4.50
TDA1044	4.30
TDA1170S	3.00
TDA1190	3.50
TDA1200	2.98
TDA1270Q	3.70
TDA1327A	1.66
TDA1352A/B	1.56
TDA1412	1.20
TDA2002	2.80
TDA2020	4.60
TDA2030	2.78
TDA2140	5.90
TDA2521	4.10
TDA2523	3.50
TDA2530	2.70
TDA2540	3.80
TDA2541	3.80
TDA2560	3.50
TDA2571A	2.50
TDA2581	3.20
TDA2590	3.20
TDA2591	2.98
TDA2593	2.98
TDA2610	3.20
TDA2611A	1.94
TDA2640	2.90
TDA2680	3.40
TDA2690	3.50
TDA3950A/B	2.60
UPC554C	1.32
UPC557H	0.90
UPC566H	2.95
UP575C2	3.20
UPC1018C	1.10
UPC1025H	2.90
UPC1032H	0.90
UPC1156H	4.20

Type	Price
UPC1158H	0.76
UPC1163H	0.98
UPC1181H	1.60
UPC185H2	3.75
UPC1212C	1.30
UPC1230H	3.90
UPC1350C	3.90
UPC1367C	3.40
UPC1378H	4.40
UPC2002H	2.80

BRIDGES

1½A 50V	0.27
100V	0.28
200V	0.32
400V	0.40
600V	0.50
800V	0.58
2A 100V	0.52
200V	0.55
400V	0.61
600V	0.67
800V	0.70
6A 100V	0.66
200V	0.68
400V	0.74
600V	0.80
800V	0.86
10A 50V	2.20
100V	2.24
200V	2.35
400V	2.50
600V	3.50
25A 50V	2.05
100V	2.25
200V	2.40
400V	3.20
600V	3.95

PANEL METERS

FSD
60 x 46 x 35mm
0-50μA
0-100μA
0-500μA
0-1mA
0-5mA
0-10mA
0-50mA
0-100mA
0-500mA
0-1A
0-2A
0-25V
0-50V AC
0-300V AC
"S"
"VU"

ALL — £5.00 EACH

RESISTORS CARBON FILM 5%

¼W 1R0 to 10M (E12 Range)	2p each. 15p/10. 75p/100
½W 2R2 to 10M (E24 Range)	2p each. 15p/10. 75p/100
1W 10R to 2M2 (E12 Range)	7p each. 65p/10. 6.00/100
2W 10R to 2M2 (E6 Range)	8p each. 70p/10. 6.00/100

¼W Metal Film 1% 10R to 1M (E24 range) 6p each 50p/10.

RESITOR KITS — each value individually packed

¼W pack 10 each value E12 — 10R to 1M 610 pieces	4.80
¼W pack 5 each value E12 — 10R to 1M 305 pieces	2.75
½W pack 10 each value E12 — 2R2 to 2M2 730 pieces	5.25
½W pack 5 each value E12 — 2R2 to 2M2 365 pieces	3.00
1W pack 5 each value E12 — 2R2 to 1M 353 pieces	15.00
2W pack 10 each value E6 — 10R to 2M2 317 pieces	18.00

RESISTORS WIREWOUND. Generally 5%

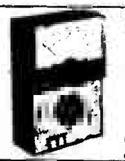
2.5W – 0.22 to 270R – Available in preferred values	0.20
4W – 1R0 to 10K – Available in preferred values	0.21
7W – 0.476R to 22K – Available in preferred values	0.25
11W – 1R0 to 22K – Available in preferred values	0.29
17W – 1R0 to 22K – Available in preferred values	0.37

TERMINAL BLOCKS

2 amp. 12 way	0.19
5 amp. 12 way	0.20
10 amp. 12 way	0.40
15 amp. 12 way	0.46
32 amp. 12 way	0.90

CO-AXIAL LOW LOSS SPLITTERS

One In Two Out = £1.00
One In Three Out = £1.95
One In Four Out = £2.40
One In Five Out = £2.93
One In Six Out = £3.40



MULTIMETER SPECIAL

Russian type U4324 — (20,000 O.P.V)
DC Volts. 0.6, 1.2, 3, 12, 30, 60, 600, 1200.
AC Volts: 3, 6, 15, 60, 150, 300, 600, 900.
DC Curr. M/A 0.06, 0.6, 6, 60, 600, 3000
AC Curr M/A 0.3, 3, 30, 300, 3000.
DC Resistance 0.2, 5, 50, 500, 5000K.
level dB. −10 to +12.
Supplied with rechargeable batteries.

Price £12.00 incl. of p/p & VAT.

FUSEHOLDERS

20mm Panel Mounting	0.28
20mm Chassis Mounting	0.06
1¼" Panel Mounting	0.35
1¼" Chassis Mounting	0.12
Carline 1¼" holder	0.10

CHART RECORDERS

Brand new 3 channel pen recorders complete with charts spares kit. Full spec upon request — Once only bargain £40 + £10 p&p plus 15% VAT.

BUZZERS

SOLID STATE
6v and 12v — 80p each

POWER SUPPLY

Integral 13A plug — 1 metre lead with 3.5m jack plug — 12V 250nA.
PRICE: £3.00 (p&p 50p).

FUSES Prices per 10

1¼" Quick Blow. 100, 150, 250mA £1.30. 1, 1.25, 1.5, 2, 2.5, 3, 10, 15A 55p. **1¼" Time Delay.** 100mA £3.50. 150mA £2.25 250, 300, 500, 600, 750, 850mA £1.84. 1, 1.25, 1.5, 1.6, 2A £1.84. 2.5A, 3.15, 3, 5A £2.82. **20mm Quick Blow.** 100, 125, 160, 200, 250, 315, 400, 500, 630 800mA, 1, 1.25, 1.6, 2, 2.5, 3.15, 4, 5, 6.3A 40p. **20mm Time Delay.** 100, 125, 160, 200mA £1.80. 250, 315, 400, 500, 630, 800mA £1.00. 1, 1.25, 1.6, 2, 2.5, 3.15, 4, 5, 6.3A 86p. **1" Mains.** 2, 3, 5, 7, 10, 13A 88p.

Manufacturers please note — we can offer very competitive production quantities of 20 mm Quick Blow & Time Delay range — apply for quotation.

SOLDERING SECTION

Antex 15W iron	5.00
Antex 18W iron	5.00
Antex 25W iron	5.20
Antex elements	2.00
Antex bits	0.95
Antex stands	1.90
Soldersucker	4.50
Spare nozzles for Soldersucker	0.45
Antex Soldering station complete with 1 iron — 30W or 40W	49.95
25W KIT — iron with 13A plug and stand	£6.40
15W KIT — iron with 13A plug and stand	£6.20

SERVICE AIDS

AC SERVICE PRODUCTS

Switch Cleaner	0.88
Circuit Freezer	0.96
Foam Cleanser	0.84
Aero Klene	0.78
Silicone Grease (Aerosol)	1.00
Antistantic Spray	0.82
Plastic Seal	0.88
Excel Polish	0.76
Fire Extinguisher 640g	2.80
Video Head Cleaner	0.88
Solda Mop (Std)	0.72
Solda Mop (L/Gauge)	0.72

Additional P&P on above 30p

Ni-CAD

Universal Ni-Cad charger, charges PP3, AA, C, D
Price £5.00

MULTIBLOCK

Multiblock 4-Way Extension Socket
PVC body with internal cable grip fitted with 13A fuse and neon indicator. Max total load 13A 250V; Length 10½; Width 2½.
Price £3.90 each (P&P) 25p in addition to 35p normal charge).

13A Mains Plugs **40p** 10/£3.50.

PLUGS & SOCKETS

Metal Co-ax Plug	0.18	10/1.60
Plastic Co-ax Plug	0.14	10/1.20
Single Junction Socket	0.80	10/6.00
Plastic Phono	0.10	10/80p
FM Plugs	0.20	10/1.75
1PL259	0.38	10/3.50
Reducer	0.15	10/1.25
¼in Plastic-Mono Plug	0.15	10/1.20
¼in Metal Mono Plug	0.30	10/2.30
2.5mm Plug Metal	0.15	10/1.40
3.5mm Plug Metal	0.16	10/80p
2.5mm Chassis Socket	0.10	10/80p
3.5mm Chassis Socket	0.10	10/1.20
2 pin ¼in Mono Chassis Socket	0.14	10/1.75
4 pin ¼in Mono Chassis Socket	0.20	10/2.70
6 pin ¼in Mono Chassis Socket	0.30	10/1.25
4mm Banana Plug Red/Black	0.15	10/1.20
4mm Banana Socket Red/Black	0.15	10/1.25
PP3 Battery Connectors	0.08	10/60p
PP9 Battery Connectors	0.15	10/125

POWER LEADS
4 Way Spider Plug **65p** 10/£6

1984 CATALOGUE

Send now for our latest catalouge — 109 pages — packed with complete range of components — fully illustrated, price 65p per copy, includes 30p credit note, special offer sheets, order form and pre-paid envelope.

TOGGLE SWITCH MIN

SPST — 2 TAG — 65p
SPDT — 3 TAG — 68p
DPDT — 6 TAG — 72p
DPDT — 6 TAG — 85p (C off)

ROTARY SWITCHES

1p 12w — 40p
2p 6w — 40p
3p 4w — 40p
4p 3w 40p

TRANSFORMERS

	1+	10+	100+	1000+
4.5-0-4.5v 400m/A	50p	45p	35p	30p
6-0-6v 100m/A	58p	52p	43p	40p
6-0-6v 500m/A	65p	60p	48p	45p

Carriage: 45p per transformer, £1.80 per 10; £4.50 per 100; £30 per 1,000

EUROPEAN ADAPTORS

These very high quality British made two pin European adaptors are ideal for driving Radios, cassette recorders, TV games, calculators etc. The adaptors fit in the UK shaver socket

REF	DC Voltage	Current	1+	10+	100+
EOB	4.5V	200m/a	50p	45p	32p
EM3	6V	200m/a	£1.00	80p	55p
EO9	6V	400m/a	£1.50	£1.25	85p

Postage & Packing. 45p per adaptor or £1.60 per 10. £4.50 per 100

(1,000 off qty price on application)

IC SOCKETS Dil to Dil

8 pin	0.08	0.70/10
14 pin	0.10	0.95/10
16 pin	0.11	1.00/10
18 pin	0.14	1.60/10
22 pin	0.21	1.95/10
24 pin	0.25	2.25/10
28 pin	0.30	2.75/10
40 pin	0.34	3.10/10

D CONNECTORS

	9 way	15 way	25 way
MALE			
Solder lugs	80p	105p	160p
Angle pins	150p	210p	250p
FEMALE			
Solder lugs	105p	160p	200p
Angle pins	165p	215p	290p
COVERS	85p	80p	80p

VOLTAGE REGULATORS

78L05 · 30p
78L12 · 30p
78L15 · 30p
7805 · 55p
7812 · 55p
7815 · 55p
LM317K · 3.50
LM317T · 90p

LEDS

3mm
Red · 10p 10/85p
Green · 13p 10/1.00
Yellow · 13p 10/1.00
5mm
Red · 10p 10/85p
Green · 13p 10/1.00
Yellow · 13p 10/1.00

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ORDERING: All components are brand new and to full specification. Please add 45p postage/packing (unless otherwise specified) to all orders then add 15% VAT to the total. Either send cheque/cash/postal order or send/telephone your Access or Visa number. Official orders from schools, universities, colleges etc most welcome. (Do not forget to send for our 1984 catalogue — only 65p per copy. All orders despatched by return of mail.
NEW RETAIL 1000 squ ft shop now open Mon-Fri 9.00-5.00. Sat 9-12.00

DIGEST

MOS-FET Amplifiers

In our June issue we mentioned the range of MOS-FET power amplifier modules available from BK Electronics and reported plans to offer complete amplifiers based upon the modules at a later date. Those plans have now come to fruition and the result is a range of stereo power amplifiers in 19" rack-mounting cases which feature LED VDU meters and have power ratings of up to 300 watts RMS per channel.

The range consists of three models, the MF200 which has an output of 100 watts RMS per channel, the MF400 which has an output of 200 watts RMS per channel and the MF600 which has an output of 300 watts RMS per channel. All output levels are quoted with both channels driven into a 4 ohm load, and the amplifiers are protected against short and open circuit conditions. Input is by ¼" jacks or XLR sockets and the input sensitivity is 775mV for full output. XLR sockets are also used for the outputs, two being provided on each channel. The rotary level controls are indented and the only other front panel control is the illuminated on-off switch.

The MF200 MOS-FET amplifier costs £159.00 plus £23.85 VAT plus £10.00 carriage; the MF400 costs £199.00 plus £29.85 VAT plus £10.00 carriage and the MF600 costs £239.00 plus £35.85 VAT plus 10.00 carriage. BK Electronics, Unit 5, Comet Way, Southend-on-Sea, Essex SS2 6TR, tel 0702 — 527572.

● Microrange Electronics, manufacturers of 19" rack mounting cases, PCBs and small batches of general electronic equipment, have opened a retail electronics shop at their workshops in Stratford, East London. The shop sells a wide range of general components as well as the company's own products and they hope to have a full list available in the near future. Contact Microrange Electronics, Unit 258, Stratford Workshops, Burford Road, London E15 2SP, tel 01 - 536 1415.

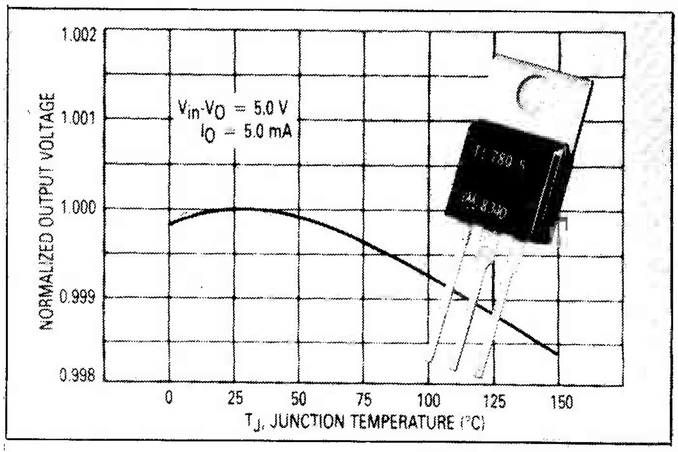
● Publishers Bernard Babani Ltd have issued a 16-page leaflet which describes their range of computing books. The titles listed cover programming and computer languages, construction of peripherals and the theory of microprocessors and digital electronics, and copies are available free from Bernard Babani (Publishing) Ltd, The Grampians, Shepherds Bush Road, London W6 7NF, tel 01-603 2581.

Close Tolerance Voltage Regulator

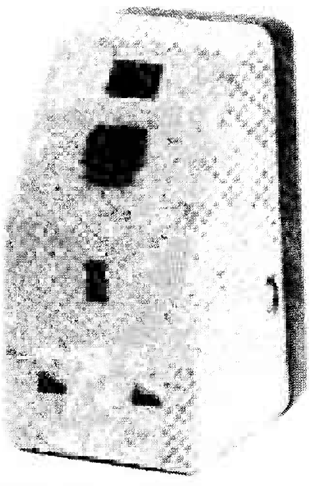
Motorola has introduced a family of fixed positive voltage regulators which offer extremely tight output voltage tolerances. The three-terminal devices have a load driving capability in excess of 1.5A and are said to offer noticeably better performance when compared with existing types.

Designated the TL780 series, the regulators are available in 5.0, 12 and 15 volt output versions and maintain an output voltage tolerance to within ±1.0% at 25°C and ±2.0% over the entire operating junction temperature range from 0°C to +125°C. Line regulation is maintained to within 5.0 mV for the 5.0 volt output devices and 15mV for the 15 volt output version, a factor-of-two improvement over existing industry-popular, premium grade, 1.5 amp regulators. Ripple rejection is also improved with minimum limits of 60,65 and 70 dB for the 15, 12 and 5.0 volt devices respectively. Load regulation is 25 mV maximum for the 5 volt device and 75 mV for the 15 volt version over a load range of 5.0 mA to 1.5 amps.

All of these monolithic devices employ internal current limiting, thermal shut down, and safe area compensation, and although designed as fixed voltage regulators they can be used with external components to obtain adjustable voltages and currents.



Devices are specified over a junction temperature range of 0°C to 125°C and are available in the TO-220 plastic power range. Motorola Ltd, European Literature Distribution Centre, 88 Tanners Drive, Blakelands, Milton Keynes MK14 5BP, tel 01-902 8836.



Plug-In RCCB

The Power-Breaker-20 from B & R Electrical Products is an RCCB (Residual Current Circuit Breaker) which plugs directly into a standard 13A socket and which has a 13A outlet into which appliances may be plugged. It thus provides a quick and convenient means of protecting against electrocution when using plug-in electrical appliances anywhere around the home, office, workshop, etc.

RCCBs (the new name for what used to be called ELCBs or Earth Leakage Circuit Breakers) work by comparing the current through the live and neutral leads and switching off the supply when the difference exceeds a certain minimum level, as would be the case were current to be passed to earth via a human body or other conductor rather than flowing back through the neutral lead. The PowerBreaker-20 is designed to break the supply within 30 ms should the difference between the live and neutral currents exceed 30 mA. Features include a test button which deliberately introduces a small current imbalance, a reset system which is claimed to be foolproof and a safety trip which automatically breaks the supply and illuminates a warning neon should the device be plugged into a socket which has its live and neutral connections reversed. The case is said to be durable and tamper-proof, allows easy access for fuse replacement, and is compact enough to allow two units to be used side-by-side in a double wall socket.

For details of the PowerBreaker-20 and the PowerBreaker Plug, a similar device designed for permanent attachment to an appliance lead, contact B & R Electrical Products, Ltd, Temple Fields, Harlow, Essex CM20 2BG, tel 0279 -443351.

COMPUTER WAREHOUSE

1000's OF BARGAINS FOR CALLERS

THE 'ALADDIN'S' CAVE OF COMPUTER AND ELECTRONIC EQUIPMENT

HARD DISK DRIVES

Fully refurbished **DIABLO/DRE** series 30 2.5 Mb disk drives. **DEC RK05, NOVA, TEXAS** compatible.
Front load. Free stand or rack mount £550.00
Exchangeable type (via lid removal) £295.00
me3029 PSU unit for 2 drives £125.00
DIABLO/DRE 44-4000A/B 5+5 ex stock from £995.00
1000's of spares for S30, 4000, 3200, HAWK ex stock.
Plus in house repair, refurbishing service.
Call for details or quotation.

HOT LINE DATA BASE

DISTEL©

THE **ORIGINAL FREE OF CHARGE** dial up data base. 1000's of stock items and one off bargains.
ON LINE NOW – 300 baud, full duplex CCITT tones, 8 bit word, no parity.
01-679 1888

COMPUTER 'CAB'

All in one quality computer cabinet with integral switched mode PSU, Mains filtering, and twin fan cooling. Originally made for the famous **DEC PDP8** computer system costing thousands of pounds. Made to run 24 hours per day the PSU is fully screened and will deliver a massive +5v DC at 17 amps, +15v DC at 1 amp and −15v DC at 5 amps. The complete unit is fully enclosed with removable top lid, filtering, trip switch, 'Power' and 'Run' LEDs mounted on Ali front panel, rear cable entries, etc. etc. Units are in good but used condition – supplied for 240v operation complete with full circuit and tech. man. **Give your system that professional finish** for only £49.95 + Carr. Dim. 19" wide 16" deep 10.5" high. Useable area 16"w 10.5"h 11.5"d.
Also available **LESS PSU**, with **FANS** etc. Internal dim. 19"w. 16"d. 10.5"h. **£19.95**. Carriage & insurance £9.50.

EX STOCK INTEGRATED CIRCUITS

D8085AH-2	D8086	D8257-5
D8202	D8271	AM2764-3DC
74LS86	74LS112	74LS373
7407	2102-6	4116-3

CALL SALES OFFICE FOR PRICES

MAINS FILTERS

Cure those unnerving hang ups and data glitches caused by mains interference.
SD5A As recommended by ZX81 news letter, matchbox size up to 1000 watt load £5.95
L2127 compact completely cased unit with 3 pin fitted socket. Up to 750 watts £9.99

COOLING FANS

Keep your hot parts COOL and RELIABLE with our range of **BRAND NEW** professional cooling fans.
ETRI 99XU01 Dim. 92 x 92 x 25 mm. Miniature 240 v equipment fan complete with finger guard **£9.95**.
GOULD JB-3AR Dim. 3" x 3" x 2.5" compact very quiet running 240 v operation. **NEW £6.95**
BUHLER 69.11.22. 8-16 v DC micro miniature reversible fan. Uses a brushless servo motor for extremely high air flow, almost silent running and guaranteed 10,000 hr life. Measures only 62 x 62 x 22 mm. Current cost £32.00. **OUR PRICE ONLY £12.95 complete with data.**
MUFFIN-CENTAUR standard 4" x 4" x 1.25" fan supplied tested EX EQUIPMENT 240 v at £6.25 or 110 v at £4.95 or BRAND NEW 240 v at £10.50. 1000's of other fans Ex Stock. Call for Details. Post & Packing on all fans £1.60

SAVE £250 — SUPER PRINTER SCOOP

BRAND NEW CENTRONICS 739-2

ONLY £199

The "Do Everything Printer" at a price that will **NEVER** be repeated. Standard **CENTRONICS** parallel interface for direct connection to **BBC, ORIC, DRAGON** etc. Superb print quality with full pin addressable graphics and 4 type fonts plus **HIGH DEFINITION** internal **PROPORTIONAL SPACED MODE** for **WORD PROCESSOR** applications. 80-132 columns, single sheet, sprocket or roll paper handling plus much more. Available **ONLY** from **DISPLAY ELECTRONICS** at the ridiculous price of **ONLY £199.00** + VAT Complete with full manual etc. Limited quantity – Hurry while stocks last.
Options. Interface cable (specify) for BBC, ORIC, DRAGON or CENTRONICS 36 way plg £12.50. Spare ribbon £3.00 each. BBC graphics screen dump utility program £8.60. Carriage and Ins. £10.00 + VAT

BUDGET RANGE VIDEO MONITORS

At a price YOU can afford, our range of **EX EQUIPMENT** video monitors defy competition!! All are for 240v working with standard composite video input. Units are pre tested and set for up to 80 col use on BBC micro. Even where MINOR screen burns MAY exist – normal data displays are unaffected.

1000's SOLD TO DATE

9" HITACHI very compact fully cased, dim. 21cm H x 21cm W x 22cm D. Black and white screen **£44.95**
12" KGM 320-321, high bandwidth input, will display up to 132 columns x 25 lines. Housed in attractive fully enclosed brushed alloy case. **B/W only £32.95 GREEN screen £39.95**
24" KGM large screen black & white monitor fully enclosed in light alloy case. Ideal schools, shops, clubs etc. **ONLY £55.00**
14" BRAND NEW Novex **COLOUR** type **NC1414-CL.** Many exacting features such as RGB TTL and composite video input, **GREEN TEXT** key, internal speaker and audio amp. Even finished in BBC micro matching colours. Fully guaranteed. **ONLY £199.00**
Carriage and ins on ALL videos £10.00

TRANSTEL PRINTERS

EX NEWS SERVICE compact, quality built 50 column matrix printer. Standard 5 bit serial, **BAUDOT CODE** current loop interface for connection to computer or radio receiver via simple filter network to decode and print most world-wide **NEWS, TELEX** and **RTTY** services. Supplied tested and in good condition with data, large paper roll and 50 and 75 baud xtals. **ONLY £49.95** Carr. £6.00

GE TERMIPRINTER

A massive purchase of these desk top printer-terminals enables us to offer you these quality 30 cps printers at a **SUPER LOW PRICE** against their original cost of over £1000. Unit comprises of full QWERTY, electronic keyboard and printer mech with print face similar to correspondence quality typewriter. Variable forms tractor unit enables full width – up to 13.5" 120 column paper, upper – lower case, standard RS232 serial interface, internal vertical and horizontal tab settings, standard ribbon adjustable baud rates, quiet operation plus many other features. Supplied complete with manual. Guaranteed working **£130.00** or untested **£85.00**, optional floor stand £12.50 Carr & Ins £10.00.

DUAL 5" DISK DRIVES

Current, quality, professional product of a major computer company, comprising 2 x 40 track **MPI** or **Shugart FULLY BBC COMPATIBLE** single sided drives in a compact, attractively styled, grey ABS structured case with internal switched mode PSU. The PSU was intended to drive both drives and an intelligent Z80 controller with over 70 ic's. The controller has been removed leaving ample space and current on the +, -5, +12 and −12 supply for all your future expansion requirements. Supplied tested with 90 day guarantee in **BRAND NEW** condition with cable for BBC micro. Ex Stock at only **£259.00** + £10.00 carr. **Limited Quantity Only**

TELETYPE ASR 33

DATA I/O TERMINALS

Industry standard combined **ASCII** 110 baud printer, keyboard and 8 hole paper tape punch and reader. Standard **RS232** serial interface. Ideal as cheap hard copy unit or tape prep. for **CNC** and **NC** machines. **TESTED** and in good condition. Only **£235.00** floor stand **10.00**
Carr & Ins **£15.00**

PROFESSIONAL KEYBOARD OFFER

An advantageous purchase of brand new surplus allows a great **QWERTY**, full travel, chassis keyboard offer at fractions of their original costs.
ALPHAMERIC 7204/60 full **ASCII** 60 key, upper, lower + control key, parallel TTL output plus strobe. Dim 12" x 6" +5 & −12 DC. **£39.50.**
DEC LA34 Uncoded keyboard with 67 quality, **GOLD**, normally open switches on standard X, Y matrix. Complete with 3 LED indicators & i/o cable – ideal micro conversions etc. pcb DIM 15" x 4.5" **£24.95** Carriage on keyboards £3.00

SEMICONDUCTOR 'GRAB BAGS'

Mixed Semis amazing value contents include transistors, digital, linear, I.C.'s triacs, diodes, bridge recs., etc. etc. All devices guaranteed brand new full spec with manufacturer's markings, fully guaranteed. 50+ **£2.95** 100+ **£5.15**.
TTL 74 Series A gigantic purchase of an "across the board" range of 74 TTL series I.C.'s enables us to offer 100+ mixed "mostly TTL" grab bags at a price which two or three chips in the bag would normally cost to buy. Fully guaranteed all I.C.'s full spec. 100+ **£6.90** 200+ **£12.30** 300+ **£19.50**

DATA MODEMS

Join the communications revolution with our range of EX TELECOM data modems. Made to most stringent spec and designed to operate for 24 hrs per day. Units are made to the CCITT tone spec. With RS232 i/o levels via a 25 way 'D' skt. Units are sold in a tested and working condition with data. Permission may be required for connection to PO lines.
MODEM 2B "Hackers Special" fully fledged up to 300 baud full duplex, **ANSWER** or **CALL** modes. **AUTO ANSWER.** Data i/o via standard **RS232** 25 way 'D' socket. Just 2 wire connection to comms line. Ideal networks etc. Complete with data, tested, ready to run at a **NEW SUPER LOW PRICE** of **ONLY £65.00** + VAT + Carr.
MODEM 20-1 Compact unit for use with **MICRONET, PRESTEL** or **TELECOM GOLD** etc. 2 wire direct connect. 75 baud transmit 1200 baud receive. Data i/o via RS232 'D' socket. Guaranteed working with data **£49.95**
MODEM 20-2 same as 20-1 but 75 baud receive 1200 baud transmit **£130.00**
TRANSDATA 307A 300 baud acoustic coupler RS232 i/o **£95.00**
NEW DSL2123 Multi Standard modem selectable V21 300-300 bps, V23 75-1200, V23 1200-75 full duplex. Or 1200-1200 half duplex modes. Full auto answer via modem or CPU. LED status indicators. CALL or ANS modes Switchable **CCITT** or **BELL 103 & 202.** Housed in ABS case size only 2.5" x 8.5" x 9". **£286.00** + VAT
For further data or details on other EX STOCK modems contact sales office.
Carriage on all modems £10.00 + VAT.

THE BENEFITS OF INSURANCE

Almost four months ago, on the 29th of February 1984, we, DISPLAY ELECTRONICS were unfortunate enough to have a serious fire at our main location, reducing a substantial part of our stock, warehouse and offices to a pile of ashes and rubble. HOWEVER, we had seen the adverts about the "Benefits of Insurance" and some years ago had taken comprehensive insurance cover to protect against an event such as this.

The day after the fire we did not even have a single pen to write with, to say nothing of the non existant showroom and burnt out warehouse with direct access to the stars via our now non existant roof!!

The loss of stock and damage to the premises has resulted in losses in excess of £400,000 pounds in real money – no price can value time and effort.

We are still, although working under great difficulties, **VERY MUCH** in business. We owe this to supreme efforts by all our staff – perhaps knowing their jobs could have been at stake, stock being located at several different locations, help from business colleagues and our bank.

To these people, I say a very loud THANK YOU.

To both the mighty **PRUDENTIAL** and **GENERAL ACCIDENT** Insurance Companies who from the date of our fire have NOT even offered or paid **A SINGLE PENNY** in compensation or have not even offered an ounce of moral support . . .

To both the mighty **PRUDENTIAL** and **GENERAL ACCIDENT** Insurance Companies who only answer our requests for help and information with "We are still looking at reports . . ." I say **"STRONG STUFF THIS INSURANCE????"**

David Fisher, Managing Director, DISPLAY ELECTRONICS

EX STOCK DEC CORNER

BA11-MB 3.5" Bax, PSU, LTC	£385.00
DH11-AD 16 x RS232 DMA interface	£2100.00
DLV11-J 4 x EIA interface	£310.00
DUP11 Sych. Serial data i/o	£650.00
DZ11-B 8 line RS232 mux board	£650.00
LA36 Decwriter EIA or 20 ma loop	£270.00
LAXX-NW LA180 RS232 serial interface and buffer option	£130.00
LAX34-AL LA34 tractor feed	£85.00
MS11-JP Unibus 32 kb Ram	£80.00
MS11-LB Unibus 128 kb Ram	£450.00
MS11-LD Unibus 256 kb Ram	£850.00
MSC4804 Qbus (Equiv MSV11-L) 256 kb	£499.00
PDP11/05 Cpu, Ram, i/o, etc.	£450.00
PDP11/40 Cpu, 124k MMU	£1850.00
RT11 ver. 3B documentation kit	£70.00
RK05-J 2.5 Mb disk drives	£650.00
KL8JA PDP 8 async i/o	£175.00
MI8E PDP 8 Bootstrap option	£75.00
VT50 VDU and Keyboard – current loop	£175.00

1000's of **EX STOCK** spares for **DEC PDP8, PDP8A, PDP11** systems & peripherals. Call for details. All types of Computer equipment and spares wanted for **PROMPT CASH PAYMENT.**

66% DISCOUNT

ELECTRONIC COMPONENTS EQUIPMENT

Due to our massive bulk purchasing programme which enables us to bring you the best possible bargains, we have thousands of I.C.'s, Transistors, Relays, Cap's, P.C.B.'s, Sub-assemblies, Switches, etc. etc. surplus to our requirements. Because we don't have sufficient stocks of any one item to include in our ads, we are packing all these items into the *"BARGAIN PARCEL OF A LIFETIME"*. Thousands of components at giveaway prices! Guaranteed to be worth at least *3 times* what you pay. Unbeatable value!! Sold by weight.

2.5kls **£4.25** + pp £1.25 — 5kls **£5.90** + £1.80
10kls **£10.25** + pp £2.25 — 20 kls **£17.50** + £4.75

ALL PRICES PLUS VAT

All prices quoted are for U.K. Mainland, paid cash with order in Pounds Sterling PLUS VAT. Minimum order value **£2.00**, Minimum Credit Card order **£10.00**. Minimum BONAFIDE account orders from Government depts., Schools, Universities and established companies **£20.00**. Where post and packing not indicated please ADD £1.00. + **VAT**. Warehouse open Mon-Fri 9.30 – 5.30. Sat. 10.15 – 5.30. We reserve the right to change prices and specifications without notice. Trade, Bulk and Export enquiries welcome.

DISPLAY -ELECTRONICS-

32 Biggin Way, Upper Norwood, London SE19 3XF
Telephone 01-679 4414 Telex 27924

5MHz Function Generators

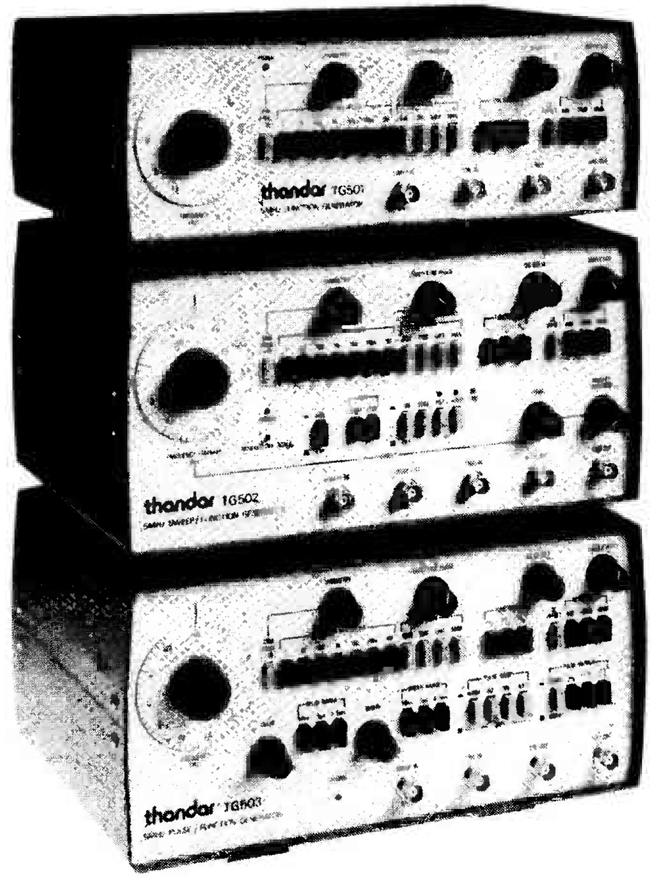
Thandar Electronics have introduced a family of function generators which, they claim, will satisfy the majority of function/sweep/pulse requirements to 5MHz. All three models offer sine, square, triangle, ramp, pulse and haverwave outputs, while the two largest models offer either a sweep generator with marker function or a variable width and delay pulse section.

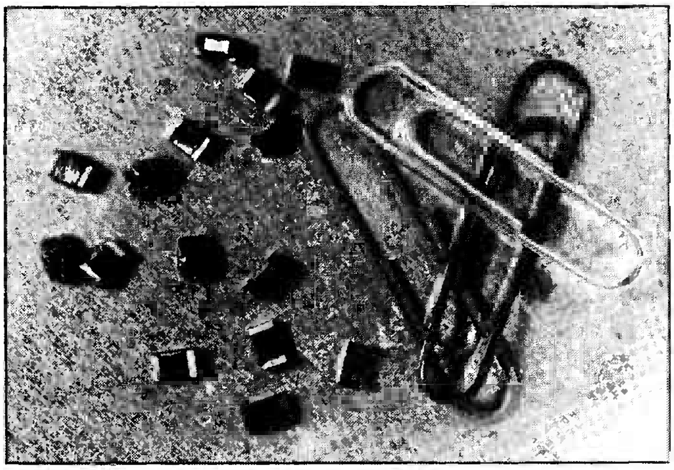
The TG501 Function Generator has free-run, triggered or gated modes, variable start/stop phase and a 19:1 symmetry range enabling ramp, pulse and haverwave outputs to be produced in addition to the usual sine, square and triangle outputs (Haverwave apparently denotes the ability to generate half cycles of sine wave only, but just what this is used for we do not know and Thandar were unable to tell us). Overall frequency range is .005Hz to 5MHz with a 1000-1 sweep within each range on the dial or via the external sweep input. The main 50 Ohm output is capable of 20V peak-to-peak and has a variable DC offset; a TTL output is also provided.

The same main generator features are also offered on the TG502, which has, in addition, an integral sweep section capable of 1000:1 linear or 10,000:1 log sweeps. Sweep limits are set by the main dial and stored digitally to eliminate drift. Both sweep rate and marker duration are variable and there is a single sweep mode, sweep reset and hold, and sweep and pen-lift outputs.

The TG503 Function/Pulse generator also offers the same features as the TG501 but in addition provides normal, double or delayed pulse modes with a 10MHz capability in double-pulse mode. Pulse width is variable from 50ns to 50ms and delay from 100ns to 50ms. The main output can be normal or complementary and can be symmetrical, positive-going or negative-going with respect to a constant baseline adjustable by the DC offset control.

The TG501 costs £295.00 plus VAT and the TG502 and TG503 both cost £495.00 plus VAT. Further details and a list of suppliers are available from Thandar Electronics Ltd, London Road, St. Ives, Huntingdon, Cambridgeshire PE17 4HJ, tel 0480 — 64646.





Miniature Chip Inductors

RBS have introduced a range of chip inductors that are designed specifically for use on surface-mounted assemblies to minimise board space and eliminate costly hand soldering.

The Coilcraft range are manufactured using ceramic or ferrite cores. The chips are available with inductances from 30 nano henry to 1000 micro henry, in 5 and 10 percent tolerances and with a minimum Q of 20. Three sizes are offered with a maximum stand-off height of 0.1 inch. The operating temperature range is −30 degrees to +105°C and the chips are protected against thermal shock to MIL standards. Terminations of moly manganese or nickel coated with silver loaded solder make the inductors compatible with alumina substrates and they are unaffected by ultrasonic cleaning or vapour degreasing.

RBS Ltd, Unit 4, Airport Trading Estate, Biggin Hill, Westerham, Kent TN16 3BW, tel 09594-71011.

Ecolight And After

The ETI staff wish it to be known that they fully realise the gravity of the situation and when they finally catch the person responsible are going to confiscate his Jelly-babies. No lesser punishment can be countenanced for those who thoughtlessly withold vital information. Meanwhile, for those still trying to track down the enigmatic G.P. Electronic Services whose name appeared in such tantalising isolation at the end of the Ecolight article, their address is:- 87, Willowtree Avenue, Gilesgate, Durham DH1 1DZ. Our apologies to readers and to G. P. Electronics for the omission.

● Yet another catalogue, this time from Verospeed. Its 450 pages are filled with information on over 8000 products, 500 of them new entries. The recent additions include sealed lead-acid batteries, computer peripherals and drawing aids, and all items are available on a same-day despatch basis. Verospeed, Stansted Road, Boyatt Wood Industrial Estate, Eastleigh, Hampshire SO5 4ZY, tel 0703 -641111.

● Basildon Adult Education Centre are running a series of courses (presumably in the evenings but this is not stated) including a one year beginners course in electronics, a one year course of preparation for the Radio Amateurs Examination and a six-week course of maths for the RAE. For details contact F. Wickert at Fryerns School, Craylands, Basildon, Essex, tel 0268-20599.

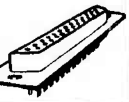
● Stotron have issued a catalogue which has over 160 pages and lists a wide range of products including connectors, displays, switches, relays and alarms. They claim to hold all lines in stock and make no minimum order charge. Copies are available from Stotron Ltd, 72 Blackheath Road, Greenwich, London SE10 8DA, tel 01 - 691 2031.

Rapid Electronics

MAIL ORDERS:
Unit 1, Hill Farm Industrial Estate,
Boxted, Colchester, Essex CO4 5RD.
Tel. Orders: Colchester (0206) 36412.
Telex: 987756.

ACCESS AND BARCLAYCARD WELCOME

MIN. D CONNECTORS



	9 way	15 way	25 way	37 way
Plugs solder lugs	60p	85p	125p	170p
Right angle	120p	180p	240p	350p
Sockets lugs	90p	130p	195p	290p
Right angle	160p	210p	290p	440p
Covers	100p	90p	100p	110p

CONNECTORS

DIN	Plug	Skt	Jack	Plug	Skt
2 pin	9p	9p	2.5mm	10p	10p
3 pin	12p	10p	3.5mm	9p	9p
5 pin	13p	11p	Standard	16p	20p
Phono	10p	12p	Stereo	24p	25p
1mm	12p	13p	4mm	18p	17p

UHF (CB) Connectors
PL259 Plug 40p. Reducer 14p.
SO239 square chassis skt 38p.
SO239S round chassis skt 40p.
IEC 3 pin 250V/6A.
Plug chassis mounting . . 38p
Socket free hanging . . 60p
Socket with 2m lead . . 120p

SCRs

▶C106D 30
400V 8A 70
400V 12A 95

SOLDERING IRONS

Antex CS 17W Soldering iron 530
2.3 and 4.7mm bits to suit . 85
CS 17W or XS 25W element 230
Antex XS 25W soldering iron 560
3.3 and 4.7mm bits to suit 85
Solder pump desoldering tool 480
Spare nozzle for above . . 70
10 metres 22 swg solder . 100
0.5kg 22 swg solder . . 750

VOICE SYNTHESISER!

Now your computer can talk. The GI SP0256 speech processor is able through stored program to synthesize speech. Allophone (extended phoname) system gives unlimited vocabulary.
Easily interfaced with any digital system; ten TTL compatible signals are used to select the allophones.
SP0256AL2 . 550 Data: 50p.

VERO

Verobloc . 430
Veroboard Size 0.1 in matrix
1.5 x 1 26
2.5 x 3.75 95
3.75 x 5 120
3.75 x 17 350
4.75 x 17 455
VQ board 190
Veropins per 100:
Single sided 55
Double sided 65
Spot face cutter . . . 145
Pin insertion tool . . 185
Wiring pen 375
Spare spool 75p Combs . 6

SWITCHES

Submin toggle:
SPST 55p. SPDT 60p. DPDT 65p.
Miniature toggle:
SPDT 80p. SPDT centre off 90p.
DPDT 90p. DPDT centre off 100p.
Standard toggle:
SPST 35p. DPOT48p
Miniature DPDT slide 14p
Push to make 14p.
Push to break 22p.
Rotary type adjustable stop.
1P12W, 2P6W, 3P4W all 55p each.
DIL switches:
4SPST 80p 6 SPST 80p. 8 SPST 100.
Min. DPDT slide 14p. Push-make 15.

MICRO

		27128	2150	6802	280	6532	520
		6116P3	600	6809	600	6551	540
		6264P15	3420	6810	140	8085A	320
2716	310	4116P4	70	6821	140	8156	380
2532	380	4164-20	420	6840	360	8251	350
2732 one time programmable	360	Z80A CPU	290	6850	165	8253	370
		Z80A P10	320	6852	240	8255	320
		Z80A CTC	320	6875	500	8259	400
2732	440	Z80A S10	880	6880	100	MC1488	70
2764-250	600	Z80A DMA	880	6502	370	MC1489	70
2764 BBC	680	6800	200	6522	330		

SOCKETS

	Low profile	Wire wrap
8 pin	6p	28p
14 pin	8p	45p
16 pin	9p	55p
18 pin	12p	60p
20 pin	13p	68p
22 pin	16p	75p
24 pin	18p	82p
28 pin	23p	95p
40 pin	25p	135p

COMPONENT KITS

An ideal opportunity for the beginner or the experienced constructor to obtain a wide range of components at greatly reduced prices. ¼W 5% Resistor kit. Contains 10 of each value from 4.7 ohms to 1M (total of 650 resistors) . . . 530
Ceramic Cap. kit. 5 of each value - 22p to 0.01u (135 caps) . . 370
Polyester Cap. kit. 5 of each value from 0.01 to 1uF (65 caps) . 575
Preset kit. Contains 5 of each value from 100 ohms to 1M (total 65 presets . . . 425
Nut and Bolt kit (total 300 items): 180p
25 6BA ¼" bolts 50 6BA washers 50 6BA nuts
25 6BA ½" bolts 25 4BA ¼" bolts 50 6BA washers
50 6BA nuts 25 6BA ½" bolts

CABLES

20 metre pack single core connecting cable ten different colours. 75p
Speaker cable . . . 10p/m
Standard screened . . 16p/m
Twin screened . . . 24p/m
2.5A 3 core mains . . 23p/m
10 way rainbow ribbon 26p/ft
20 way rainbow ribbon 47p/ft
10 way gery ribbon . . 14P/ft
20 way grey ribbon . . 28p/ft

REGULATORS

78L05	30	79L05	45
78L12	30	79L12	45
78L15	30	79L15	45
7805	40	7905	45
7812	40	7912	45
7815	45	7915	45
LM317K	270	LM723	40
LM317T	90	78H0S	550
LM323K	420		

DIODES

		▶1N4001	3
BY127	12	1N4002	5
OA47	10	1N4006	7
OA90	8	1N4007	7
OA91	7	1N5401	12
OA200	8	1N5404	16
OA202	8	1N5406	17
1N914	4	400mW zen	6
▶1N4148	3	1.3W zeners	13

OPTO

3mm red	8	5mm red	8
3mm green	11	5mm green	11
3mm yellow	11	5mm yellow	11

Clips to suit - 3p each.

Rectangular:		TIL32	40
red	12	TIL111	60
green	17	TIL78	40
yellow	17	ORP12	85
ILD74	95	ILQ74	185
TIL38	35	TIL100	75
2NS777	45	Tri-color Led	35

Seven segment displays:
Com cathode. Com anode.
DL704 0.3" 95 DL707 0.3" 95
FND5000.5" 100 FND5070.5" 100
10 bar DIL LED display, red 180
5mm superbright LED 250mcd red 30

HARDWARE

PP3 battery clips . . . 6
Red or black crocodile clips . 6
Black pointer control knob . 15
Pr Ultrasonic transducers 390
▶6V Electronic buzzer 60
▶12V Electronic buzzer . 65
▶PB2720 Piezo transducer . 75
▶64mm 64 ohm speaker . 70
▶64mm 8 ohm speaker . 70
20mm panel fuseholder . 25
Red or black probe clip . 35
4mm terminals 33
12 way 'chocolate' block 30
ultra-min. 6 or 12v rel. SPDT 130
ditto, but DPDT . . 195

EURO CONNECTORS

Gold flashed contacts:	Rt. angle plug	Wirewrap socket
64 way A+B	195	230
64 way A+C	220	270
96 way A+B+C	320	330

TRIACS

400V 8A 65
400V 16A 95
400V 4A 50 BR100 25

JUMPER LEADS

Length	14pin	16pin	24pin	40pin
Sgle ended DIP(header plug) jumper				
24 ins.	145	165	240	380
Dble ended DIP(header plug) jumper				
6 ins.	185	205	300	465
12 ins.	195	215	315	490
24 ins.	210	235	345	540
36ins.	230	250	375	595

25 way D Connector jumpers
18ins. long single ended male 495p.
18ins. long single ended f/male 525p.

COMPUTER CONNECTORS

ZX81 2 x 23 way edge connector wire wrap for ZX81 150
SPECTRUM 2 x 28 way edge connector wire wrap. . . . 200
AMPHENOL PLUGS
24 way IEEE IDC. . . . 450
36 way Centronix IDC . . . 490

RIBBON CABLE

Grey Ribbon cable. Price per foot

10 way	14	34 way	58
16 way	25	40 way	68
20 way	28	50 way	90
26 way	38	60 way	100

CAPACITORS

Polyester, radial leads. 250v. C280 type: 0.01, 0.015, 0.022, 0.033 - 6p; 0.047, 0.068, 0.1 - 7p; 0.15, 0.22 - 9p; 0.33, 0.47 - 13p; 0.68 - 20p; 1u - 23p.
Electrolytic, radial or axial leads: 0.47/63V, 1/63V, 2.2/63V, 4.7/63V, 10/25V - 7p; 22/25V, 47/25V - 8p; 100/25V - 9p; 220/25V - 14p; 470/25V - 22p; 1000/25V - 30p; 2200/25V - 50p.
Tag end power supply electrolytics: 2200/40V - 110p; 4700/40V - 160p 2200/63V - 140p; 4700/63V - 230p
Polyester, miniature Siemens PCB: 1n, 2n2, 3n3, 4n7, 6n8, 10n, 15n, 7p; 22n, 33n, 47n, 68n, 8p; 100n, 9p; 150n, 11p; 220n, 13p; 330n, 20p; 470n 26p; 680n, 29p; 1u 33p; 2u2, 50p.
Tantalum bead: 0.1, 0.22, 0.33, 0.47, 1.0 @ 35V - 12p. 2.2, 4.7, 10 @ 25V - 20p; 15/16V - 30p; 22/16V - 27p; 33/16V - 45p; 47/6V - 27p; 47/16V - 70p; 68/6V - 40p; 100/10V - 90p.
Cer. disc. 22p-0.01u 50V, 3p each.
Mullard miniature ceramic plate: 1.8pF to 100pF 6p each.
Polystyrene, 5% tol: 10p-1000p, 6p; 1500-4700, 8p; 6800 0.012u, 10p.
Trimmers. Mullard 808 series: 2-10 pF, 22p, 2-22pF, 30p, 5.5-65pF, 35p

BRIDGE RECTIFIERS

		2A 200V	40
		2A 400V	45
		6A 100V	80
		6A 400V	95
1A 50V	20	VM18 DIL 0.9A	
1A 400V	35	200V	50

IDC CONNECTORS

	PCB Plug St.	PCB Plug Rt. ang	Socket	Edge Conn.
10 way	90	90	85	120
16 way	130	130	110	175
20 way	145	145	125	195
26 way	175	175	150	240
34 way	205	205	170	320
40 way	220	220	190	340
50 way	235	235	200	395
60 way	330	330	230	495

LINEAR

		IC7611	98	LM358	50	LM3915	270	NE567	130	TDA1024	115
		ICL7621	190	LM377	210	LM13600N	120	NE570	370	TL061	40
555CMOS	80	ICL7622	200	LM380	90	MC1310	150	NE571	370	TL062	65
556CMOS	150	ICL8038	295	LM381	120	MC1496	70	NE5532	160	TL064	105
709	35	ICL8211A	220	LM382	110	MC3302	75	NE5534	105	TL071	38
741	16	ICM7224	785	LM384	140	MC3340	130	RC4136	65	TL072	60
748	35	ICM7555	80	LM386	90	MAOCN	330	RC4558	40	TL074	110
AY31270	720	ICM7556	150	LM387	120	ML922	390	SL486	195	TL081	30
AY38910	390	LF347	150	LM393	60	ML924	290	SL490	220	TL082	50
AY38912	430	LF351	40	LM710	48	ML925	290	SN76018	150	TL084	105
CA3046	65	LF353	75	LM711	60	ML926	210	SN76477	380	TL170	50
CA3080E	65	LF356	90	LM725	70	ML927	210	SP8629	250	UA2240	140
CA3089	200	LM10C	325	LM733	70	ML928	210	SP0256AL2	550	ULN2003	80
CA3090AQ	375	LM301A	30	LM741	16	ML929	210	TBA120S	70	ULN2004	80
CA3130E	85	LM311	45	LM747	60	NE529	225	TBA800	70	XR2206	365
CA3140E	38	LM318	135	LM748	35	NE531	135	TBA810	90	ZN414	80
CA3160	95	LM324	45	LM1458	35	NE544	170	TBA820M	65	ZN423	135
CA3136	100	LM3342	85	LM2917N8	195	NE555	18	TBA950	220	ZN424P	130
CA3189	260	LM3352	125	LM3900	45	NE556	45	TCA940	165	ZN425E	350
CA3240E	100	LM339	40	LM3909	85	NE565	115	TDA1008	320	ZN426E	300
ICL7106	680	LM348	60	LM3914	270	NE566	140	TDA1022	490	ZN427E	600
										ZN428E	450
										ZN459	285
										ZN1034E	200

TRANSISTORS

				BC548	10	BFX29	30	2N2218A	45	2N4062	10		
				BC549	10	BFX84	30	2N2219A	28	40360	40		
				BC557	10	BFX85	30	2N2221A	25	40361	50		
AC125	35	BC158	11	BC558	10	BFX86	30	2N2222A	20	40362	50	MPSA12	29
AC126	30	BC158	10	BCY70	16	BFX87	30	2N2368	25	40408	50	MPSA55	30
AC127	30	BC159	10	BCY71	16	BFX88	30	2N2369	18	BF24413	35	MPSA56	30
AC128	30	BC160	40	BCY72	16	BFY50	27	2N2484	27	BF245	35	MPSU05	55
AC176	25	BC168C	10	BD115	55	BFY51	27	2N2904	28	BF25613	45	MPSU06	55
AC187	25	BC169C	10	BD131	40	BFY52	27	2N2904A	28	VN10KM	65	MPSU55	55
AC188	25	BC170	8	BD132	40	BFY53	30	2N2905	28	VN46AF	94	MPSU56	55
AD142	120	BC171	10	BD133	50	BFY55	30	2N2905A	28	VN66AF	110	TIP29	35
AD161	42	BC17?	8	BD135	35	BFY56	30	2N2906	28	VN88AF	120	TIP29A	35
AD162	42	BC17?	16	BD136	35	BSX20	22	2N2906A	28	MPF102	40	TIP29B	35
AF124	60	BC178	16	BD137	35	BSX29	35	2N2907	24	MPF104	40	TIP29C	35
AF126	50	BC179	18	BD138	35	BSY95A	30	2N2307A	24	2N3819	32	TIP30	35
AF139	40	BC182	10	BD139	35	BU205	160	2N2926	10	2N3820	50	TIP30A	35
AF186	70	BC182L	10	BD140	35	TIS45	45	2N3053	28	2N3823	65	TIP30B	35
AF239	55	BC183	10	BD204	110	TI590	30	2N3054	55	2N5457	30	TIP30C	40
BC107	10	BC183L	10	BD206	110	TI591	30	2N3055	50	2N5458	30	TIP31A	35
BC107B	12	BC184	10	BD222	85	ZTX107	11	2N3442	120	2N5459	30	TIP33A	65
BC108	10	BC184L	10	BF180	35	ZTX108	11	2N3702	9	2n5485	35	TIP33C	75
BC108B	12	BC212	10	BF182	35	ZTX109	11	2N3703	10	BRY39	50	TIP34A	70
BC108C	12	BC212L	10	BF184	35	ZTX300	14	2N3704	9	2N5777	45	TIP34C	80
BC109	10	BC213	10	BF185	25	ZTX301	16	2N3705	10	TIS43	40	TIP35A	105
BC109C	12	BC213L	10	BF194	12	ZTX302	16	2N3706	10	2n2646	60	TIP35C	125
BC114	22	BC214	10	BF195	12	ZTX304	20	2N3707	10	TIP31B	35	TIP36A	115
BC115	22	BC214L	10	BF196	12	ZTX341	20	2N3708	10	TIP31C	40	TIP36C	130
BC117	22	BC237	10	BF197	12	ZTX500	13	2N3709	10	TIP32A	35	TIP41A	45
BC119	35	BC238	10	BF198	15	ZTX501	18	2N3772	170	TIP32B	38	TIP42A	45
BC137	40	BC308	10	BF199	18	ZTX502	18	2N3773	195	TIP32C	40	TIP120	60
BC139	38	BC327	12	BF200	35	ZTX503	18	2N3866	90	BU206	200	TIP121	60
BC140	29	BC328	12	BF257	32	ZTX504	25	2N3903	10	BU208	170	TIP122	60
BC141	30	BC337	12	BF258	30	2N697	20	2N3904	10	MJ2955	99	TIP141	110
BC142	28	BC338	12	BF259	30	2N698	40	2N3905	10	MJE340	50	TIP142	120
BC143	30	BC477	22	BF337	35	2N706A	20	2N3906	10	MJE520	50	TIP147	120
BC147	10	BC478	22	BFR40	35	2N708	25	2N4037	45	MJE521	90	TIP2955	70
BC148	10	BC479	22	BFR40	23	2N918	35	2N4058	10	MJE3055	70	TIP3055	60
BC149	10	BC517	30	BFR80	23	2N118L	22	2N4060	10	MPSA05	23	TIS43 See VJTs	
BC157	11	BC547	10	BFR81	23	2N1613	30	2N4061	10	MPSA06	25	TIS44	45

RESISTORS

Carbon film	1+	25+
¼W 5% 4.7ohm - 10M	2p	1p
½W 5% 4.7ohm - 4M7	3p	2p
Metal film		
¼W 1% 10ohm - 1M	4p	3p

25+ price applies to 25+ per value not mixed

CRYSTALS

		4.194MHz	150
		4.43MHz	100
100KHz	235	5.008MHz	240
1MHz	275	6.0MHz	140
1.8432M	200	6.144MHz	150
2.0MHz	225	7.0MHz	150
2.4576M	200	8.0MHz	140
3.276M	150	10.0MHz	170
3.579M	95	12.0MHz	170
4.0MHz	140	16.0MHz	200

BOXES

		Aluminium	
		3 x 2 x 1"	65
Plastic with lid & screws		4 x 2¾ x 1½"	95
		4 x 2¾ x 2"	95
71x46x22mm	56	6 x 4 x 2"	120
95x71x35mm	88	7 x 5 x 2½"	165
140x90x55mm	140	8 x 6 x 3"	205

TTL

		7412	25	7440	25	7476	40	74107	40	74157	80	74180	85		
		7413	36	7442	74	7480	50	74109	60	74160	90	74181	230		
		7414	60	7444	105	7483	65	74121	50	74161	90	74182	85		
7400	25	7416	43	7446	130	7485	110	74122	50	74162	90	74190	120		
7401	25	7417	43	7447	98	7486	38	74123	92	74163	90	74191	120		
7402	25	7420	25	7448	98	7489	170	74125	50	74164	115	74192	120		
7403	25	7421	30	7450	25	7490	55	74126	50	74165	90	74193	110		
7404	25	7422	30	7451	25	7491	80	74132	60	74167	200	74194	80		
7405	25	7427	30	7453	25	7492	55	74141	80	74170	170	74195	63		
7406	45	7428	30	7454	25	7493	55	74145	85	74173	100	74196	120		
7407	45	7430	25	7460	25	7494	90	74147	130	74174	100	74197	85		
7408	25	7432	35	7472	35	7495	70	74148	105	74175	80	74198	195		
7409	25	7433	35	7473	40	7496	80	74150	130	74176	80	74199	195		
7410	25	7437	43	7474	36	7497	170	74153	70	74177	80				
7411	25	7438	45	7475	55	74100	125	74154	135	74179	90				

CMOS

		4016	32	4034	145	4054	70	4081	24	4502	50	4529	80
		4017	53	4036	270	5055	70	4082	25	4503	35	4532	65
		4018	55	4039	270	4059	400	4085	60	4507	45	4534	390
4000	20	4019	35	4040	58	4060	80	4086	60	4508	115	4538	70
4001	22	4020	65	4041	55	4063	80	4089	120	4510	55	4543	65
4002	24	4021	55	4042	50	4066	33	4093	30	4511	55	4549	390
4006	65	4022	60	4043	50	4067	230	4094	70	4512	50	4553	215
4007	24	4023	24	4044	50	4068	24	4095	70	4514	115	4555	50
4008	50	4024	45	4046	90	4069	24	4097	260	4515	115	4556	50
4009	40	4025	24	4047	60	4070	24	4098	50	4516	55	4559	390
4010	40	4026	120	4048	50	4071	24	40106	43	4518	55	4560	110
4011	22	4027	35	4049	32	4072	24	40109	100	4520	55	4584	43
4012	24	4028	45	4050	32	4073	24	40163	75	4521	110	4585	65
4013	35	4029	60	4051	60	4075	24	40173	100	4526	70	4724	140
4014	50	4030	24	4052	60	4076	60	40175	75	4527	60		
4015	53	4031	130	4053	60	4077	24	40193	90	4528	50		

LS TTL

		LS20	24	LS75	42	LS123	80	LS161	60	LS221	85	LS365	45
		LS21	24	LS76	30	LS125	38	LS162	60	LS240	105	LS366	45
		LS22	24	LS78	30	LS126	38	LS163	60	LS241	105	LS367	45
LS00	22	LS26	25	LS83	70	LS132	50	LS164	80	LS242	95	LS368	43
LS01	22	LS27	25	LS85	82	LS136	35	LS165	100	LS243	95	LS373	110
LS02	22	LS30	24	LS86	34	LS138	55	LS166	140	LS244	105	LS374	110
LS03	24	LS32	24	LS90	40	LS139	55	LS170	170	LS245	160	LS375	60
LS04	24	LS37	25	LS92	48	LS145	90	LS173	90	LS247	80	LS377	115
LS05	24	LS38	25	LS93	48	LS147	130	LS174	87	LS251	60	LS378	90
LS08	22	LS40	24	LS95	60	LS148	110	LS175	80	LS257	60	LS390	85
LS09	24	LS42	60	LS96	120	LS151	80	LS190	80	LS258	60	LS393	85
LS10	24	LS47	80	LS107	40	LS153	80	LS191	55	LS259	130	LS399	110
LS11	24	LS48	80	LS109	40	LS154	220	LS192	80	LS266	30	LS541	120
LS12	24	LS51	25	LS112	40	LS155	55	LS193	80	LS273	110	LS670	200
LS13	35	LS55	25	LS113	35	LS157	50	LS195	60	LS279	55		
LS14	60	LS73	30	LS114	35	LS158	50	LS196	85	LS283	80		
LS15	24	LS74	32	LS122	58	LS160	60	LS197	85	LS353	90		

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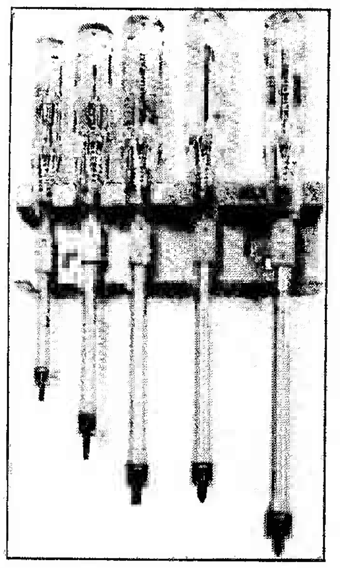
Single-Handed Driving

Facom Tools have introduced a range of screwdrivers which allow the user to insert screws and tighten them using one hand only. A moulded guide on the end of a sliding sheath holds the screw in place during assembly and a conveniently-placed button enables the screw to to be gripped or released in the same operation.

The seven screwdrivers in the range all feature clear yellow handles and are made to German VDE standards. The sliding sheath is made from red PVC and is extended and retracted along the blade by means of a moulded thumb-guide. A spring in the handle of the screwdriver holds the screwhead firmly against the end of the blade so that there is no need for the user to maintain pressure on the thumb-guide while tightening. Once the screw has been tightened sufficiently to hold it in place, the supporting sheath can be released and the screwdriver then used in the usual way to drive it fully home.

There are four flat-bladed screwdrivers in the range, a 2.5 mm (blade width) × 75 mm (blade length) at £3.93, a 3.0 × 100 mm at £4.10, a 4.0 × 125 mm at £5.05 and a 5.0 × 150 mm at £5.87. The remaining three screwdrivers in the range have cross-point blades in standard sizes, a no. 0 with a 125 mm long blade at £5.08, a no. 1 with a 150 mm blade at £5.96 and a no. 2 with a 175 mm blade at £6.92. A five screwdriver set is also available which comprises the 3.0 × 100, 4.0 × 125 and 5.0 × 150 mm flat bladed screwdrivers, the no. 1 and no. 2 cross-point screwdrivers, and an enamelled sheet steel wall-mounting holder. The set costs £30.43 and all prices exclude VAT.

Facom Tools Ltd, Bridge Wharf, Bridge Road, Chertsey, Surrey KT16 8LJ, tel 09328 — 66099.



Conferences, Exhibitions, Etc

The Fourth International Conference on Dielectric Materials, Measurements and Applications is being organised by the IEE and will take place at the University of Lancaster from the 10th to the 13th of September. The conference is aimed at those concerned with dielectrics and insulators and their applications in power engineering, electronic systems, electronic devices and integrated circuits and will cover test techniques from DC to high frequency and materials from the traditional through to modern polymers. The papers to be presented include contributions from many parts of the world, and those interested should contact Conference Services, The Institution of Electrical Engineers, Savoy Place, London WC2R 0BL, tel 01-240 1871 extension 222.

The IEE are also organising a conference entitled Advanced Signal Processing in Radar, Sonar and Communications which will take place at the University of Warwick, Coventry, from the evening of Monday 17th September to the afternoon of Friday 21st. The conference will concentrate on components and will consider the applications of microprocessors and other devices in a variety of signal processing systems. For details contact the IEE at the address above.

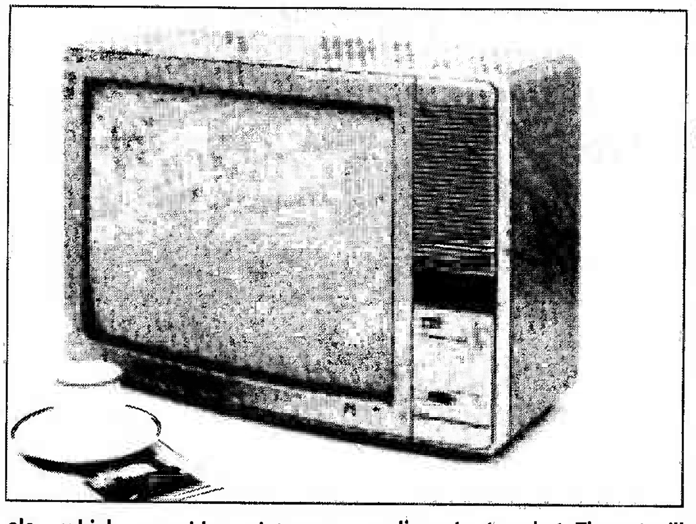
If those two events sound highly specialised and likely to appeal only to a limited circle of people, the Leisuretronics exhibition goes almost to the other extreme. Leisuretronics will take place at the Royal Horticultural Hall near Victoria, London from November the 8th to the 11th and aims to cater for all those with technology-related hobbies. Radio controlled models, electronic music making, ham radio, hi-fi and audio, robotics, photography, electronic games and disco lighting are just some of the areas covered by the equipment on display and the organisers promise a number of special features which they say will bring visitors right up to date on their hobbys. For details contact Trident International Exhibitions Ltd, 21 Plymouth Road, Tavistock, Devon PL19 8AU, tel 0822-4671.

Finally, and briefly, Electronic Displays '84 will take place at Kensington Exhibition Centre, London, from the 28th to the 30th of November. It's a combined conference and exhibition which covers all aspects of electronic displays and that's all we know about it, so if you think it sounds interesting, contact the organisers, Network Events Ltd, Printers Mews, Market Hill, Buckingham, MK18 1JX, tel 0280-815226.

Square-Screen Television

ITT recently previewed a new colour television which has a flat-faced, square cornered screen. They claim that 'flat square' television is widely considered to be the next step forward in colour television and have marked the change by adopting a metric measure for screen size rather than the existing imperial measure.

The new tube provides a largely flat screen area which does not protrude from the front of the television and which eliminates the familiar black border around the picture. The new measurement takes account of this and, instead of measuring the overall diagonal size of the tube face, refers only to the visible picture. The new tube provides a picture which measures 51 cm across the diagonal and thus falls in between existing 20" and 22" models which provide pictures measuring 48 cm and 53 cm respectively.

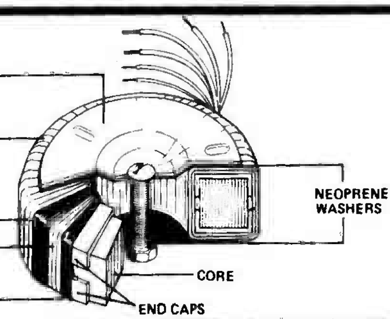


Other features of the new television include remote control and optional Teletext, thirty preset programmes with channel thirty VCR-ready, tone control, headphone socket and an audio output socket. The set will come complete with a purpose-designed stand which includes a VCR shelf and the first examples should be in the shops by October. ITT have not quoted a price but they say it should cost roughly the same as an equivalent 22" model.

● Quality Control International, an independent testing laboratory which inspects over 3000 domestic appliances, toys and electrical goods each year, reports that one third of foreign goods intended for import into this coutry fail to meet basic safety standards. Such goods, often manufactured in the Far-East, usually fail because they are either electrically unsound or because they have unacceptably high levels of toxicity.

● The Oric Owners' Users Group has now completed its reorganisation and has produced another issue of its magazine, "Oric Computing". OUG have a number of utility and educational software packages for the ORIC-1 and ATMOS computers and planned hardware projects include a ROM cartridge, a six-slot expansion motherboard and a serial interface adaptor. Contact OUG, 1 Marlborough Drive, Worle, Avon BS22 0DQ, tel 0934 — 516680.

TOROIDALS



The toroidal transformer is now accepted as the standard in industry, overtaking the obsolete laminated type. Industry has been quick to recognise the advantages toroidals offer in size, weight, lower radiated field and, thanks to I.L.P., PRICE.

Our large standard range is complemented by our SPECIAL DESIGN section which can offer a prototype service within 14 DAYS together with a short lead time on quantity orders which can be programmed to your requirements with no price penalty.

15 VA — 62 x 34mm, 0.35Kg, Regulation 19%

SERIES No	SECONDARY Volts	RMS Current
0x010	6+6	1 25
0x011	9+9	0 83
0x012	12+12	0 63
0x013	15+15	0 50
0x014	18+18	0 42
0x015	22+22	0 34
0x016	25+25	0 30
0x017	30+30	0 25

(encased in ABS plastic)

30 VA — 70 x 30mm, 0.45Kg, Regulation 18%

SERIES No	SECONDARY Volts	RMS Current
1x010	6+6	2 50
1x011	9+9	1 66
1x012	12+12	1 25
1x013	15+15	1 00
1x014	18+18	0 83
1x015	22+22	0 68
1x016	25+25	0 60
1x017	30+30	0 50

50 VA — 80 x 35mm, 0.9Kg, Regulation 13%

SERIES No	SECONDARY Volts	RMS Current
2x010	6+6	4 16
2x011	9+9	2 77
2x012	12+12	2 08
2x013	15+15	1 66
2x014	18+18	1 38
2x015	22+22	1 13
2x016	25+25	1 00
2x017	30+30	0 83
2x028	110	0 45
2x029	220	0 22
2x030	240	0 20

80 VA — 90 x 30mm, 1Kg, Regulation 12%

SERIES No	SECONDARY Volts	RMS Current
3x010	6+6	6 64
3x011	9+9	4 44
3x012	12+12	3 33
3x013	15+15	2 66
3x014	18+18	2 22
3x015	22+22	1 81
3x016	25+25	1 60
3x017	30+30	1 33
3x028	110	0 72
3x029	220	0 36
3x030	240	0 33

120 VA — 90 x 40mm, 1.2Kg, Regulation 11%

SERIES No	SECONDARY Volts	RMS Current
4x010	6+6	10 00
4x011	9+9	6 66
4x012	12+12	5 00
4x013	15+15	4 00
4x014	18+18	3 33
4x015	22+22	2 72
4x016	25+25	2 40
4x017	30+30	2 00
4x018	35+35	1 71
4x028	110	1 09
4x029	220	0.54
4x030	240	0 50

160 VA — 110 x 40mm, 1.8Kg, Regulation 8%

SERIES No	SECONDARY Volts	RMS Current
5x011	9+9	8 89
5x012	12+12	6.66
5x013	15+15	5 33
5x014	18+18	4 44
5x015	22+22	3 63
5x016	25+25	3 20
5x017	30+30	2 66
5x018	35+35	2 28
5x026	40+40	2.00
5x028	110	1 45
5x029	220	0 72
5x030	240	0 66

225 VA — 110 x 45mm, 2.2Kg, Regulation 7%

SERIES No	SECONDARY Volts	RMS Current
6x012	12+12	9 38
6x013	15+15	7 50
6x014	18+18	6 25
6x015	22+22	5 11
6x016	25+25	4 50
6x017	30+30	3 75
6x018	35+35	3 21
6x026	40+40	2 81
6x025	45+45	2 50
6x033	50+50	2 25
6x028	110	2 04
6x029	220	1 02
6x030	240	0 93

300 VA — 110 x 50mm, 2.6Kg, Regulation 6%

SERIES No	SECONDARY Volts	RMS Current
7x013	15+15	10 00
7x014	18+18	8 33
7x015	22+22	6 82
7x016	25+25	6 00
7x017	30+30	5 00
7x018	35+35	4 28
7x026	40+40	3 75
7x025	45+45	3 33
7x033	50+50	3 00
7x028	110	2 72
7x029	220	1 36
7x030	240	1 25

500 VA — 140 x 60mm, 4Kg, Regulation 4%

SERIES No	SECONDARY Volts	RMS Current
8x016	25+25	10 00
8x017	30+30	8 33
8x018	35+35	7 14
8x026	40+40	6 25
8x025	45+45	5 55
8x033	50+50	5 00
8x042	55+55	4 54
8x028	110	4 54
8x029	220	2 27
8x030	240	2 08

625 VA — 140 x 75mm, 5Kg, Regulation 4%

SERIES No	SECONDARY Volts	RMS Current
9x017	30+30	10 41
9x018	35+35	8 92
9x026	40+40	7 81
9x025	45+45	6 94
9x033	50+50	6 25
9x042	55+55	5 68
9x028	110	5 68
9x029	220	2 84
9x030	240	2 60

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120	4	11.73	625	9	31.63

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For 220V primary (Europe) insert "1" in place of "X" in type number.
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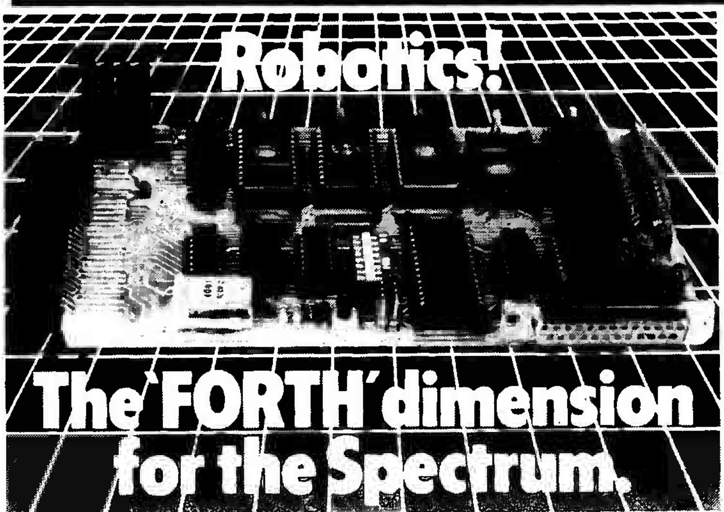

Now your 16k and 48k Spectrum get 12k of fig-FORTH from a new cartridge that's perfect for robotics.

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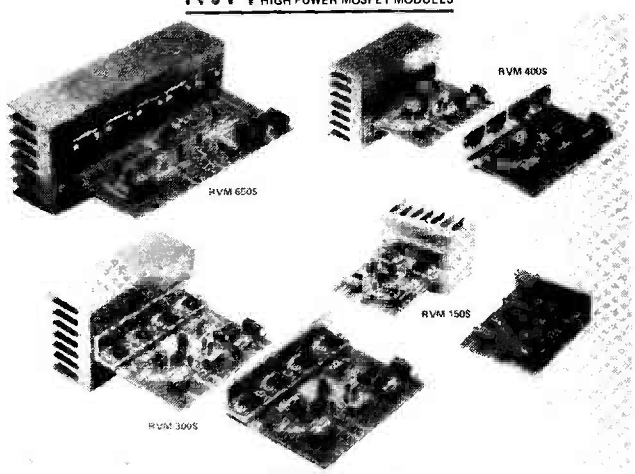
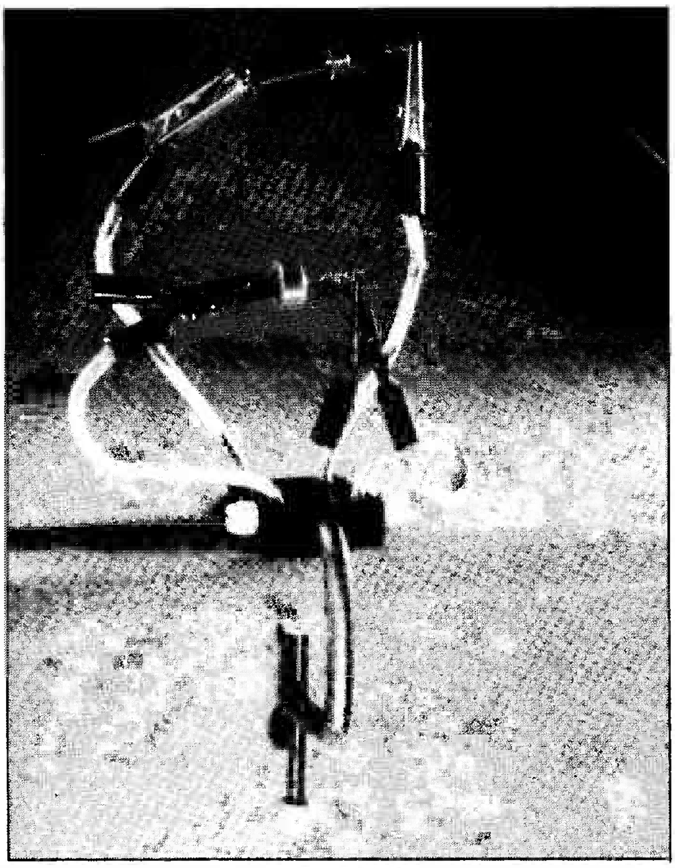


SPECIFICATION SHEET

Modules	Frequency Response	Slew Rate	T H D	S N R	Damping Factor	Input Impedance	Output Impedence	Vs Typical	Power Output	Output Device	Input Sensitivity
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	100 Watt [illegible] Watt	H. Paks	1 25 V R.M.S. Variable on Request
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	160 Watt [illegible] Watt	H. Paks	1 25 V R M S Variable on Request
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible] Watt [illegible] Watt	H. Paks	1 25 V R M S Variable on Request
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible] W [illegible] W 650 W	H. Paks	1 25 R M S Variable on Request

GUARANTEED :

RVM Audiotronic



Many Hands...

Gripmate is the answer to a hobbyist's prayer — a device which can hold several component parts in the correct relation to one another during soldering and other operations whilst leaving the user's hands completely free. It consists of a base block which can be clamped to a bench or table and four semi- rigid wire arms, each terminated in a crocodile clip. The wires can be bent into any position and the crocodile clips will then hold the item being worked upon. A magnifiying glass and a magnet, each similarly attached to a semi-rigid wire, are also available and they can be used in place of any of the existing wires.

The four-handed Gripmate costs £4.85, a basic two-handed version costs £3.85, and the magnifying glass and the magnet cost £2.50 and £1.50 respectively. All prices include VAT and postage, etc.

Kemplant Ltd, Durfold Wood, Plaistow, Billingshurst, West Sussex RH14 OPN, tel 048649 —344.

● Texas Instruments have produced a 'pinwheel' selection guide covering their range of CMOS op-amps. The LinCMOS part-finder consists of several concentric plastic discs which are so arranged that, by lining up all of the desired parameters on one side, the part number of the op-amp fulfilling those requirements appears in a little cut-out. The part finder is available free from TI or any of their distributors. Texas Instruments Ltd, Manton Lane, Bedford MK41 7PA, tel 0236 - 67466.

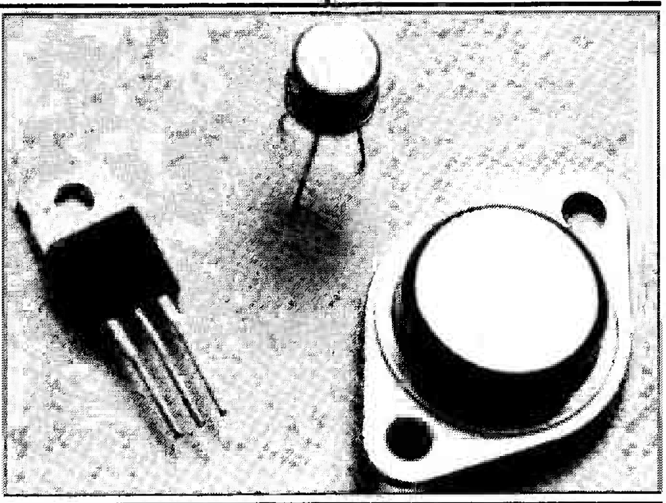
● The Amateur Computing Club have sent us a copy of the June issue of their newsletter, ACCumulator. Its contents include an article on Basicode, a look at the internal organisation of the BBC microcomputer and a simple speech processsor design which can be connected to any Centronics port or directly to the bus of ZX Spectrum and ACE microcomputers. For details contact Andy Leeder who looks after membership — his address is Church Farm, Stratton St. Michael, Norwich NR15 2QB.

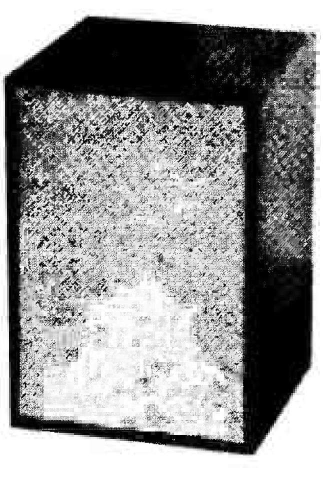
Logic Level FETs

Power Technology have launched a range of FETs which provide on-off control of loads and yet can be driven directly by low level logic circuitry. Designated Logic Level FETs or L^2FETs, they are manufactured by RCA and are said to be the first power MOSFETs capable of operating directly from TTL and NMOS circuitry.

The L^2FETs are manufactured using a thin oxide process and require only 5V of gate drive to produce full output current. Unlike other power MOSFETs which require higher gate drive voltages, they can be driven directly by the logic and thus remove the need for an interface circuit and a separate interface supply. In spite of this, Power Technology say they will cost only a fraction more than conventional 10V power MOSFETs. They are available in T03, T039, T0220 and other industry standard packages and are expected to find applications in motor and solenoid drive circuits, linear and switching regulators, automotive assemblies, DC/DC converters and laser drivers.

Power Technology Ltd, Boulton Road, Reading, Berkshire RG2 0LT, tel 0734-866766.





Growing Smaller

Merseyside Acoustic Developments, whose "Musician" loudspeaker design was featured as a constructional article in our June issue, have now introduced a smaller loudspeaker which they call the Musician Bonsai. Named after the Japanese technique of miniaturising trees while retaining all of their natural characteristics, the new loudspeakers are said to offer a performance similar to that of their larger stable mates, albeit with a slightly lower power handling.

The Musician Bonsai measures approximately 9" × 7" × 6" and is intended as a bookshelf system. It employs a single, full-range, flat diaphragm drive unit which is a scaled down version of the one used in the original Musician loudspeaker and described in our article. For the benefit of those who didn't see that article, the flat diaphragm used is ellipse or 'lozenge' shaped and is attached to a similarly shaped coil so that the drive is evenly distributed. The manufacturers claim that this reduces problems with diaphragm break-up, etc, and that, by being narrower than the distance between human ears when stood on end, the ellipse-shape improves stereo imaging. Other novel features include a cabinet construction which uses cork filleting between the panels to damp down cabinet resonances and, in the more expensive models, the use of a newly-developed inorganic plastic called NIMS-127 which futher reduces resonance problems.

The Musician Bonsai loudspeakers are available in either standard wooden enclosures at £140.00 a pair plus VAT or in enclosures made from NIMS-127 at £210.00 a pair plus VAT. For details contact Merseyside Acoustic Developments Ltd, Merseyside Innovation Centre, 131, Mount Pleasant, Liverpool L3 5TF, tel 051 - 709 0427.

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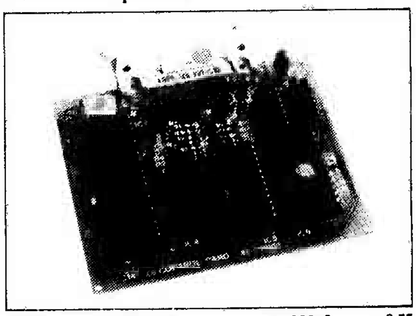

C12 Computer Cassette	21-00012	0.55
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'C'	1.2V	2.2AH	01-12024	2.35	1.99
'D'	1.2V	4.0AH	01-12044	3.05	2.85
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LM308CN	DIL version	61-03081	0.65
LM311CN	Popular comparator	61-00311	0.46
LM324	Low power quad op amp	61-03240	0.67
LM339N	Low power quad comparator	61-03390	0.68
LM346	Programmable quad op amp	61-00346	3.72
LF347	Quad Bi-FET op amp	61-00347	1.82
LM348	Quad 741 type op amp	61-03480	1.26
LF351	Bi-FET op amp	61-03510	0.49
LF353	Dual version of LF351	61-03530	0.76
LM380N	IW AF power amp	61-00380	1.45
NE555N	Multi-purpose low cost timer	61-05550	0.45

for a better service.

NE556N	Dual version of the 555	61-05560	0.50
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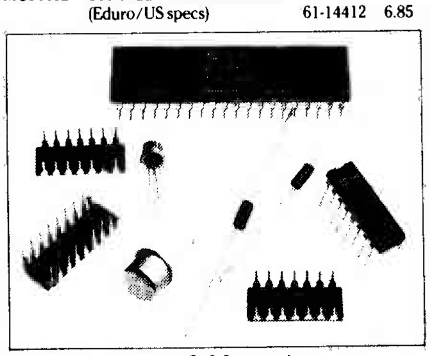
uA747CN	Dual 741 op amp	61-07470	0.70
uA748CN	741 with external frequency comp	61-04780	0.40
HA1388	18W PA from 14V	61-01388	2.75
TDA2002	8W into 2 ohms power amp	61-02002	1.25
ULN2283	1W max. 3-12V power amp	61-02283	1.00
MC3357	Low power NBFM IF system and detector	61-03357	2.85
ULN3859	Low current dual conversion NBFM IF and detector	61-03859	2.95
LM3900	Quad norton amp	61-39000	0.60
LM3909N	8-pin DIL LED flasher	61-39090	0.68
KB4445	Radio control 4 channel encoder and RF	61-04445	1.29
KB4446	Radio control 4 channel receiver and decoder	61-04446	2.75
ICM7555	Low power CMOS version of timer	61-75550	0.98
ICL8038CC	Versatile AF signal generator with sine/square/triangle OPs	61-08038	9.50
TK10170	5 channel version of KB4445	61-10170	1.87
HA12002	Protection monitor system for amps, PSUx, TXs etc	61-12002	1.22
HA12017	83dB S/N phono preamp 0.001% THD	61-12017	0.80
MC14412	300 baud MODEM controller (Eduro/US specs)	61-14412	6.85



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Z6132-6	32K (4kx8) quasi RAM 350nS	26-06132	15.00
4116-2	16K (16kx1) 150nS	26-24116	1.59
2764	64K (8kx8) 450nS	26-02764	9.50
2732	32K (4kx8) 450nS	26-02732	5.70

Voltage Regulators

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7812	12V 1A positive	27-78122	0.40
7815	15V 1A positive	27-78152	0.40
7905	5V 1A negative	27-79052	0.49
7912	12V 1A negative	27-79122	0.49
7915	15V 1A negative	27-79152	0.49

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BC212	General purpose	58-00212	0.10
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BC238	Plastic BC108	58-00238	0.08
BC239	Plastic BC109	58-00239	0.08
BC307	Complement to BC237	58-00307	0.08
BC308	Complement to BC238	58-00308	0.08
BC309	Complement to BC239	58-00309	0.08
BC327	Driver/power stage	58-00327	0.13
BC337	Driver/power stage	58-00337	0.13
MPSA13	NPN Darlington	58-04013	0.30
MPSA63	PNP Complement to MPSA13	58-04063	0.30
J310	JFET for HF-VHF	59-02310	0.69
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3SK51	Dual gate MOSFET-VHF amp	60-04051	0.60
3SK88	Dual gate MOSFET-Ultra lo noise	60-04088	0.99
TIP31A	Output stage	58-15031	0.35
TIP32A	Complement to TIP31A	58-15032	0.35
VN66AF	VMOS Power FET	60-02066	0.95
IN4001	Rectifier diode	12-40016	0.06
IN4002	Rectifier diode	12-40026	0.07
IN4148	General purpose silicon	12-41486	0.05

Silicon Controlled Rectifiers

BRY55-100	100V .8A	52-55100	0.50
C106DI	400V 4.0A	52-00106	0.70
C122DI	400V 8.0A	52-00122	1.45

3mm Diameter LEDs

V178P	Red	15-01780	0.15
V179P	Green	15-01790	0.16
V180P	Yellow	15-01800	0.18

5mm Diameter LEDs

CQY40L	Red	15-10400	0.12
CQY72L	Green	15-10720	0.15
CQY74L	Yellow	15-10740	0.15

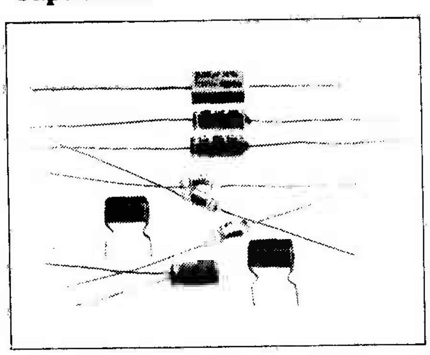
Infra-Red LEDs

CQY99	Emitter	15-10990	0.56
BPW41	Detector	15-30410	1.51

Tri Colour LED

V518	Orange-Green-Yellow	15-05180	0.60

Capacitors



Aluminium Electrolytics Radial PCB Mounting

			Pack of 4
10u	16V	05-10606	0.24
47u	16V	05-47606	0.28
47u	25V	05-47607	0.28
470u	6.3V	05-47705	0.36
470u	16V	05-47706	0.48

Tantalum Beads

			Each
1uf	35V	05-10501	0.18
10uf	16V	05-10601	0.28
47uf	6.3V	05-47601	0.45
47uf	16V	05-47602	0.92

Monolithic Capacitors

		Pack of 3
1n	04-10204	0.39
10n	04-10304	0.42
100n	04-10404	0.45

Low Voltage Disc Cermaic

		Pack of 5
1n	04-10203	0.20
10n	04-10303	0.20

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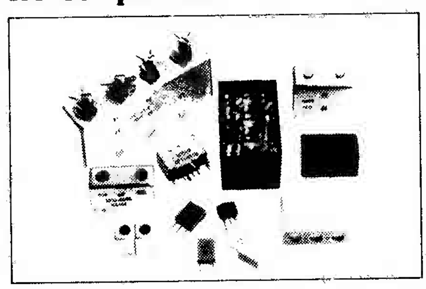
47n	04-47305	0.24
100n	04-10405	0.24
470n	04-47405	0.51
1uF	04-10505	0.66

R F Components



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MLXS	Handy 12V 15W soldering iron complete with crocodile clips and solder	54-20004	5.60

Please add 15% VAT to all advertised prices and 60p post and packing. Minimum order value £2 please. We reserve the right to vary prices in accordance with market fluctuation.

COMMUNICATIONS SATELLITES (PART 3)

Roger Bond takes a historical look at earth-based antennas in the UK and at Intelsat V.

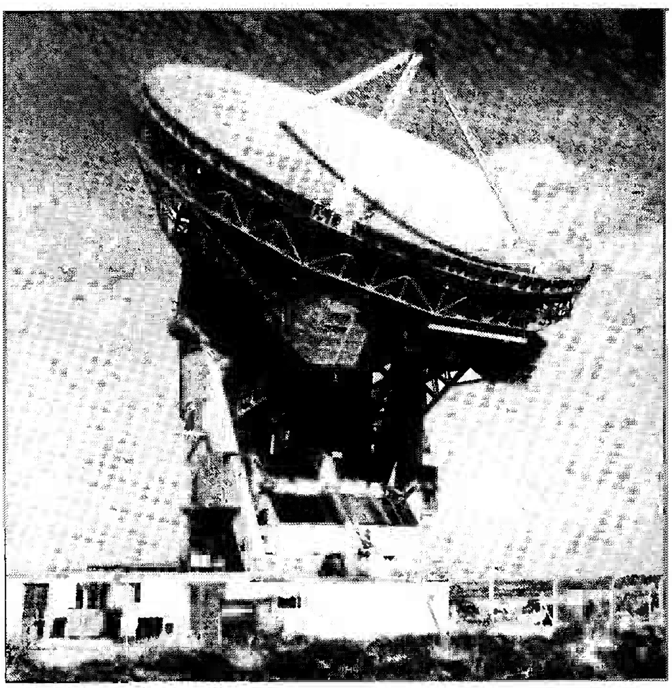
Until very recently, all the UK's earth station aerials were sited at or near Goonhilly in Cornwall. Recently, however, BT has started to build up a site in the London Dockland for European satellite communications, and Mercury will almost certainly be seeking to develop their own earth station. However, the vast bulk of the UK's satellite traffic will pass through Goonhilly for the next few years.

The aerials at Goonhilly have achieved many firsts in the field of satellite communications. Apart from being the first to participate in transmisssion of voice channels, Goonhilly was also the first European station to transmit colour television signals by satellite. Goonhilly's aerial one has now retired from service but is used as a standby.

After the first crop of aerials at Goonhilly, there was a need for a second site in order to provide a secure service and in 1970 a 140 acre farm was found at Madley near Hereford. This lies in a slight dip which shields it from terrestrial microwave radio.

Table 2 gives a comparison of Goonhily and Madley aerials. In general the main reflectors are constructed from stainless steel with a central dish surrounded by petals and adjustment of the aerial shape is by means of jacks positioned at the petal joints.

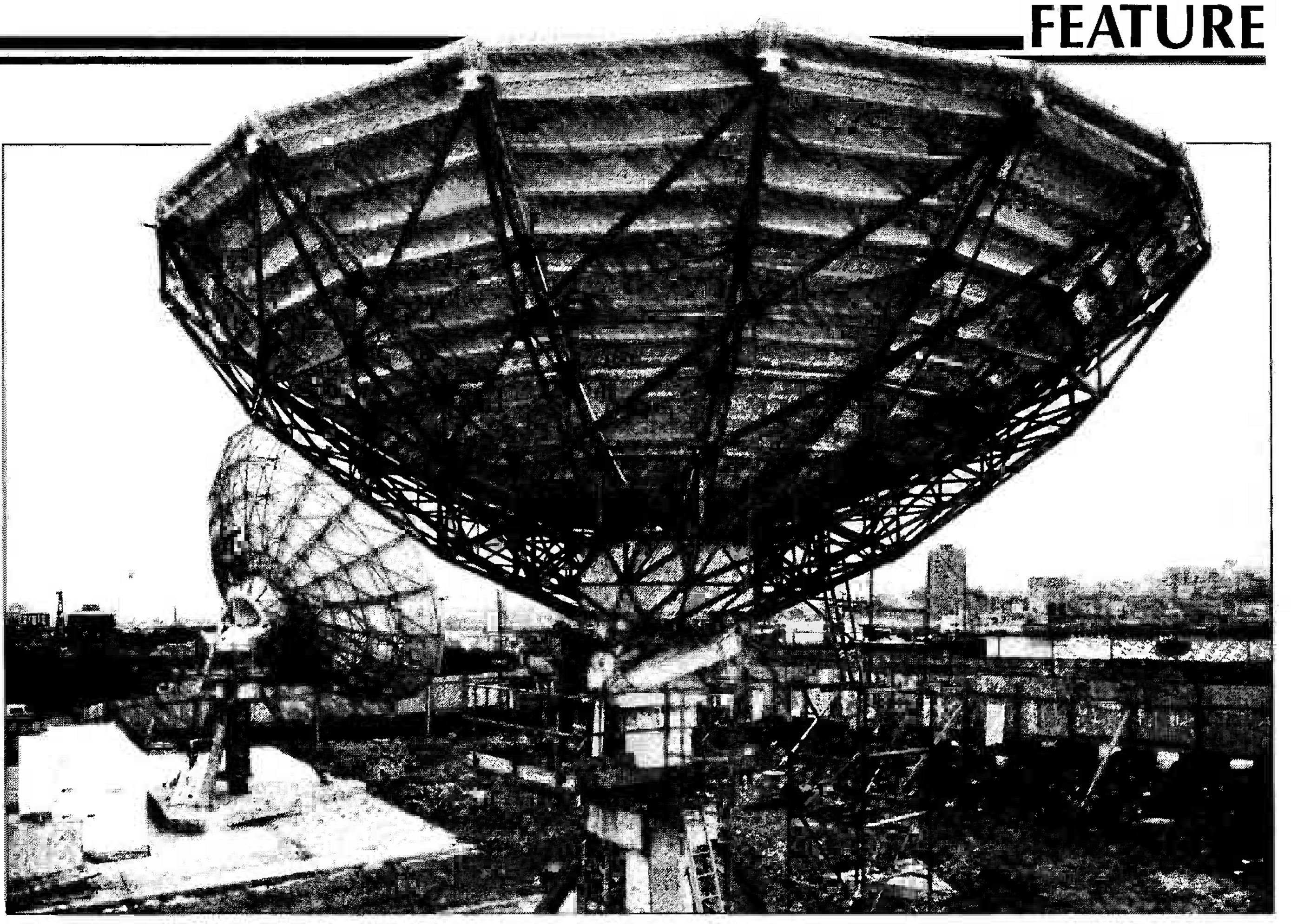
Most modern aerials are only 300-4000 tons in weight and require 10-20 hp DC motors to move



The one that started it all — Goonhilly's Aerial No. 1.

	Year Completed	Frequencies Used GHz	Diameter in feet	Subreflector Diameter	Motors HP	Route
Goonhilly 1	1962	6/4	85	—	100	Spare
2	1968	6/4	90	—	15	AOR-MP1
3	1972	6/4	97	10	20&2	AOR-P
4	1978	14/11	62	7	10	AOR-P
5	1982	6/4	54	6	10	INMARSAT
Madley 1	1978	14/11	105	9.5	5.5	IOR-P
2	1980	14/11	105	9.5	5.5	AOR-MP2
3	1981	14/11	105	9.5	5.5	IOR-MP
4	Under	14/11	62	7	10	ECS
5	Construction	14/11	62	7	10	AOR-MP1

Table 1 Aerials at Goonhilly and Madley.



The new generation — Aerials 1 and 2 (undergoing installation) in the London Docklands.

them but Aerial 1 at Goonhilly weighed 1100 tons and required 100 hp motors. Quite apart from moving this weight, the motors were tracking an orbiting satellite! The motors move the aerial both in azimuth (sideways) and elevation (up and down).

The construction of each aerial tower is different but there are two basic patterns: the beam axis kind and the railway bogie kind. Fig. 1 is an example of the beam axis type where the dish is mounted on a beam which is itself supported on a kingpost. The kingpost rotates in a 60 foot high concrete tower.

Fig. 2 shows the gyrating joints of the railway bogie type where railway tracks some 50 feet in diameter give it a sweep of about 270 degrees. This is aerial 5 at Goonhilly and it can withstand wind speeds of 28m/s. During gales it is stored vertically and is capable of resisting windy puffs of 57m/s. Since this aerial works to INMARSAT it serves a few single channel users requiring high power unlike the high capacity INTELSAT users. It is aided and abetted in this task by low noise amplifiers housed at the back of the dish.

Madley's aerial 1 has a subreflector whose legs are elliptical in cross section to reduce beam blocking. Aerial 4 is still under construction and will work to the European Communications Satellite (ECS) carrying speech and television. It will carry digital signals employing time division multiple access(TDMA) and also digital speech interpolation (DSI), ie. when a talker is silent, the time slot will be used by another talker. The assignments of the slots will be computer controlled.

In general aerials have become smaller and lighter. The mechanical design has changed from beam axis to the railway bogie type. Electrically they have become more complex with the introduction of dual polarisation.

At 4 GHz there is about 200dB attenuation of signal between satellite and earth. This means that the signal reaching earth is only 10^{-16} watts per square metre. With an aerial of 500 square metres area, the received power is about 10^{-13} watts. This is less than the thermal noise from a resistor at room temperature. Hence the need to have a cooled amplifier that will be sensitive to low signals and give them an immediate boost.

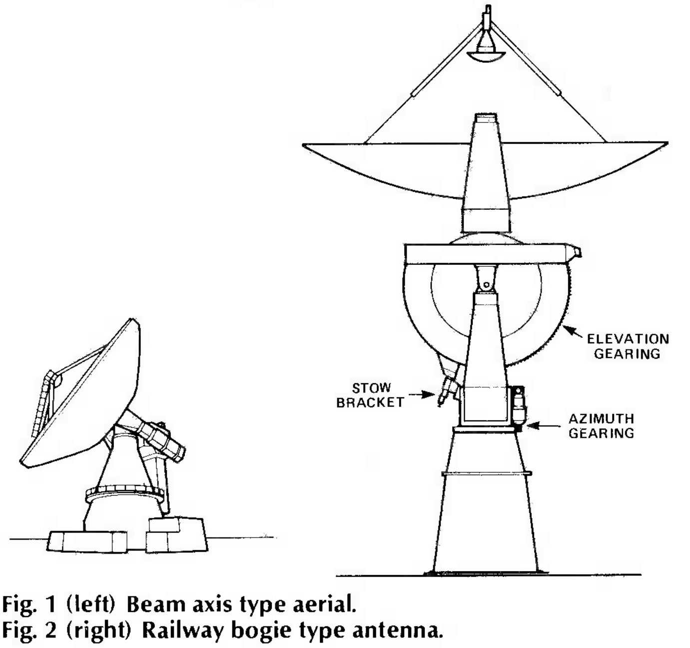


Fig. 1 (left) Beam axis type aerial.
Fig. 2 (right) Railway bogie type antenna.

Ever Increasing

Every new range of satellites has an increased capacity. INTELSAT IV had a capacity of 7000 channels, INTELSAT IVA could carry 11,000 channels and two television links. The new INTELSAT V has double the capacity of INTELSAT IVA. However it must be remembered that capacity in terms of voice channels is only an approximate guide to a satellite's capacity.

For instance if we put data links over a satellite, such continuous demands on satellite power will limit the total number of channels it can carry, as would DSI (digital speech interpolation). Speech has silent periods which helps to conserve satellite power so if DSI is used to put continuous streams of speech on a satellite channel then there is a need to increase the satellite's power or reduce the number of channels it will carry. Similarly, methods of transmission which require a continuous signal to be transmitted, such as tone-on-idle, have to be avoided.

Of the solutions available above, clearly we are not in a position to reduce the number of channels. There is such a heavy demand for international traffic that the number of channels must be increased. There are five hundred million telephones in the world and two thirds of the traffic including data transmission is by satellite.

Satellites are always in hot competition with trans-oceanic cables and for every new satellite system, there is a new cable. By far the hottest route is the Atlantic which is covered by three satellites working to nearly seventy earth stations. The Primary path works to all the earth stations but those busy countries that need to work to the Major paths as well, require additional aerials.

In competition with satellites are several submarine cables across the Atlantic to Canada and the USA. CANTAT2 has twenty-three supergroups (one supergroup=60 channels). CANTAT stands for Canadian transatlantic. TAT7 has fifty-three supergroups and TAT8 due for completion in 1988 will carry 8,000 channels capable of being increased to forty thousand using digital speech interpolation.

So what's the attraction of satellites? They can be launched and operational in a few months. They are also versatile since the aerials on the INTELSAT IV onwards are steerable from the ground. It takes just a few elementary commands from the ground to concentrate the beams on a different area of the earth.

A brief history of INTELSAT launches is given in Table 2. Note the failures. The apogee motor is the one that puts the satellite in stationary orbit after the launch rocket lifts it away from the gravitational field of the earth. Insurance premiums are based on a statistical average of failures and Lloyd's of London are always glad to quote if you have a satellite to launch. For the past twenty years NASA has been the sole launcher of satellites in the Western World. Others have sprung up in recent years and The European Space agency went through an anxious period with launch failures recently.

Satellite	Flight No	Launched
INTELSAT I	—	1965
INTELSAT II	F1	1966
	F2	1967
	F3	1967
	F4	1967
INTELSAT III	F1	1968
	F2	1968
	F3	1969
	F4	1969
	F5	1969
	F6	1970
	F7	1970
	F8	1970
INTELSAT IV	F1	1975
	F2	1971
	F3	1972
	F4	1972
	F5	1972
	F6	1975
	F7	1973
	F8	1974
INTELSAT IVA	F1	1976
	F2	1976
	F4	1977
	F5	1977

Table 2 A summary of INTELSAT launches.

INTELSAT V

INTELSAT V first went into orbit in 1980, when the first satellite of this series was successfully positioned over the Atlantic. There are now 6 of these satellites in service.

Fig. 3 shows the interesting parts of INTELSAT V; the most immediately obvious difference between V and its predecessors is the use of paddle solar-panels. These make it possible to have a much higher power generation, and on V, they provide 1.54 kW immediately after launch, degrading to 1.16 kW towards the end of the satellites's life. The solar cells charge up two batteries each consisting of 28 NiCad cells capable of supplying 34 Ah; the transponders on board require nearly 800W of power - still rather less than a single-bar electric fire!

All this gives the V a much higher weight than its predecessors; it is approximately 170 kg heavier (if one can use that term for a satellite!) than IV-A.

Most of the previous satellites have been built by the Hughes Aircraft Company and launched, by NASA, using an Atlas Centaur rocket. INTELSAT V can be launched by the European Space Agency's ARIANE rocket, or by the space shuttle, as well as by Centaur. As with all other geostationary satellites, launch from Cape Canaveral requires the use of an apogee motor to transfer the satellite to its final, equitorial aerial.

Aerials

There are a total of six aerials on the satellite. Firstly, there are two global horns operating on 6/4GHz; these are fully steerable

Secondly, there are two independant, 14/11 spot beam dishes, both operating on transmit and receive. These have limited steering, and can be directed towards areas of very high traffic; one dish is designated 'east', and the other 'west', and, on the Atlantic circuit, they can be steered so as to take in

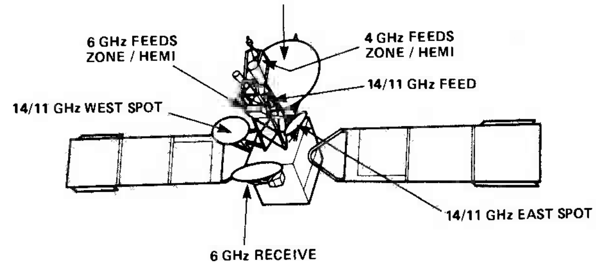
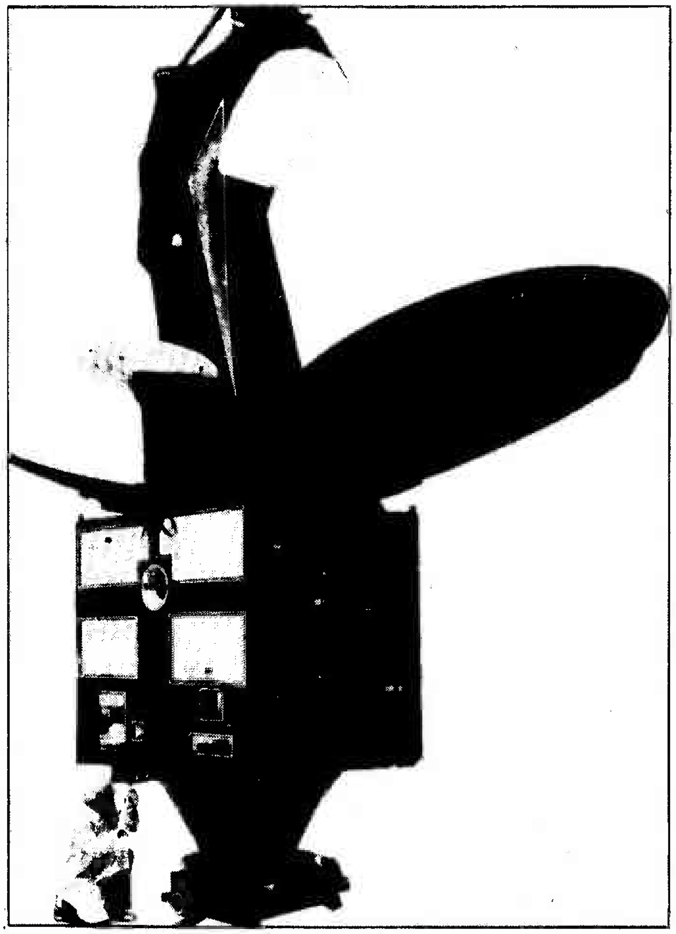


Fig. 3 Parts of INTELSAT V.

INTELSAT 5 undergoing testing.



different areas of Europe or the American mainland respectively.

Finally, there are two dishes operating on 6/4 GHz; one is for receive (6 GHz), the other for transmit (4 GHz). These have a very large battery of feeds - 88 in all - which makes precise beam-shaping possibe. This is used to get good beam symmetry and to cancel out side lobes, but beyond this, to radiate two different beam shapes, designated 'zone' (the smaller area coverage) and 'hemisphere' (the larger). These use opposite circular polarisations.

Figure 4 shows the coverage of all the beams except the global and Table 3 gives the polarising arrangements. An idea of the size of the 4 GHz transmit aerial may be gained from the photograph - it is, in fact, 2.4 m approx in diameter.

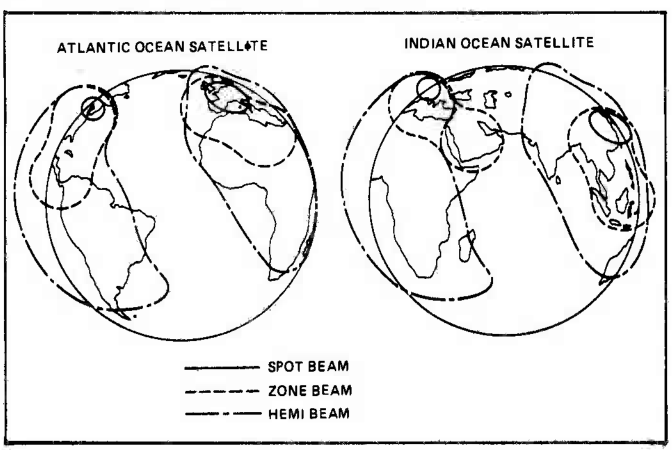


Fig. 4 Beam coverages.

Beam	Frequency GHz	Receive Polarisation	Transmit Polarisation
West Zone	6/4	RHC	LHC
East Zone	6/4	RHC	LHC
West Hemispheric	6/4	LHC	RHC
East Hemispheric	6/4	LHC	RHC
West Spot	14/11	linear	linear
East Spot	14/11	linear	linear
Global	6/4	LHC	RHC

RHC = Right Hand Circular
LHC = Left Hand Circular

Table 3 Beam frequencies and polarisations on INTELSAT V.

The gain for each beam is quoted as the gain at the edge of the beam and is 17 DBI for the global (I stands for an isotropic radiating source ie relative to a light source radiating in all directions). The beam edge gain for hemispheric and zone beams is about 23 dBi and for spot beams about 35 dBi.

The aerial dishes are made from graphite-fibre reinforced plastic (GFRP) which is stronger than other alloys used in the aerospace business. There are steep temperature gradients in space and GFRP also has a low co-efficient of thermal expansion which is useful in such a hostile environment. The aerial reflectors are folded inside the launch rocket and deployed once the satellite is in position and the aerial feeds are mounted on the aerial tower which is also made of GFRP.

Stabilisation

Previous communications satellites have used the revolving drum body to stabilise the satellites orientation; with the design of INTELSAT V this isn't possible, and a momentum wheel weighing 15 kg and revolving at 3500 RPM is used instead (there is also a back-up wheel).

The satellite needs to be controlled in three directions, Fig. 5, and the spinning wheel holds it fairly steady in the roll and yaw directions. Fine control in roll and yaw axes is by gas jets. Nearly 12Kg of hydrazine (N_2H_4H) is carried and expected to last seven years if fired at two month intervals. The hydrazine is prevented from freezing by electric heating and the gas jets are activated by passing the hydrazine over a catalyst which breaks the hydrazine down into nitrogen, hydrogen and ammonia. The jets achieve a pointing accuracy of $\pm 0.1\%^{\circ}$

Control in the pitch is achieved by electric motors which react on the momentum wheel. Regular corrections are necessary since the sun and the moon combine their gravity variations in space. The satellite is equipped with infra-red sensors which sense the edge of the earth against the background of cold space and a sun sensor.

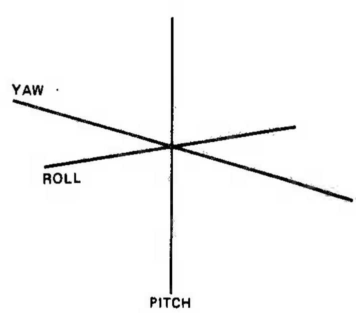


Fig. 5 Yaw, pitch and roll axes.

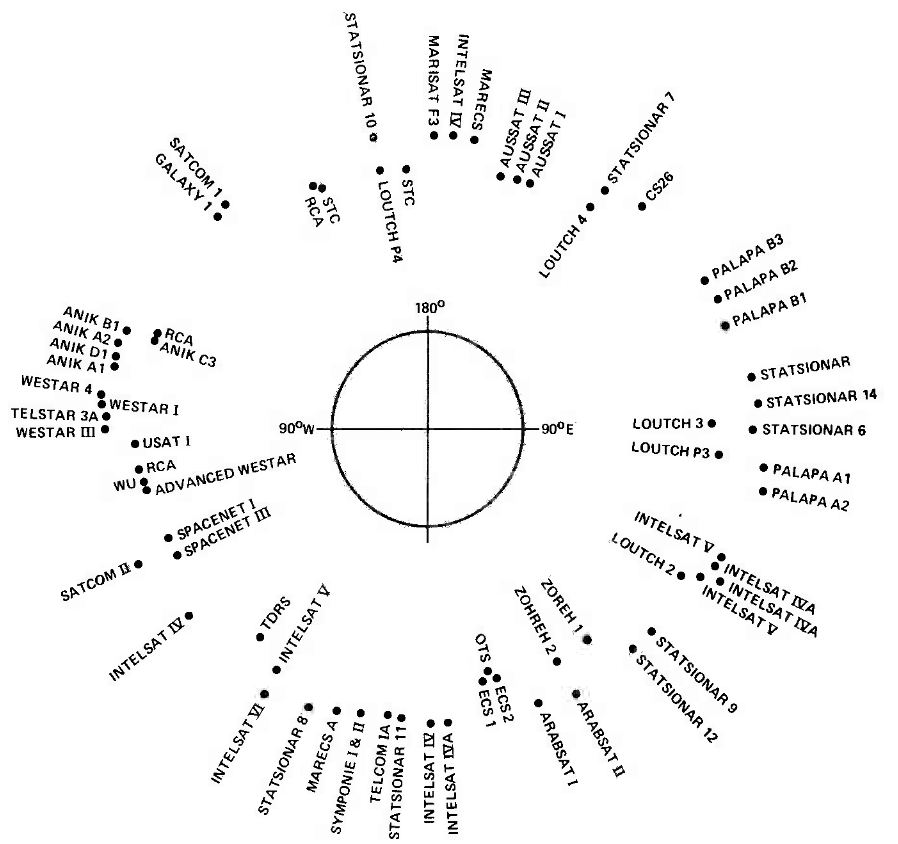


Fig. 6 Positions of satellites; the outer band of satellites operate on 4/6 GHz, the inner on 10-30GHz. In reality, they are all actually exactly the same distance away from earth!

Receiver Section

All incoming signals at 6 GHz or 14 GHz are converted to 4 GHz. This permits ease of processing. Transponders have a bandwidth of 72 MHz, twice the bandwidth of earlier transponders. These are switchable from the ground and the state of each switch is telemetred. At 4 GHz a coaxial switch is used and at 11 GHz a waveguide switch is used.

There are four receivers for the 14 GHz signals, one for each spot beam and two standby. The germanium tunnel diode feeds directly into a Schottky-diode mixer and the down conversion is assisted by a crystal oscillator. After the mixer there is a five-stage preamplifier and a five-stage driver amplifier.

There are eleven receivers altogether for the 6/4 GHz transmissions. Once again each receiver is a low noise amplifier, mixer, preamplifier and driver amplifier. Six of these receivers are standby and one each for the global beam, east and west zones, east and west hemispheric beams. As can be seen in Table 4 the same aerial is used to transmit and receive in the 14/11 GHz band but separate aerials in the 6/4 GHz band. The 6 GHz aerial is a scaled version of the 4 GHz one.

On reception the 6 GHz signal is amplified through four stages of silicon bipolar transistor amplifiers which have response flat to within 0.25dB over a 500MHz bandwidth. The mixer converts the 6 GHz to 4 GHz and feeds it through a four stage preamplifier giving a gain of 27dB, then through a five stage driver amplifier with a gain of 24dB. There is a single-step gain adjustment of 7.5dB which can be switched from the ground.

The signal is then fed through GFRP filters with a Q of approximately 10,000.There are sixty such filters and GFRP is lighter than invar, which is normally used on earth.

Satellite	Height (Span) m	Diameter	Weight kg	Frequency GHz
INTELSAT I				
(Early Bird)	0.59	0.72	38	6/4
INTELSAT II	0.67	0.14	86	6/4
INTELSAT III	1.04	1.42	151	6/4
INTELSAT IV	5.27	2.37	730	6/4
INTELSAT IVA	6.77	2.37	750	6/4
INTELSAT V	(15.8)	—	1012	6/4, 14/11
INTELSAT VI	9	2.37	3675	6/4, 14/11
OTS	(9.3)	—	440	14/11
ECS F1	(13.8)	—	610	14/11
ECS F2	(13.8)	—	680	14/11, 14/12

Table 4 Comparison of different generations of satellites.

Transmit Direction

Global and spot transponders use TWAs (travelling wave amplifiers) with full back up ie one standby for every TWA in use. The other signal paths have two standby TWAs for every three in use. For the 11 GHz path there is a single-path 5dB gain adjustment switchable from the ground.

At 11 GHz, the TWA has a saturated power of 10W and at 4 GHz, 4.5W for the zone beam and 8.5W for the hemispheric beam. Spot beam transponders will have up convertors to convert from 4 GHz to 11 GHz and the other transponders will supply amplification only, since the signal is at the correct frequency for transmission.

From TWAs the signal passes to the aerial via GFRP filters and on INTELSAT IV, the odd and even channels were fed to separate aerials to ease filter design. On INTELSAT V, this separation does not take place so the GFRP filters have to be sharp in cut-off and immune to pick up from adjacent filters.

Next month — a look at the future.

We would like to thank British Telecom Photo Library for the use of their photographs in this article.

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250V
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8n2 to 47nF 8p
56nF to 150nF 12p
100V
100nF to 150nF 13p
180nF to 270nF 16p
330nF to 390nF 25p
470nF to 560nF 32p
680nF 38p
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22nF, 33nF
47nF, 68nF
100nF 7p
150nF, 200nF 10p
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4 7 35V 20p
6 8 25V 20p
6 8 35V 21p
10 16V 18p
10 35V 27p
15 10V 22p
15 16V 30p
15 25V 32p
22 6.3V 26p
22 16V 29p
33 10V 30p
47 3V 14p
47 6.3V 34p
47 16V 39p
100 3V 32p

ELECTROLYTICS

Mainly Matsushita (Panasonic) & Siemens
AXIALS (Wires each end)

uFd	V	
.47	63	8p
47	100	9p
47	350	30p
1	63	8p
1	100	9p
1	500	40p
2.2	25	8p
2.2	63	9p
2 2	100	11p
2 2	350	30p
3 3	25	10p
3 3	40	11p
3.3	63	12p
4.7	16	8p
4 7	25	9p
4 7	40	11p
4 7	63	12p
4 7	100	14p
10	25	8p
10	40	12p
10	63	14p
10	100	16p
10	350	55p
22	25	11p
22	40	14p
22	63	16p
22	100	21p
47	25	14p
47	40	17p
47	63	26p
47	100	28p
100	16	14p
100	25	16p
100	40	22p
100	63	25p
100	100	30p
220	10	16p
220	16	17p
220	25	22p
220	40	25p
220	63	30p
220	100	40p
470	16	22p
470	25	28p
470	40	33p
470	63	43p
470	100	60p
1000	16	30p
1000	25	38p
1000	40	46p
1000	63	65p
2000	16	40p
2200	25	63p
2200	40	70p
2200	63	1 34p
4700	16	75p
4700	25	89p

RADIALS (PCB wires one end) Matsushita only

uFd	V	
10	16	6p
22	10	6p
22	16	7p
47	10	7p
47	16	8p
100	10	9p
100	16	10p
220	10	11p
220	16	12p
470	10	17p
470	16	18p
1000	10	20p
1000	16	24p
2200	10	34p
2200	16	44p
3300	10	50p
3300	16	65p
4700	10	65p
4700	16	95p

74TTL

7400 75p
7401 24p
7402 29p
7403 29p
7404 35p
7405 35p
7406 1 69p
7407 1.69p
7408 35p
7409 35p
7410 35p
7411 35p
7412 35p
7413 35p
7414 55p
7416 1 49p
7417 1 49p
7420 35p
7421 35p
7422 35p
7423 35p
7425 35p
7426 35p
7427 35p
7428 35p
7430 35p
7432 95p
7433 35p
7437 35p
7438 95p
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7454 29p
7460 29p
7470 49p
7472 49p
7473 35p
7474 49p
7475 49p
7476 49p
7480 59p
7481 1 29p
7482 99p
7483 69p
7484 99p
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7489 1 99p
7490 45p
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7497 1 75p
74100 1 39p
74104 59p
74105 59p
74107 45p
74109 45p
74110 69p
74116 1 25p
74118 1.25p
74119 1.25p
74120 1 25p
74121 45p
74122 49p
74123 79p
74125 49p
74126 49p
74128 65p
74132 59p
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74148 99p
74150 1 39p
74151 59p
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74174 89p
74175 69p
74176 69p
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74178 99p
74180 69p
74181 1.59p
74182 69p
74184 1 49p
74185 1 49p
74190 69p
74191 75p
74192 85p
74193 69p
74194 55p
74195 59p
74196 55p
74197 89p
74198 1 50p
74221 1 50p

74LS TTL

74LS00 75p
74LS01 29p
74LS02 29p
74LS03 29p
74LS04 pls ask
74LS05 29p
74LS08 29p
74LS09 29p
74LS10 29p
74LS11 35p
74LS12 35p
74LS13 35p
74LS14 45p
74LS20 29p
74LS21 29p
74LS22 29p
74LS27 35p
74LS28 29p
74LS30 29p
74LS32 pls ask
74LS33 29p
74LS37 29p
74LS38 59p
74LS40 39p
74LS42 45p
74LS47 75p
74LS51 29p
74LS54 29p
74LS55 35p
74LS73 45p
74LS74 59p
74LS75 45p
74LS76 39p
74LS78 45p
74LS83 55p
74LS85 59p
74LS86 39p
74LS90 35p
74LS92 45p
74LS93 35p
74LS95 55p
74LS96 75p
74LS107 45p
74LS109 45p
74LS112 45p
74LS113 39p
74LS114 39p
74LS122 59p
74LS123 1 19p
74LS124 1.55p
74LS125 55p
74LS126 55p
74LS132 49p
74LS133 39p
74LS136 45p
74LS138 89p
74LS139 59p
74LS145 95p
74LS147 1.35p
74LS148 1.25p
74LS151 59p
74LS153 59p
74LS154 2.35p
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74LS160 75p
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74LS163 85p
74LS164 5p
74LS165 99p
74LS168 1.39p
74LS169 1.29p
74LS170 99p
74LS173 99p
74LS174 65p
74LS175 85p
74LS181 1.05p
74LS183 1.45p
74LS190 65p
74LS191 65p
74LS192 65p
74LS193 65p
74LS194 65p
74LS195 65p
74LS196 65p
74LS197 65p
74LS221 1.15p
74LS240 1.99p
74LS241 1.99p
74LS242 1.99p
74LS243 1.99p
74LS244 2.95p
74LS245 3.25p
74LS247 1.99p
74LS248 1.99p
74LS249 1.99p
74LS251 75p
74LS253 75p
74LS257 75p
74LS258 75p
74LS259 1.19p
74LS261 99p
74LS266 55p
74LS273 pls ask
74LS275 1 75p
74LS279 65p
74LS280 1.75p
74LS283 75p
74LS290 75p
74LS293 65p
74LS295 75p
74LS298 75p
74LS299 1.75p
74LS323 2 25p
74LS324 1.75p
74LS325 1 75p
74LS326 2 99p
74LS327 2 99p
74LS347 75p
74LS348 1 75p
74LS352 85p
74LS353 85p
74LS362 1 99p
74LS365 49p
74LS366 49p
74LS367 49p
74LS368 49p
74LS373 2 80p
74LS374 2 80p
74LS378 99p
74LS386 75p
74LS390 75p
74LS393 99p
74LS395 99p
74LS396 2 95p
74LS398 1.29p
74LS399 1 29p
74LS445 99p
74LS490 1 15p
74LS540 1 19p
74LS541 1 45p
74LS640 2 50p
74LS641 2 50p

CMOS

4000 28p
4001 28p
4002 28p
4006 69p
4007 25p
4008 89p
4009 55p
4010 29p
4011 28p
4012 29p
4013 49p
4015 65p
4016 45p
4017 69p
4018 69p
4019 55p
4020 89p
4021 79p
4022 79p
4023 49p
4024 99p
4026 89p
4027 45p
4028 53p
4029 89p
4030 39p
4031 1.60p
4032 89p
4034 1.99p
4035 79p
4036 2.69p
4038 1 19p
4040 72p
4041 72p
4042 72p
4044 72p
4045 1.19p
4046 89p
4047 75p
4048 54p
4049 45p
4050 49p
4051 75p
4052 75p
4053 75p
4054 85p
4056 99p
4059 4.49p
4060 88p
4063 89p
4066 44p
4067 2.79p
4068 31p
4069 31p
4070 31p
4071 31p
4072 31p
4073 31p
4075 31p
4076 85p
4077 31p
4078 31p
4081 31p
4085 59p
4086 69p
4089 1.25p
4093 65p
4094 99p
4095 89p
4096 89p
4098 99p
4099 1 09p
40103 2.59p
4502 59p
4503 59p
4505 3.75p
4507 45p
4508 1.49p
4510 69p
4511 69p
4512 69p
4514 1.25p
4515 1 25p
4516 89p
4518 69p
4519 75p
4520 69p
4521 1.05p
4522 89p
4526 89p
4527 89p
4528 75p
4529 89p
4532 89p
4534 3.95p
4536 2.29p
4538 89p
4543 99p
4553 2 19p
4555 58p
4556 58p
4560 1 79p
4566 1.99p
4569 1 99p
4584 49p
4585 64p

LOGIC

CPUs
1802 6 49p
6502 3.99p
6502A 6 49p
6800 2 75p
6802 2 99p
6809 9 95p
8035 pls ask
8039 pls ask
8080A 3 55p
8085 pls ask
Z80A CPU 3.59p
Z80B CPU 9 45p

MEMORIES
2114 pls ask
2532 4 25p
2564 pls ask
2708 3.95p
2716 (5v) 3.45p
2764 8 99
4116 pls ask
4118 4 39p
4164 4.99p
6116 pls ask
6810 1 95p

MISC LOGIC IC's
ADC0804 pls ask
ADC0816 pls ask
ADC0817 pls ask
INS1771 pls ask
RD2513LC 7.50p
RO2513UC 7 50p
SAA5000 4 05p
SAA5010 7.81p
SAA5012 7 81p
SAA5020 5 95p
SAA5030 6.99p
SAA5040 15 95p
SAA5041 15 95p
SAA5050 8 95p
SAA5070 18.95p
8T26 1 19p
8T28 1 19p
8T95 89p
8T97 99p
81LS95 2 27p
81LS96 2.27p
81LS97 2.27p
81LS98 2 27p
6522 3 69p
6522A 5 55p
6532 6 45p
6821 1 99p
6840 3 75p
6845 6 49p
6847 6 49p
8154 pls ask
8155 pls ask
8212 pls ask
8216 pls ask
8226 pls ask
Z80ACTC 3 49p
Z80ADART 8.39p
Z80APIO 3.45p
ZN425E8 3 49p
ZN426E8 3.10p
ZN427E8 5.99p
ZN428E8 4.55p

V REGS

– Positive – 100mA
78L05A 29p
78L12A 29p
78L15A 29p
78L24A 29p

1 Amp TO202
7805T 45p
7812T 45p
7815T 45p
7824T 45p

– Negative – 100mA TO92
79L05 49p
79L12 49p
79L15 49p

1 Amp TO220
7905T 57p
7912T 57p
7915T 57p
7924T 57p

TRANSISTORS

2N2219 33p
2N2219A 36p
2N2220 33p
2N2221A 33p
2N2222 29p
2N2222A 33p
2N2223 5.85p
2N2223A 6.25p
2N2368 33p
2N2369 34p
2N2369A 35p
2N2904A 35p
2N2905 35p
2N2905A 38p
2N2906 35p
2N2907 35p
2N2907A 38p
2N2926 13p
2N3053 35p
2N3054 65p
2N3055 65p
2N3055H 1.89p
2N3439 1 15p
2N3440 99p
2N3441 1 49p
2N3442 1 59p
2N3638 62p
2N3702 16p
2N3703 16p
2N3704 16p
2N3705 16p
2N3706 16p
2N3707 16p
2N3708 16p
2N3709 31p
2N3710 34p
2N3711 37p
2N3773 2 09p
2N3819 55p
2N3902 6 88p
2N3903 19p
2N3904 19p
2N3905 19p
2N3906 19p
2N4030 88p
2N4031 82p
2N4032 87p
2N4036 72p
2N4037 66p
2N4400 19p
2N4401 33p
2N4402 37p
2N4902 2 25p
2N4903 2 38p
2N4904 2.46p
2N4905 2 99p
2N4906 3.09p
2N4907 3 42p
2N4908 3 58p
2N4909 3 15p
2N5089 43p
2N5190 75p
2N5191 79p
2N5192 99p
2N5194 83p
2N5245 46p
2N5246 59p
2N5247 63p
2N5248 65p
2N5249 67p
2N5262 3.25p
2N5401 57p
2N5415 1 36p
2N5416 1 73p
2N5447 29p
2N5448 31p
2N5449 27p
2N5450 63p
2N5451 66p
2N5457 39p
2N5458 39p
2N5459 31p
2N5460 83p
2N5551 41p
2N6121 91p
2N6122 93p
2N6123 99p
2N6124 1 01p
2N6125 1 03p
2N6126 1 09p
2N6129 99p
2N6130 1 05p
2N6131 1 23p
2N6132 1 09p
2N6133 1 15p
2N6134 1 33p
2N6253 1 63p
2N6254 1.77p
2SC1306 99p
3N201 1.99p
40361 75p
40362 75p
40363 3.99p
40406 1.75p
40408 1.75p
40410 1 99p
40411 3.99p
40673 1.49p
40822 1 99p
AC125 99p
AC126 35p
AC127 35p
AC128 39p
AC141K 39p
AC142K 39p
AC151 77p
AC152 77p
AC153 77p
AC153K 87p
AC176 39p
AC176K 49p
AC187 39p
AC188 39p
AC187K 49p
AC188K 49p
BC107 17p
BC107A 17p
BC107B 17p
BC108 16p
BC108A 17p
BC108B 18p
BC108C 20p
BC109 17p
BC109B 18p
BC109C 21p
BC140 38p
BC141 43p
BC142 39p
BC147 15p
BC147A 16p
BC147B 17p
BC147C 27p
BC148 15p
BC148A 17p
BC148B 19p
BC148C 25p
BC149 16p
BC149B 19p
BC149C 26p
BC157 39p
BC157A 41p
BC157B 44p
BC158A 37p
BC158B 39p
BC159 44p
BC159A 45p
BC159B 46p
BC159C 48p
BC160 55p
BC161 59p
BC167 15p
BC169 19p
BC169B 19p
BC169C 23p
BC177 29p
BC177A 33p
BC177B 36p
BC178 29p
BC178A 33p
BC178B 36p
BC179 31p
BC179B 38p
BC179C 41p
BC182 15p
BC182A 17p
BC182B 19p
BC182L 15p
BC182LA 17p
BC182LB 19p
BC183 14p
BC183A 17p
BC183B 19p
BC183C 25p
BC183L 15p
BC183LA 16p
BC183LB 18p
BC183LC 23p
BC184 16p
BC184B 19p
BC184C 24p
BC186 29p
BC187 29p
BC212 16p
BC212A 18p
BC212B 21p
BC213 17p
BC213A 18p
BC213B 19p
BC213C 24p
BC213L 15p
BC213LA 16p
BC213LB 19p
BC213LC 23p
BC214 18p
BC214B 22p
BC214C 27p
BC214L 16p
BC214LB 21p
BC214LC 25p
BC300 59p
BC301 59p
BC302 59p
BC303 59p
BC307 16p
BC327A 19p
BC327B 19p
BC327C 25p
BC440 35p
BC441 37p
BC460 42p
BC461 45p
BC547 19p
BC550C 29p
BC560C 29p
BCY70 31p
BCY71 33p
BCY72 25p
BD124 2 99p
BD131 63p
BD135 38p
BD136 38p
BD137 39p
BD138 39p
BD139 42p
BD140 42p
BD239A 65p
BD239C 69p
BD240A 68p
BD240C 79p
BD241A 72p
BD241C 79p
BD242A 75p
BD242C 79p
BD243A 85p
BD243C 89p
BD244A 88p
BD244C 1 15p
BD245A 1 19p
BD245C 1 49p
BD246A 1.39p
BD246C 1.67p
BD249A 2 30p
BD249C 2 57p
BD250A 2.48p
BD250C 2.75p
BD529 1 95p
BD535 89p
BD536 89p
BD537 97p
BD538 97p
BD539 1 08p
BD539C 1.33p
BD540 1.04p
BD540C 1.39p
BDX66B 6.35p
BDX67B 6.35p
BDY54 2 28p
BDY55 2.39p
BDY56 1.99p
BDY57 5 91p
BDY58 6.33p
BF194 18p
BF195 18p
BF196 18p
BF197 18p
BF198 18p
BF199 18p
BF200 79p
BF244A 61p
BF244B 55p
BF245A 63p
BF245B 66p
BF246 77p
BF246A 79p
BF246B 79p
BF247A 79p
BF247B 79p
BF254 66p
BF255 68p
BF256A 59p
BF256B 59p
BF256C 69p
BF257 39p
BF258 41p
BF259 45p
BF457 48p
BF458 59p
BF459 65p
BFR39 pls ask
BFR40 pls ask
BFR41 pls ask
BFR79 pls ask
BFR80 pls ask
BFR81 pls ask
BFR90 2 25p
BFS61 99p
BFS98 99p
BFX29 44p
BFX30 46p
BFY53 53p
BSX19 29p
BSX20 33p
BSX21 49p
BU104 2 32p
BU105 1 89p
BU108 2 49p
BU109 2.49p
BU126 1 55p
BU204 2 49p
BU205 1 99p
BU206 2 16p
BU208 1 93p
BU226 4.45p
BU326S 2.63p
BU406 1 45p
BU407 1 58p
BU408 1.49p
BU409 1 65p
BU500 3.56p
BUY18S 4 33p
E430 6 32p
J300 88p
J310 88p
MJ802 4 25p
MJ900 3.21p
MJ901 3.39p
MJ1000 2 76p
MJ1001 3.26p
MJ1800 3 79p
MJ2500 7 39p
MJ2501 2 63p
MJ2955 99p
MJ3000 2 39p
MJ3001 2.63p
MJ4502 4 25p
MJE340 75p
MJE350 1.49p
MJE2955 1 99p
MJF2955T 95p
MJE3055 1 59p
MJE3055T 69p
MPSA05 29p
MPSA06 33p
MPSA10 59p
MPSA12 49p
MPSA14 49p
MPSA20 49p
MPSA42 49p
MPSA43 48p
MPSA55 29p
MPSA56 33p
MPSA65 62p
MPSA66 65p
MPSA70 49p
MPSA92 49p
MPSA93 48p
MPSL01 69p
MPSL51 75p
MPS405 89p
MPSU06 99p
MPSU07 1 75p
MPSU51 1 29p
MPSU56 1 22p
MPSU57 1 95p
TIP29A 35p
TIP29C 42p
TIP30A 37p
TIP30C 44p
TIP31A 39p
TIP31C 47p
TIP32A 46p
TIP32C 49p
TIP33A 69p
TIP33C 83p
TIP34A 1.19p
TIP34C 1.26p
TIP35A 1.26p
TIP35C 1 39p
TIP36A 1.42p
TIP36C 1 49p
TIP41A 52p
TIP41C 58p
TIP42A 62p
TIP42C 65p
TIP49 1 29p
TIP50 1 52p
TIP53 1 58p
TIP54 1 65p
TIP110 79p
TIP112 85p
TIP115 89p
TIP117 1 05p
TIP120 79p
TIP122 85p
TIP127 99p
TIP130 1.06p
TIP132 1 09p
TIP135 1 16p
TIP137 1.19p
TIP140 1 21p
TIP142 1.22p
TIP145 1.21p
TIP147 1 22p
TIP162 4.99p
TIP2955 81p
TIP3055 79p
TIS43 61p
VN10KM 69p
VN46AF 1.15p
VN66AF 1 09p
ZTX107 12p
ZTX108 13p
ZTX109 14p
ZTX300 12p
ZTX301 16p
ZTX302 17p
ZTX303 25p
ZTX304 18p
ZTX310 39p
ZTX311 36p
ZTX312 39p
ZTX313 41p
ZTX314 27p
ZTX320 37p
ZTX330 39p
ZTX341 31p
ZTX450 41p
ZTX500 15p
ZTX501 15p
ZTX502 15p
ZTX503 18p
ZTX504 19p
ZTX510 28p
ZTX531 29p
ZTX650 47p
ZTX651 48p
ZTX652 49p
ZTX653 50p
ZTX750 47p
ZTX751 48p
ZTX752 49p
ZTX753 50p

DIODES

IN34A 52p
IN821 70p
IN823 92p
IN914 4p
IN916 6p
IN4001 4p
IN4002 4½p
IN4003 5p
IN4004 5½p
IN4005 6p
IN4006 6½p
IN4007 7p
IN4009 20p
IN4148 3p
IN4150 18p
IN4448 22p
IN5400 12p
IN5401 13p
IN5402 14p
IN5404 16p
IN5406 18p
IN5407 19p
IN5408 20p
BA102 49p
BA115 29p
BA133 51p
BA138 36p
BA142 25p
BA155 18p
BA156 41p
BA157 28p
BA158 34p
BA159 38p
BA182 49p
BA201 23p
BA202 29p
BA316 27p
BA317 28p
BA318 31p
BAX13 21p
BB105 65p
BB109G 69p
BY126 12p
BY127 14p

SCR's TRIACS DIACS

THYRISTORS 4.8 & 12 Amps Texas T0220
Suffix A = 100V
B = 200V
C = 300V
D = 400V
M = 600V

4A
TIC106A 49p
TIC106B 51p
TIC106C 53p
TIC106D 55p
TIC106M 72p
8A
TIC116A 69p
TIC116B 72p
TIC116C 75p
TIC116D 78p
TIC116M 84p
12A
TIC126A 74p
TIC126B 75p
TIC126C 76p
TIC126D 79p
TIC126M 99p

TRIACS Texas 400V TD220 Case
TIC206D(4A) 69p
TIC225D(6A) 79p
TIC226D(8A) 92p
TIC236D(12A) 1 25p
TIC246D(16A) 1.35p
TIC253D(20A) 1.99p
TIC263D(25A) 2 25p

DIACS
BR100 29p
ST2 29p

ZENER'S

many inc specials see our CAT
400 to 500mW E24 Series
2.4 to 47V 7p

1 3 Watt E24 Series
3 3 to 82V 14p

BRIDGE

(PIV shown in brackets)

1½ amp type
W01(100) 28p
WO2(200) 34p
WO4(200) 38p
WO8(800) 50p

2 amp type Square with hole
S01(100) 48p
S02(200) 50p
S04(400) 55p
S08(800) 66p

6 amp type Square with hole
PW01(100) 95p
PW02(200) 99p
PW04(400) 1.30p
PW06(600) 1.39p

25 amp type Metal clad with hole
K01(100) 2.62p
K02(200) 2 75p
K04(400) 3.25p
K06(600) 4.10p
BYW64
35A 400V 4.50p

OPTO

many inc specials see our CAT

LED LAMPS
R = Red
G = Green
Y = Yellow

Large diffused 1 +
R5D 10p
G5D 16p
Y5D 15p

Small diffused
R3D 8p
G3D 13p
Y3D 13p

Micro 0 1"
RIM 27p
GIM 29p
YIM 29p

Large clear
R5C 12p
G5C 17p
Y5C 17p

Super bright high efficiency Large (100 times brighter)
R5U 42p
G5U 47p
Y5U 47p

Rectangular Stackable LEDs
R5R 19p
G5R 20p
Y5R 22p

LIN ICs

AY15050 99p
AY38910 3 99p
AY38912 4.95p
CA3048 2.15p
CA3059 3.29p
CA3090AO 3.70p
CA3130E 87p
CA3130T 2.35p
CA3140E 54p
CA3140T 1.40p
HA1366W 2.40p
HA1388 2.54p
ICL7106 7.50p
ICL7107 9 50p
ICL7611 97p
ICL8038 2 99p
ICM7555 1.10p
ICM7556 1.49p
LC7120 3 20p
LC7130 3.40p
LC7137 3.95p
LF347 1.50p
LF351 59p
LF353 1 05p
LF355 83p
LF356 99p
LF357 1 30p
LF398 4.62p
LM335Z 1.60p
LM348N 62p
LM349N 1.09p
LM350K 4.89p
LM379S 5.50p
LM380N14 pls ask
LM380N8 pls ask
LM381AN 2.26p
LM381N 1.40p
LM382N 1 22p
LM383T 3.40p
LM384N 1 40p
LM386N 1.20p
LM388N 2.43p
LM391N60 2.25p
LM391N80 1.65p
LM723CH 99p
LM723CN 49p
LM725CH 3.40p
LM725CN 3.19p
LM741CH 96p
LM741CN 19p
LM741CN14 80p
LM747CN 69p
LM748CH 1.00p
LM748CN 42p
LM1871 3.25p
LM1872 4.39p
LM1877 5.95p
LM1886 7.44p
LM1889 3.77p
LM2907N 2.75p
LM2907N8 2.60p
LM2917N 2.40p
LM2917N8 2.40p
LM3900 62p
LM3911 1.45p
LM3914 3.25p
LM3915 3.25p
LM13600 1.15p
MF10 3.75p
NE531N 1.36p
NE543N 2 50p
NE544N 1.95p
NE555 22p
NE556 65p
NE558 1.89p
NE560 3 25p
NE565 1.18p
NE566 1.49p
NE567 1.37p
NE570 4.07p
NE571 3.99p
NE5534A 1 95p
RC4194 3.95p
RC4195 2.95p
RC4558 44p
SN76477 7.95p
SN76003 3.45p
SN76013 3.45p
SN76023 3 45p
SN76033 3.45p
TA7204 1 99p
TA7205 1 20p
TA7222 1.75p
TA7227 5.82p
TBA500 2.97p
TBA500Q 3.11p
TBA510 2.95p
TBA510Q 3 05p
TBA520 2.57p
TBA520Q 2 75p
TBA530 2.55p
TBA530Q 2.76p
TBA540 2.72p
TBA540Q 2.74p
TBA550 3.25p
TBA550Q 3 27p
TBA560C 2 87p
TBA570 2 37p
TBA570Q 2.48p
TDA1002 3.39p
TDA1003 4.35p
TDA1004 P.O.A.
TDA1004A 5.45p
TDA1005 4.35p
TDA1010A 2.25p
TDA1022 4.95p
TDA2002 3.25p
TDA2003 3.25p
TDA2020 3.15p
TDA2030 2.85p
TDA2611A 2.50p
TDA7000 3.45p
TL061 51p
TL062 77p
TL064 1.50p
TL071 47p
TL072 62p
TL074 1.50p
TL081 47p
TL082 55p
TL084 1.20p
UAA170 2.49p
UAA180 2 49p
ULN2003 75p
UPC575C2 2.00p
UPC1156 2.75p
UPC1156H 2.75p
UPC1182 3.75p
UPC1185 1.95p
UPC2002 2.95p
XR2206 3.95p
ZN409 2.25p
ZN414 1.00p
ZN1034 1.99p

TRANS-FORMERS

Post inclusive prices cheaper to callers.
All 240V Primary Split Bobbin
100mA
6-0-6 1 50p
9-0-9 1,70p
12-0-12 1 85p
15-0-15 1.95p
1A as above 3.75p
20 0 20V 0.125A 3 75p
12.0 12V 50VA 7.95p
12.0 12V 100VA 11.99p
0 + 6 + 6 + 9 + 9 1.25A 5 65p

VERO

0 1" COPPER TRACKS
2.5 × 3.75 95p
2.5 × 5 1.08p
3.75 × 3.75 1.09p
3.75 × 5 1.23p
2.5 × 17 3.27p
3.75 × 17 4.29p
4.79 × 17 5.99p
VQ Board 2.10p
DIP Board 3.95p
Track Cutter 1.63p
Pin insertor 2.21p
100 Pins 61p
Verobloc 4.66p
Vero Wiring Pen & Spool 3.39p
Spare Spool 75p
Combs 6p

PCB

FERRIC CHLORIDE
Quick dissolving Enough to make over 1 litre 1.69p
ETCH RESIST TRANSFERS
1 Thin lines
2 Thick lines
3 Thin bends
4 Thick bends
5 DIL pads
6 Transistor pads
7 Dots & holes
8 0.1" edge connectors
9 Mixture
Any sheet of above 39p
GRADE ONE GLASS PCB SINGLE-SIDED
178 × 240mm 1.50p
420 × 195mm 1.95p
420 × 245mm 2.95p
DALO ETCH RESIST PEN + spare nib 1.29p
PHOTO SENSITIVE PCB
1st Class Epoxy Glass for better results than spraying expose to UV
Single sided
100 × 160 2.10p
100 × 220 2.50p
203 × 114 2.40p
233 × 220 5.20p
Double sided
100 × 160 2.20p
100 × 200 2.80p
203 × 114 2 20p
233 × 220 5.90p
Developer for above (do not use Sodium Hydroxide)
500ml 2.95p

WIRE

PRICES PER METRE
Solid connecting wire
MAINS SPEAKER
Twin 1 Amp 14p
Twin 2½ Amp 16p
3 Core 2½ Amp 18p
3 Core 13 Amp 66p
SCREENED
Single 14p
Stereo 27p
Mini Single 12p
Mini Stereo 15p
4 Core 4 screens 44p
4 Core single screen 54p
8 Core 61p
12 Core 60p
Heavy Duty Mike/Guitar Lead 25p
AERIAL
50Ω RG58A 25p
75Ω UHF 29p
75Ω VHF 28p
300Ω Flat 14p
RAINBOW RIBBON
Prices per foot
10 way 25p
16 way 39p
20 way 48p
24 way 62p
30 way 75p
34 way 82p
40 way 88p
64 way 1.49p

RECHARGE BATTERIES

Top quality Don't throw these batteries away – they charge up to 1000 times!
HP2(1.2AH) 2.39p
HP2(4AH) 4.75p
HP7(½AH) 99p
HP11(1.2AH) 2.29p
PP3(110mAH) 4.95p
Chargers
TYPE H: Adjusted to 6 of any HP type
Above 15.59p
TYPE M: As above but faster charge for 4AH 25 95p
TYPE P: PP3 5.50p
TYPE A: HP7(Up to 4 at a time) 5.85p

SOLDER

ANTEX SOLDERING IRONS
C240(15W) 5.20p
XS240(25W) 5.40p
Iron Stand 1.75p
Elements (State Iron) 2.05p
C240 Bits
No2 (Small) 85p
No3 (Med) 85p
No6 (Micro) 85p
XS240/X25 Bits
No50 (Small) 85p
No51 (Med) 85p
No52 (Lge) 85p
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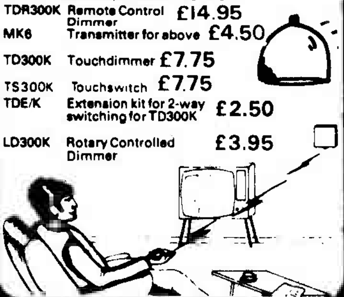

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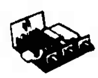

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KEYBOARD INTERFACE

Following on from our typewriter interface, here's a project that allows you to make use of the (rather nice) keyboard of the EX42 typewriter for input into your micro! Design and development by Jon Tyler.

Following my article describing the typewriter interface for the Silver Reed EX42 (ETI October 1983) I have had a number of requests to design a similar interface to allow the keyboard of the typewriter to be used as an input peripheral for a microcomputer. Certainly, for the 'home brew' micro builder, the terminal is about the most expensive component. If it is built using a domestic TV and a video modulator, you still need a keyboard and the total cost is still fairly high. A solution to part of this problem is described here and a typical system is shown in Fig. 1.

Using the keyboard as an additional input peripheral may also appeal to the owners of commercial micros such as the Spectrum which do not have a conventional typewriter keyboard layout. In this case, the interface connection details depend very much on the individual micro so a general purpose serial or parallel interface is described here. You will need to provide a suitable input port to the micro being used.

The keyboard layout of the Silver Reed EX42 is a fairly standard typewriter layout but with some additional keys. This means that it will not conform exactly to any particular keyboard interface chip. The manufacturers use an Intel 8049 microcontroller with proprietary software. This article describes the use of a readily available keyboard encoder chip, the KR2376, together with a decoder to convert the output codes into standard ASCII codes for the micro. The decoder may be implemented in hardware or software and both will be described.

The connections to the keyboard are in the form of one 10-way and one 15-way ribbon cable connector and these give access to the 8 x 8 array of keyswitches as shown in Fig. 2.

Construction

The prototype was constructed in a plastic box measuring about 5" by 3" by 1½". Connections are taken from the interface to the typewriter in the form of a 26-way ribbon cable. The typewriter keyboard is connected to the typewriter electronics by means of single-in-line ribbon cable connectors. To make connection into the sockets a home made connector constructed from a strip of Vero board and some wire wrap pins was used. Fig. 3 shows how these are connected to the keyboard. Note that the 26th way of the ribbon cable is connected to ground via a solder tag. A suitable point exists on the typewriter PCB

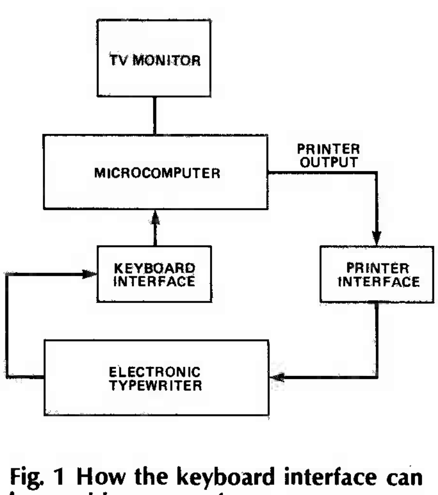


Fig. 1 How the keyboard interface can be used in your system.

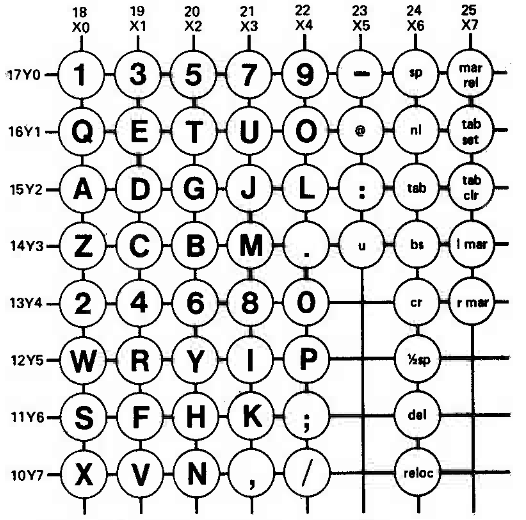


Fig. 2 The keyboard matrix layout.

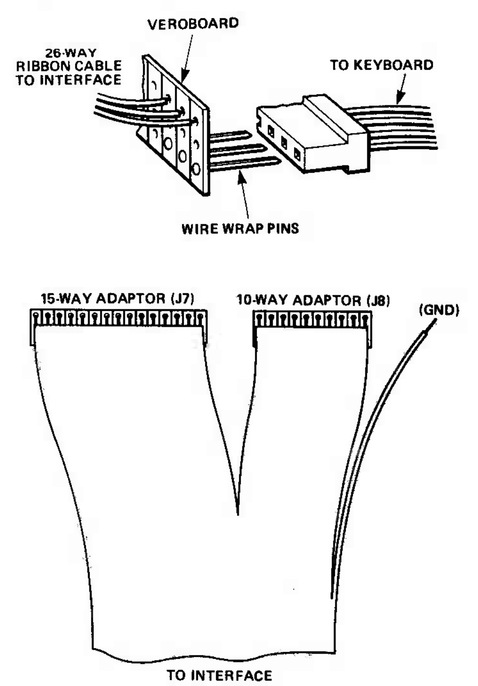
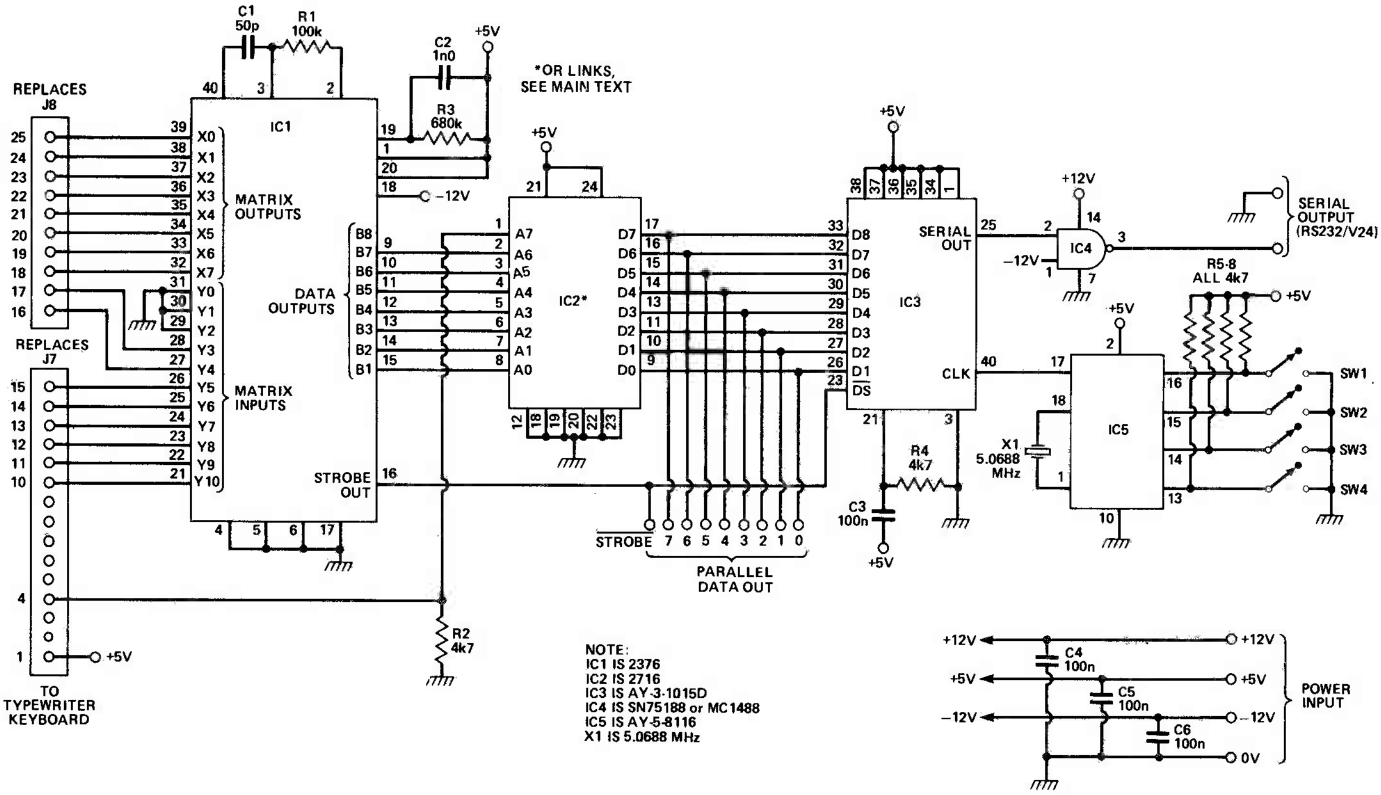


Fig. 3 Construction of the adaptors and fitting to keyboard connectors in place of J7 and J8.

Fig. 4 Circuit diagram for the keyboard interface.



HOW IT WORKS

The keyboard encoder IC (IC1) is designed to interface with a 11 x 8 array of keyswitches conforming to a particular layout. The device translates the key closure, together with the levels from the shift and control inputs, into an 8-bit ASCII code. When connected as suggested (Fig. 4.) a different set of codes are produced as the key intersections do not conform to the ones assumed by the IC manufacturers. The IC comprises two counter-decoder sections, a comparator, timing circuits and ROM encoder.

When a switch is closed, a single path is created between one of the counter outputs and one of the comparator inputs. After a time the two inputs to the comparator will match, one coming from the keyboard and the other from the second counter. A key bounce delay network is then enabled which checks to see if the key is still depressed at the end of the delay time. If it is, then the corresponding position code is used as the input to the ROM which outputs a specific code.

This code will not be correct for the reasons already mentioned, and therefore it has to be converted to ASCII. This can be done in hardware or software. If the hardware option is chosen, the output from the keyboard interface IC is passed to a 2716 EPROM (IC2) which is programmed according to the data in Table 1. The device translates the codes into ASCII codes which appear on the eight output lines.

If the software option is chosen, then the conversion is done after the information is accepted by the microcomputer. It is likely that this will be a machine code program and thus dependent on the micro used. However, to assist in the writing of the program, a BASIC test program is given in Fig. 5. This was written for a Z80 based micro in Micropolis BASIC but it should be easy to modify to suit other dialects of BASIC. The port numbers will of course have to be modified to suit the particular input port decoding used.

The fact that a key has been pressed is noted by IC1 and the STROBE output (pin 16) becomes active. This remains active during the time the key is pressed. In the case of a parallel interface, this may be used to strobe the data into a suitable port on the micro. If the serial interface is required, then this signal is used to strobe data into the input buffer of the UART (IC3). The UART converts the eight-bit parallel data into an asynchronous data stream, which is then converted from TTL levels to RS232/V24 levels by means of the line driver IC (IC4). The particular baud rate to be used is generated by the baud rate generator, IC5. The inputs to pins 13,14,15 and 16 determine the baud rate and the relationship is shown in Table 2. The baud rate used must correspond to the baud rate of the microcomputer serial interface.

marked 'GND'.

The typewriter cover is removed by unscrewing the two grub screws at either end of the platten (roller) using an Allen key. Then the platten is removed by pulling the two platten knobs out at either end and lifting out the platten and the paper pan below it. Unscrewing the four screws underneath the typewriter body then allows the top cover to be removed. The keyboard may then be released from its clips and turned upside down to gain access to the ribbon cable connectors. These are then unplugged and connected to the interface cable. Note that the interface must not be connected in parallel with the typewriter electronics, although the interface to the printer mechanism (October 1983 ETI) can be used with the keyboard interface described here also.

There are various options available in the circuit, and you can select software code conversion, EPROM code conversion, and serial or parallel code output. The most basic option is that of software code conversion, and for this only IC1 and associated passive components are needed: in this case, it is probably not worth using the special PCB. However, if you do use the PCB, and you would like to retain the possibility of going over to EPROM conversion in future, then we suggest that you install an IC socket and header plug for IC2, and link the following pins on the header socket: pins 1 and 17; 2 and 16; 3 and 15; 4 and 14; 5 and 13; 6 and 11; 7 and 10;and 8 and 9.

To use EPROM code conversion, you will need to program a suitable EPROM according to

ch	(a) loc	(a) cont	(b) loc	(b) cont
/	00	2F	000	047
	01	00	001	000
	02	00	002	000
	03	00	003	000
	04	00	004	000
,	05	2C	005	044
3	06	33	006	051
K	07	4B	007	075
4	08	34	008	052
8	09	38	009	056
	0A	00	010	000
E	0B	45	011	069
6	0C	36	012	054
D	0D	44	013	068
R	0E	52	014	082
	0F	00	015	000
	10	00	016	000
J	11	4A	017	074
U	12	55	018	085
	13	00	019	000
	14	00	020	000
	15	00	021	000
	16	00	022	000
5	17	35	023	053
T	18	54	024	084
G	19	47	025	071
C	1A	43	026	067
B	1B	42	027	066
I	1C	49	028	073
M	1D	4D	029	077
Y	1E	59	030	089
	1F	00	031	000
9	20	39	032	057
S	21	53	033	083
0	22	30	034	048
X	23	58	035	088
.	24	2E	036	046
	25	00	037	000
	26	00	038	000
	27	00	039	000
	28	00	040	000
	29	00	041	000
	2A	00	042	000
	2B	00	043	000
	2C	00	044	000
	2D	00	045	000
	2E	00	046	000
	2F	00	047	000
	30	00	048	000
	31	20	049	032
	32	0A	050	010
	33	00	051	000
	34	00	052	000
	35	00	053	000
	36	00	054	000
	37	00	055	000
	38	00	056	000
	39	00	057	000
	3A	00	058	000
	3B	00	059	000
	3C	00	060	000
	3D	00	061	000
	3E	00	062	000
O	3F	4F	063	079

ch	(a) loc	(a) cont	(b) loc	(b) cont
	40	00	064	000
	41	00	065	000
	42	00	066	000
:	43	3A	067	058
	44	00	068	000
	45	00	069	000
	46	00	070	000
	47	00	071	000
	48	00	072	000
1	49	31	073	049
Q	4A	51	074	081
A	4B	41	075	065
Z	4C	5A	076	090
2	4D	32	077	050
W	4E	57	078	087
	4F	00	079	000
	50	00	080	000
	51	00	081	000
	52	00	082	000
7	53	37	083	055
	54	00	084	000
	55	00	085	000
	56	00	086	000
	57	00	087	000
	58	00	088	000
	59	00	089	000
	5A	00	090	000
	5B	00	091	000
	5C	00	092	000
	5D	00	093	000
	5E	00	094	000
	5F	00	095	000
@	60	40	096	064
-	61	2D	097	045
	62	00	098	000
	63	00	099	000
N	64	4E	100	078
	65	00	101	000
	66	7F	102	127
	67	00	103	000
	68	0D	104	013
	69	00	105	000
	6A	00	106	000
	6B	00	107	000
	6C	00	108	000
	6D	00	109	000
	6E	00	110	000
	6F	00	111	000
	70	00	112	000
	71	00	113	000
P	72	50	114	080
H	73	48	115	072
V	74	56	116	086
;	75	3B	117	059
F	76	46	118	070
L	77	4C	119	076
	78	00	120	000
	79	00	121	000
	7A	00	122	000
	7B	00	123	000
	7C	00	124	000
	7D	00	125	000
	7E	00	126	000
	7F	00	127	000

ch	(a) loc	(a) cont	(b) loc	(b) cont
?	80	3F	128	063
	81	00	129	000
	82	00	130	000
	83	00	131	000
	84	00	132	000
,	85	2C	133	044
£	86	24	134	036
k	87	6B	135	107
£	88	24	136	036
(	89	28	137	040
	8A	00	138	000
e	8B	65	139	101
&	8C	26	140	038
d	8D	64	141	100
r	8E	72	142	114
	8F	00	143	000
	90	00	144	000
j	91	6A	145	106
u	92	75	146	117
	93	00	147	000
	94	00	148	000
	95	00	149	000
	96	00	150	000
%	97	25	151	037
t	98	74	152	116
g	99	67	153	103
c	9A	63	154	099
b	9B	62	155	098
i	9C	69	156	105
m	9D	6D	157	109
y	9E	79	158	121
	9F	00	159	000
)	A0	29	160	041
s	A1	73	161	115
=	A2	3D	162	061
x	A3	78	163	120
.	A4	2E	164	046
	A5	00	165	000
	A6	00	166	000
	A7	00	167	000
	A8	00	168	000
	A9	00	169	000
	AA	00	170	000
	AB	00	171	000
	AC	00	172	000
	AD	00	173	000
	AE	00	174	000
	AF	00	175	000
	B0	00	176	000
	B1	20	177	032
	B2	0A	178	010
	B3	00	179	000
	B4	00	180	000
	B5	00	181	000
	B6	00	182	000
	B7	00	183	000
	B8	00	184	000
	B9	00	185	000
	BA	00	186	000
	BB	00	187	000
	BC	00	188	000
	BD	00	189	000
	BE	00	190	000
o	BF	6F	191	111

ch	(a) loc	(a) cont	(b) loc	(b) cont
	C0	00	192	000
#	C1	23	193	035
	C2	00	194	000
*	C3	2A	195	042
	C4	00	196	000
	C5	00	197	000
	C6	00	198	000
	C7	00	199	000
	C8	00	200	000
!	C9	21	201	033
q	CA	71	202	113
a	CB	61	203	097
z	CC	7A	204	122
"	CD	22	205	034
w	CE	77	206	119
	CF	00	207	000
	D0	00	208	000
	D1	00	209	000
	D2	00	210	000
'	D3	27	211	039
	D4	00	212	000
	D5	00	213	000
	D6	00	214	000
	D7	00	215	000
	D8	00	216	000
	D9	00	217	000
	DA	00	218	000
	DB	00	219	000
	DC	00	220	000
	DD	00	221	000
	DE	00	222	000
	DF	00	223	000
	E0	00	224	000
_	E1	5F	225	095
	E2	00	226	000
	E3	00	227	000
n	E4	6E	228	110
	E5	00	229	000
	E6	7F	230	127
	E7	00	231	000
	E8	0D	232	013
	E9	00	233	000
	EA	00	234	000
	EB	00	235	000
	EC	00	236	000
	ED	00	237	000
	EE	00	238	000
	EF	00	239	000
	F0	00	240	000
	F1	00	241	000
p	F2	70	242	112
h	F3	68	243	104
v	F4	76	244	118
+	F5	2B	245	043
f	F6	66	246	102
l	F7	6C	247	108
	F8	00	248	000
	F9	00	249	000
	FA	00	250	000
	FB	00	251	000
	FC	00	252	000
	FD	00	253	000
	FE	00	254	000
	FF	00	255	000

Table 1 EPROM contents in hexadecimal (a) and decimal (b)

Table 1 and insert it into the IC2 position. Owners of the EX44 may wish to include the characters <and > and to do this you must alter the contents of locations 133 and 164 to 194 and 196 respectively (addresses and data in decimal). The STROBE line is low while any key is pressed.

To use the serial interface option, IC3, 4 and 5 must be installed, along with the associated passive components. The four DIL switches, SW1 - 4, are used to set the transmission speed, and could be replaced with links if the interface will be required to operate at only one speed. Table 2 shows the appropriate switch (or link) settings.

It is assumed that the power supplies (+12V −12V and +5V)

SW1	SW2	SW3	SW4	Baud rate
0	1	0	0	110
1	0	1	0	300
0	1	1	0	600
1	1	1	0	1200
0	1	0	1	2400
0	0	1	1	4800
0	1	1	1	9600

Note 1 = open.

Table 2 Baud rate switch settings.

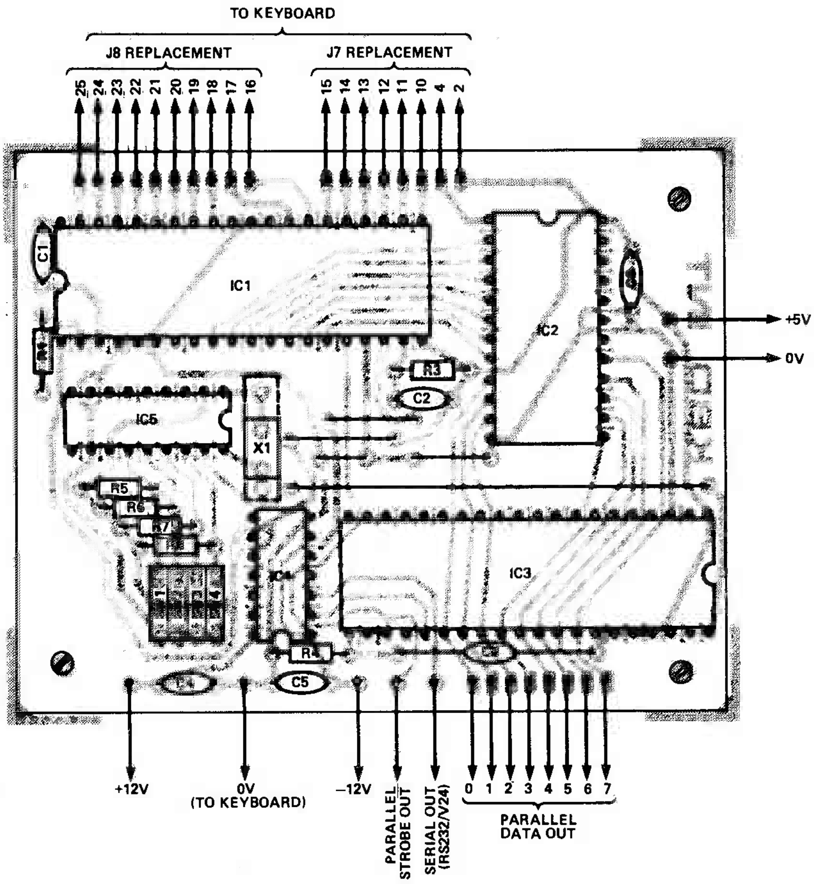


Fig. 5 Overlay diagram for the PCB.

may be obtained from the microcomputer. The keyboard encoder requires about 12mA at −12V and 12mA at 5V, the EPROM requires about 60mA at 5V and the UART typically 10mA at 5V. The baud rate generator takes up to about 50mA.

PARTS LIST

RESISTORS (all ¼W 5%)

R1	100k
R2,4,5-8	4k7 (6 off)
R3	680k

CAPACITORS

C1	50p (or 47p)
C2	1n0
C3-6	100n (4 off)

SEMICONDUCTORS

IC1	KR2376-ST (or AY-5-2376)
IC2	2716 EPROM, programmed
IC3	AY-3-1015D
IC4	SN75188 or MC1488
IC5	AY-5-8116

MISCELLANEOUS

X1	5.0688 MHz crystal
SW1-2	DIL switches or links as required.

Connectors (see text); IC sockets as required (2 off 40 pin, 1 off 24 pin, 1 off 14 pin, 1 off 18 pin); 24 pin header plug if required (see text); wire-wrap pins and veroboard for input connectors (see text); PCB, ribbon cable, box to suit, wire, etc.

BUYLINES

IC1 (KR2376-ST), IC3 (AY-3-1015D), IC4 (SN75188) and IC5 (AY-5-8116) are all available from Technomatic, and some of these are also available from other sources as well; Crystal X1 (5.0688 MHz) is available from Cricklewood Electronics for £2.95 + 60p p&p + VAT. The PCB is available from the ETI PCB service.

```
10  rem keyboard decoder test program
20  rem uses port 8A(hex) bit 3 as a status port
30  rem and port 89(hex) as data port (both input)
40  rem alter these to suit microcomputer used.
50  dim d(256)          : rem initialise decoder array
60  for n=0 to 255
70   read d(n)
80  next n
90  x=inp(138)          : rem input status bit
100 x=int(x/8) mod 2    : rem isolate bit 3
110 if x=0 goto 90
120 y=inp(137)          : rem input data byte
130 print char£(d(y));
140 goto 90
150 data 47, 0, 0, 0, 0, 44, 51, 75, 52, 56, 0, 69, 54, 68, 82, 0, 0, 74, 85, 0, 0, 0
160 data 0, 53, 84, 71, 67, 66, 73, 77, 89, 0, 57, 83, 48, 88, 46, 0, 0, 0, 0, 0, 0
170 data 0, 0, 0, 0, 0, 0, 32, 10, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 79
180 data 0, 0, 0, 58, 0, 0, 0, 0, 0, 49, 81, 65, 90, 50, 87, 0, 0, 0, 0, 55, 0, 0
190 data 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 64, 45, 0, 0, 78, 0, 127, 0, 13, 0, 0
200 data 0, 0, 0, 0, 0, 0, 0, 80, 72, 86, 59, 70, 76, 0, 0, 0, 0, 0, 0, 0, 0
210 data 63, 0, 0, 0, 0, 44, 36, 107, 36, 40, 0, 101, 38, 100, 114, 0, 0, 106, 117, 0, 0, 0
220 data 0, 37, 116, 103, 99, 98, 105, 109, 121, 0, 41, 115, 61, 120, 46, 0, 0, 0, 0, 0, 0
230 data 0, 0, 0, 0, 0, 0, 32, 10, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 111
240 data 0, 35, 0, 42, 0, 0, 0, 0, 0, 33, 113, 97, 122, 34, 119, 0, 0, 0, 0, 39, 0, 0
250 data 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 95, 0, 0, 110, 0, 127, 0, 13, 0, 0
260 data 0, 0,, 0, 0, 0, 0, 0, 112, 104, 118, 43, 102, 108, 0, 0, 0, 0, 0, 0, 0, 0
270 end
```

Fig. 6 BASIC test program for when EPROM decoding is not used.

ETI

DIGITAL CASSETTE DECK

The desire to have something more convenient than the ubiquitous START CASSETTE IN RECORD MODE type of message buried in programs was one reason for designing this project; the other was to speed up storage and retrieval without having to pay out for a floppy. Design and devepopment by Bob Campbell.

This article describes the design of a high-quality fast tape deck, which, with the right software, is capable of recording and reading data at speeds in excess of 4800 baud.

The reason for the reliability and speed of the recorder lies in the way the data is recorded onto the tape. Instead of the normal record/replay amplifiers, which tend to be optimised for low audio distortion and which therefore do not respond well to large amplitude square waves, a high-power read/write amplifier is used so that the head can, on record, be driven into saturation. Because of this, single bits can be recorded on to the tape as negative (or positive) flux with such reliability that the more usual FSK technique need not be used.

The cassette deck used, the Tanashin Electric TN-3600, is really a cassette mechanism as it has no record or replay amplifiers supplied. It does, however, come with a high-quality stereo sendust tape head, an erase head and five

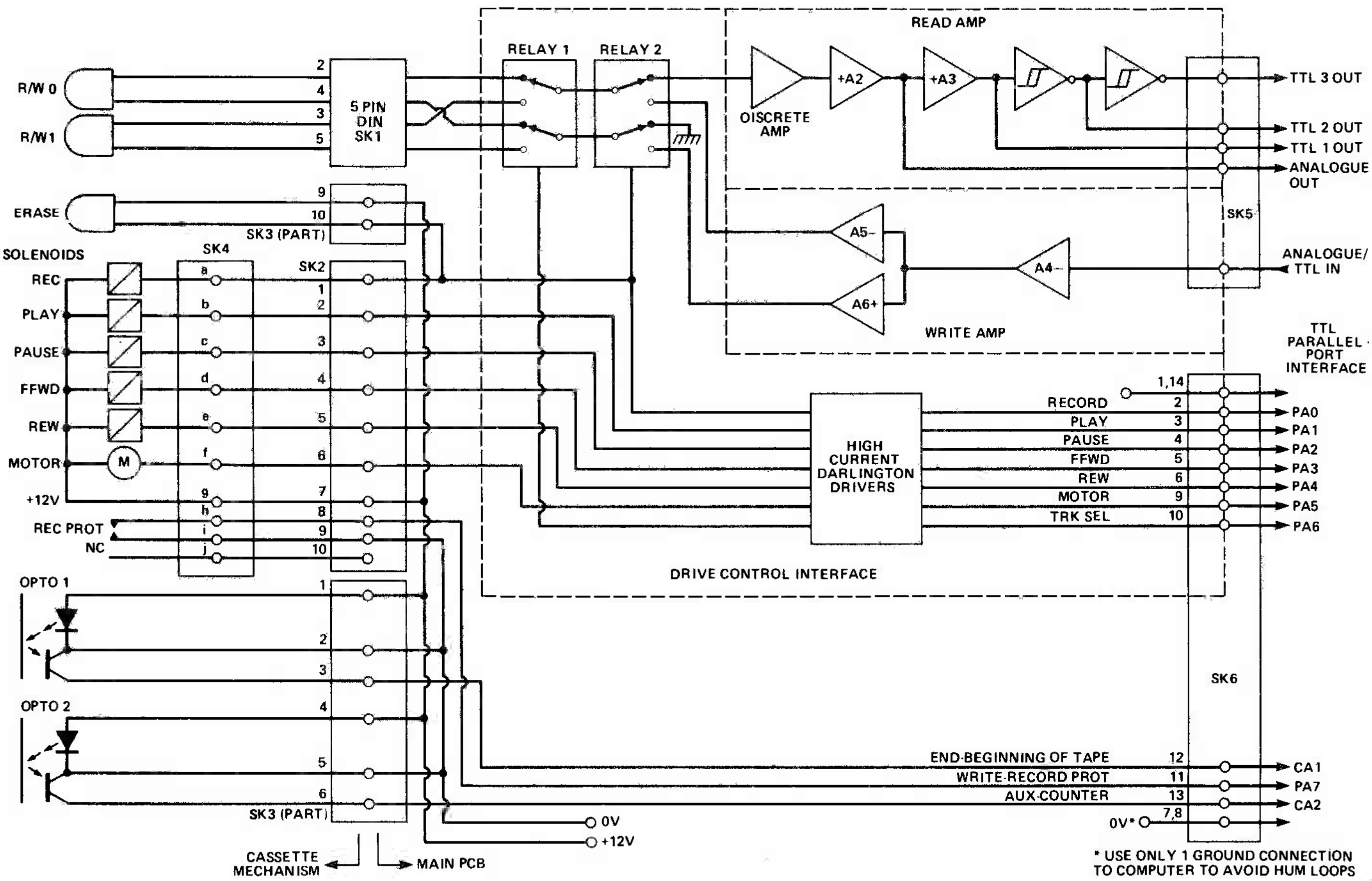


Fig. 1 Block diagram of the complete digital cassette deck.

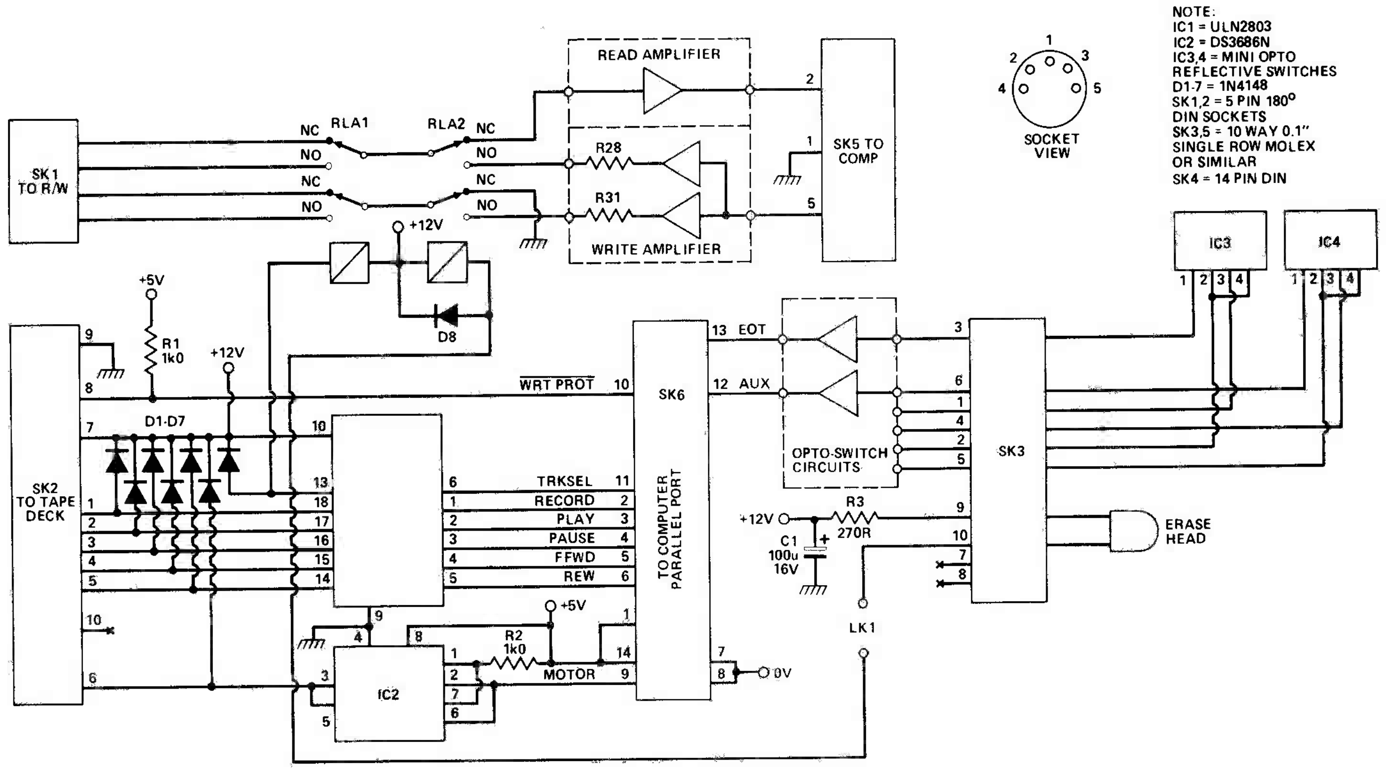


Fig. 2 Circuit diagram of the drive control interface with the rest of the circuit shown in block form.

solenoids. These miniature solenoids are hidden away within the mechanism and are used to select the normal functions of any cassette deck (see Table 1 for details). The solenoids do not directly substitute for the normal key mechanisms, as the size and power required to do that would be prohibitive; instead they are used as gear-changers, the motive power to move the tape heads coming from the drive motor through a complex gearbox. In this way they have been kept very small and they each consume less than 100 mA from a 12V supply.

Although this is not a vast amount of power it is still too much for the average computer to control directly, so some sort of interface is required. This interface is one of the four functional parts of this design, they are:

1. Drive control interface;
2. Opto switch circuit EOT — rev counter;
3. Write amplifier;
4. Read amplifier.

Drive Control Interface

The computer interface consists of two ICs, IC1 and 2. These are high-current Darlington transistor arrays with TTL compatible inputs. Although seven outputs are required and IC1 has eight available, a second chip, IC2, has been used to spread the power consumption over two chips. Since the power consumption of the motor can rise to 3.6W under stall conditions (ie, at the end of a rewind operation) IC2 has been used to drive the motor alone and IC1 is used to control the five solenoids on the tape deck and the two relays on the control board.

The two relays are used to select between READ and WRITE modes RE2, and also to select either TRACK 0, or TRACK 1 of the stereo tape head. The inputs to the seven control functions are terminated in a 14-pin DIL socket which can be connected to any eight bit I/O port. The last bit, bit 8, is used as an input to the computer. It is connected to the micro-switch on the tape deck which is activated by the lever which detects the presence of the record protect tab on the top edge of the cassette. As the circuit, is configured, this input is LOW when the tab is removed and by convention the casssette is protected. However it has been left to the user to make use of this feature in his or her own application software.

The final part of the circuit is just the connector assignments, which are tabulated in Table 1, and the protection diodes D1-D8. These diodes are used to clamp

SOLENOID/MOTOR	PLAY	PAUSE	FFWD	REW	REC	MOTOR
STOP						NOTE 1
PLAY	X					X
PAUSE	X	X				X
FFWD			X			X
REW				X		X
CUE	X	X	X			X
REV	X	X		X		X
REC (NOTE2)					X	X
REC/PLAY	X				X	X
REC/PLAY	X	X			X	X

NOTE 1 : The motor can be turned off or on at the stop mode. However it must be turned on at the same time or before starting any function.
NOTE 2 : In the record mode all the mechanisms except the record interlock arm are prevented from operating.

X= Solenoid conduction.

Table 1 Selection of solenoids to achieve cassette operating functions.

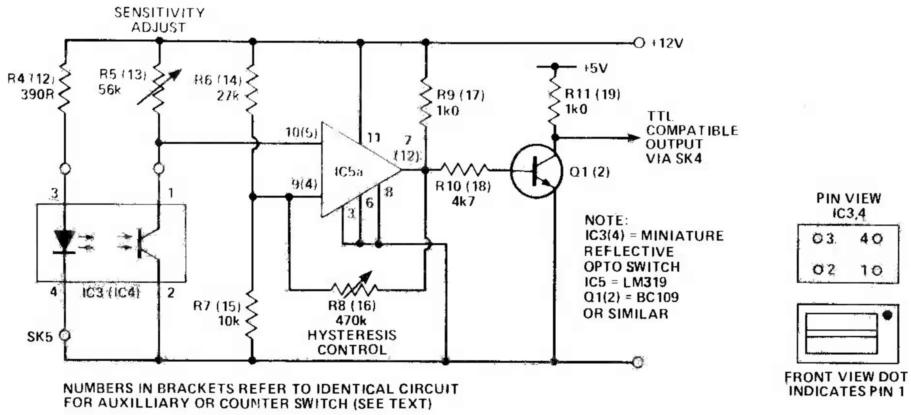


Fig. 3 Circuit diagram of the beginning and end of tape sensor.

the back EMF generated when switching off inductive loads such as relay and solenoid coils and must be fitted if you wish your computer to survive.

Opto Switch Circuits

Two identical circuits, Fig. 3, are used to drive two opto reflective switches, IC3, 4. One of these two switches senses the end or beginning of the tape so that the computer can automatically turn off the tape drive after, for example, rewinding the tape.

Each of the circuits consists of half of an LM319 dual fast comparator IC5, and a miniature opto-reflective switch. The other identical circuit using the other half of the 319, can be used either for a revolution counter or some other sensor, e.g. a cassette-in-place (CIP) circuit.

The position of the end-of-tape (EOT) and the sensitivity of the circuit is largely dependent upon the bias current through R5 (R13), and the object separation. Exact details of the mounting of the opto-reflective switch (ORS) depends on the type used. The reflective switch must be placed facing the open slot in the face of the cassette not occupied by either erase or R/W head or the pinch wheel, so that it is approximately 1 mm from the cassette body. Adjustment of R5 can then be made, if necessary, so that the output from IC5 is triggered when the tape is over the ORS but not when the tape leader is covering it. The outputs from the comparator is used to turn on a transistor with an open collector which provides a TTL-compatible output; this will present a rising edge when the tape leader is encountered. The outputs from the two circuits are taken to SK 4, pins 12 and 13; they correspond to the CA1, CA2, CB1, CB2, inputs to the VIA chip on the TANEX extension board on the Microtan computer, but could be used with any similar device, capable of recognising a positive or negative edge.

HOW IT WORKS — WRITE AMPLIFIER

The input voltage, which can be an analogue voltage or TTL output, is first AC coupled and clamped to + or − 0.6V by the two diodes D9, D10. This is then AC coupled to the input of the first amplifier IC7a, which is biased by the DC offset of R21 and R22. This first amplifier is configured purely as a buffer-compressor as its output is limited or clipped to 0.6V by the two diodes D11 and D12. This clipping also has some effect on the hysteresis of the output waveform, see Fig. 5.

The buffered signal is then split and fed into two further amplifying stages, one configured as an inverting amp and the other as a non inverting amp. The output of these two amps are 180° out of phase and approximately ±6V about the 6V DC offset. These signals are fed to both the read/write head terminals (note that it is not earthed separately). The actual recording current is controlled by R28 and R31. The values for R28 and R31 should be selected to give maximum recording current for the head and the type of tape used.

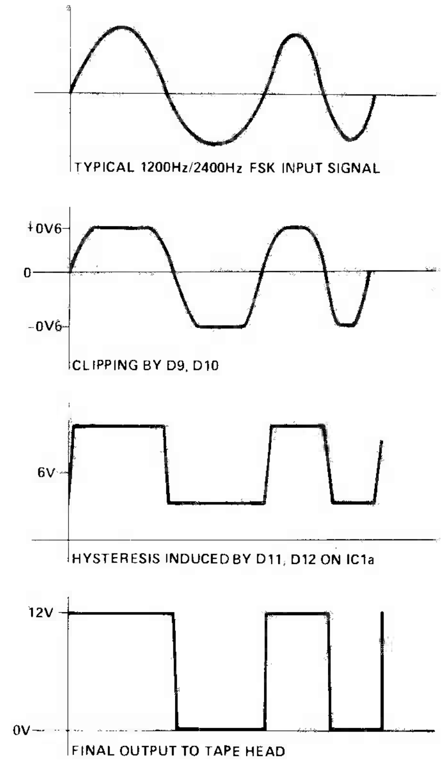


Fig. 5 Processing of the input signal by the write amplifier.

Write Amplifier

The heart of this system is the

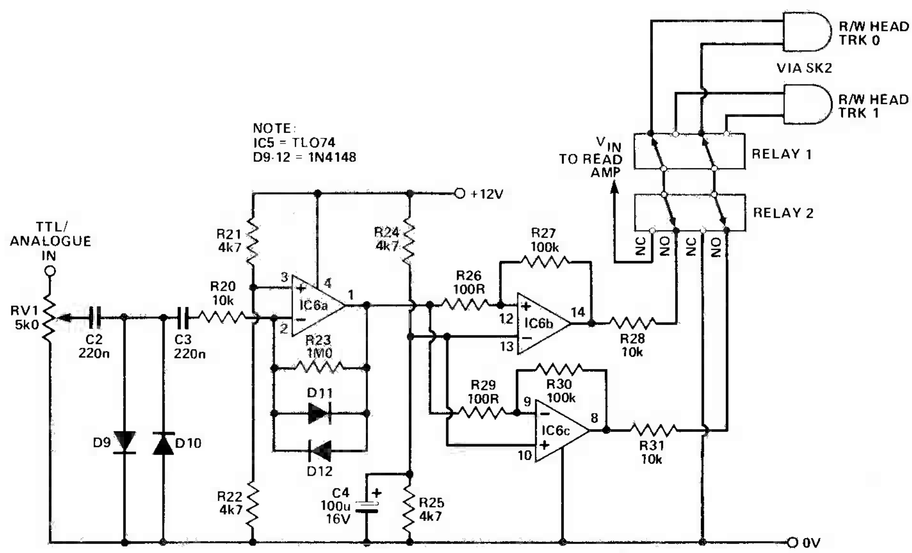


Fig. 4 Circuit diagram of the write amplifier.

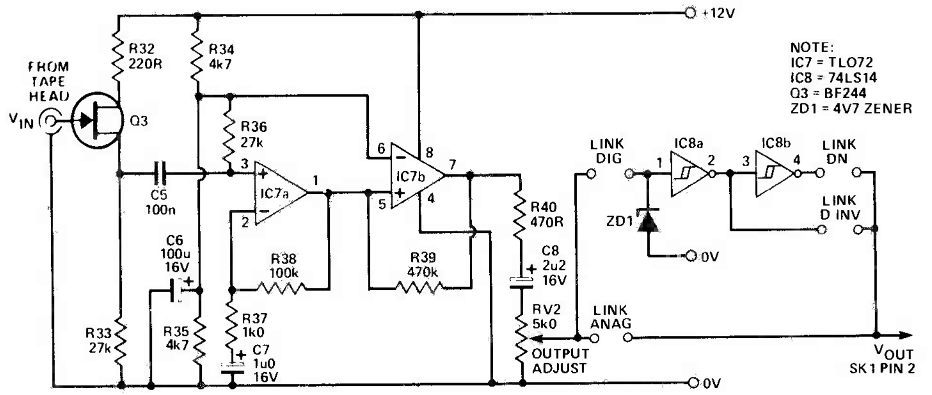


Fig. 6 Circuit diagram of the read amplifier.

HOW IT WORKS — READ AMPLIFIER

The primary stage is a very high impedance single FET amplifier, which is then in turn AC coupled to the first of two low noise op-amp amplifiers TL07s. The first op-amp, IC7a, is set up as a standard non-inverting amp with a DC offset achieved by the potential divider R34-R35. Further amplification is achieved by using a second op-amp stage, IC7b, DC coupled to the A1, and which is actually driven into saturation. So the output will swing between the supply rails as in Fig. 5. The output of this final stage is AC coupled directly to give an analogue output, a proportion of which is taken via RV2 the volume control. This output is normally suitable for most home computers which expect an ear or aux output from a normal cassette recorder. However, in a more specific application where TTL output is required, this analogue signal is clipped to 4.7V by ZD1 and this in turn is cleaned up by Schmitt trigger inverters to give an inverted or non-inverted output.

write amplifier. The secondary but no less important objective I had in mind when I designed this system was to provide a reliable recording system capable of much higher baud rates than the average tape system. In addition it should also be able to record TTL signals directly without the need of the FSK modulation techniques normally employed in the standard CUTS type systems, while it should still be able to read/record such FSK tapes.

The basic design philosophy is that something should be recorded on the tape at all times when data is present at the input and that a logic high is recorded as the complete opposite magnetic flux to a logic low. This is achieved by forcing one terminal of the R/W head to +12V and the other to 0V during one state and then reversing the connections to 0V and +12V respectively during the opposite input state. Note it does not matter which is which.

Thus during the read mode when one terminal of the R/W head is connected to GND and the other terminal swings between 0V and almost 12V, the maximum output can be achieved from the R/W head.

To achieve this voltage swing the signal is actually superimposed on a 6V DC offset, created by two potential dividers, R21 — R22 and R24 — R25; Fig. 5 shows the various waveforms around the circuit. The high level of recording current removes the need to use the erase head under most circumstances. Thus both tracks of the stereo head can be used independently, something impossible if the standard erase head were used. This second track can be used for normal data or, as will be demonstrated in a later article, for a clock track to be used for both a tape position sensor and the data record-replay clock.

Although a DC erase circuit consisting of C1 and resistor R3 has been incorporated on the PCB it is not normally required and link 1 should be left out (not installed).

Read Amplifier

This is a very simple three-stage amplifier, formed by Q3, IC7a and IC7b. The novel feature of the design is that it incorporates the facility to have either an analogue output, to suit most home computers, or a digital output (or inverted digital). In the majority of cases where the existing tape interface is to be used the analogue output will be required and the link LINK ANAG should be installed. To use the digital output only LINK DIG and one of either LINKDN or LINKD INV should be installed.

This project will be concluded in next month's ETI with a description of the construction and setting up of the circuit and some advice on programming.

ETI

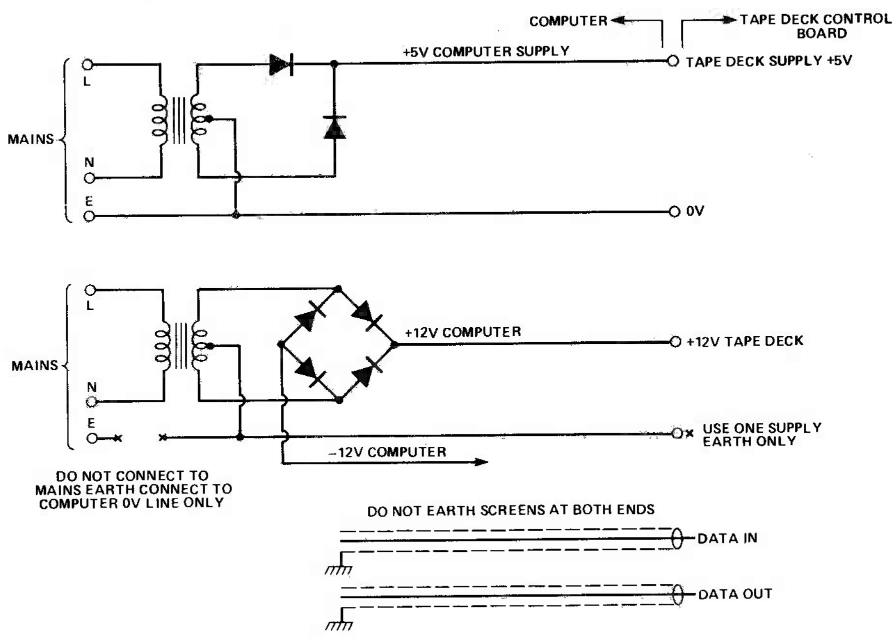


Fig. 7 Supply wiring arrangements to avoid earth loops.

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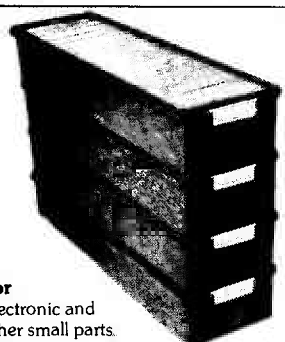

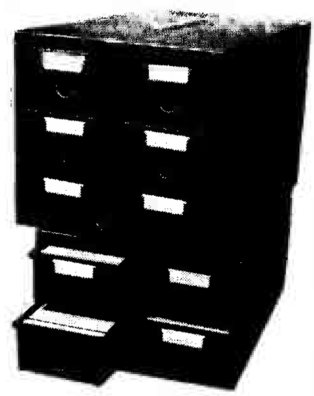

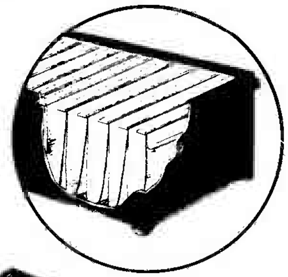

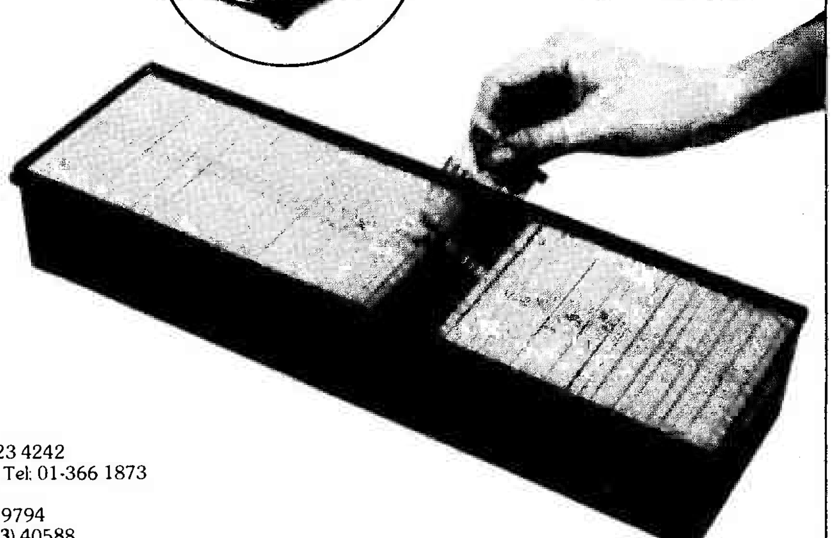

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REVIEW : GSC 1301 POWER SUPPLY

Looking for more power to your elbow? The ETI team has been looking over a new unit from Global Specialties Corporation that could be what you're looking for.

In electronics, power has little to do with megalomania; it is, as well we all know, a necessary prerequisite for our profession or hobby to exist. So one of the most critical items of test gear one can possess is a good PSU. Not having a good reliable PSU can make life well nigh impossible.

The unit reviewed here is made by Global Specialties Corporation in the USA, and costs £159 plus VAT. For this you get three supply channels: one fixed at 5V with a maximum rated current of 1A; and two independently variable channels (V1 and V2 capable of supplying +5 to +18V at 0.5A. All three channels are fully independent, in as much as they come from separate secondaries on the mains transformer and they have separate regulating circuits.

On the front panel there are two meters: a moving coil meter which measures current and, unusually, a moving iron meter to measure the voltage. As one would expect, the meters can be switched between the three channels.

We checked the accuracy of the meters against our lab Avo, and the Fluke DMM reported on elsewhere in this issue. We found that the current meter was accurate enough, any disrepancy between it and our test instruments being negligible. However, the voltage meter was unsatisfactory, being well over a volt out at the top end of its range, although rather better than this is at the lower end of its range, below 12V, where the maximum error found was under 0.2 volts.

Just How Meaty?

One of the ideal requirments of a PSU is that it should be able to deliver the maximum output current over the full range. So it was a little disappointing to find that the variable supplies are power dissipation limited. In other words, if there is excessive heat dissipation *inside* the PSU, it will shut down. Obviously, the lower the output voltage, the higher the voltage being dropped across the regulating IC, so the lower the current that can be drawn before the dissipation limit is reached.

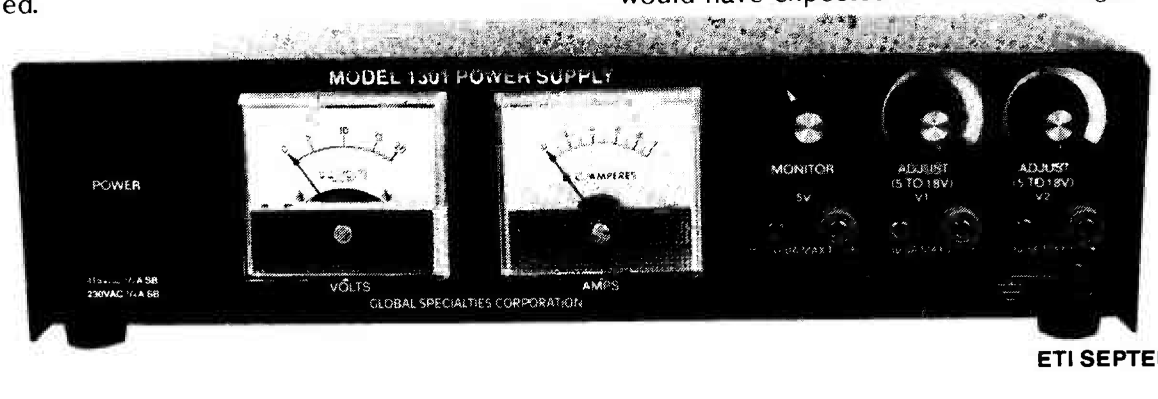
A graph in the handbook suggests, for instance, that the maximum current that can be drawn at 10V output on the variable channels is 0.3A; however, on a 'soak' test, we were able to draw 0.5A from the V1 supply and 0.45A from the V2 supply without any sign of either of them shutting down. Going a little beyond these would cause the current limiting to take effect (at least, it seems likely that it was current limiting because the supply would limit the output voltage to reduce the current, and when the voltage setting was reduced, the supply would resume normal operation).

It was noticed that the supply is capable of a couple of nasties associated with limiting. Firstly, and perhaps not entirely unexpectedly, the ripple on the limited output climbs steeply the further into limiting the supply is driven. Secondly, and potentially more seriously, the supply is capable of oscillating at high frequency.

This oscillation can occur on the channel that is limiting, but more seriously, it can break through to other channels. For instance, whilst driving the V1 and V2 channels both into 20R loads, the V1 supply voltage supply was kept at 10V and out of limiting. Turning V2 up until it limited led to bursts of oscillation from the V1 channel (which could also be just detected on the 5V channel). This oscillation was at above 10MHz and of amplitude around 30mV P-P (lower on the 5V channel). Obviously, it could easily be taken out with a suitable bypass capacitor in the circuit being supplied, but it's not really the sort of thing you'd expect to find in the first place.

A Heavy Load

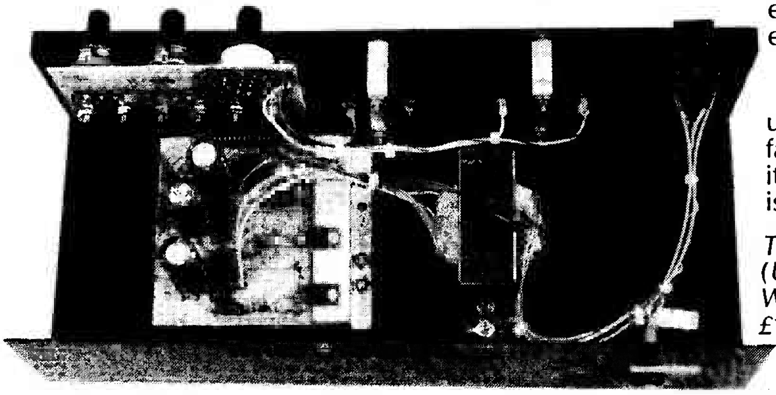
We tried drawing maximum power from the different channels independently and together. Starting with the 5V supply, this seemed just about acceptably well regulated, though slightly on the low side. However, the ripple performance was very good up to overload. One slightly surprising aspect was the current limiting, which, while the supply was feeding directly into the lab Avo on its 10A range, permitted just over 1A to flow; we would have expected a much lower figure. What this



implies is that with increasing load, the channel volts will drop even further beyond the 1.5A that we tested to, and then start to fold in relatively slowly.

On the two variable channels, it is possible to make the regulator try to give out too many volts for the available head room. Any regulator will need a certain voltage headroom between the minimum volts that appear across the reservoir capacitor and the ouptut from the regulator. Once this headroom is breached, the regulator cannot function correctly, and that seems to be what is going on here.

With just one variable channel feeding 17.9 volts into approximately 37 ohms (ie current just under 0.5A), the ripple voltage observed on the oscilloscope was around 20mV P-P. However, increasing the voltage to 18.0 volts makes the ripple climb to 50mV. However, more significant than this, the ripple develops a noticeable downward peak at the bottom of its cycle. Exceeding 18V output (not recommended by the manufacturer) makes the ripple increase very steeply, most of it from the downward peak mentioned above growing, until at the maximum output of 18.4 volts, the ripple is 0.5V P-P.



With both variable channels, V1 and V2, supplying loads of 27 ohms, and both kept at the same voltage, the point at which the ripple begins to alter shape is lower, around 17.2 volts. The PSU can't actually supply 18V on both channels under these conditions, the maximum output was found to be 17.8V but with 0.8V P-P ripple. At 17.0 volts, the ripple is an acceptable 20 mV or so P-P.

It may seem like splitting hairs to find faults in the performance of the PSU at a setting that is likely to be used only very occasionally. However, the supply does say "5 TO 18V" and "0.5A MAX" on its front panel, and it's annoying to find that this has to have qualifications, especially on a unit of this price, where one would expect a top-quality transformer.

Conclusions

Were it not for the price, we would be able to give this unit our qualified recommendation, in that it is at least fairly well protected and will do for many jobs. However, it must have suffered from the high rate of the dollar, and is undercut quite seriously by UK-produced units.

The 1301 supply is available from Global Specialties GSC (UK) Ltd, Unit 1, Shire Hill Industrial Estate, Saffron Walden, Essex CB11 3AQ, tel: 0799 21682. The cost is £159.00 plus VAT.

ETI

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80	3v - 30v	0 - 120	7.25	2.00	1.38	10.63
120	3v - 30v	0 - 120	8.00	2.00	1.50	11.50
160	3v - 30v	0 - 120	9.00	2.00	1.65	12.65
225	3v - 30v	0 - 120	11.50	2.50	2.10	16.10
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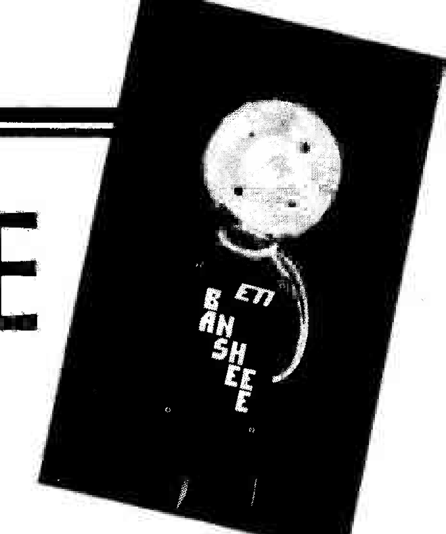
ETI BANSHEEE ALARM



The ETI Bansheee follows (fairly) closely (and noisily) on the heels of the Warlock alarm, published in July. Together, the two should provide the essential components of a versatile alarm system — and they can be used separately as well. Design and development by Phil Walker.

The ETI BANSHEEE is essentially a self-powered alarm sounder. The actual noise is made by any bell, buzzer or siren which will operate from a 12V supply without taking too much current. The unit as described was designed with a solid-state driven siren in mind which took about 20mA at 12V. This gives a self powered operating time of 14 hours with the battery fully charged (at least in theory). Other sounder devices and battery capacities could be used for your own requirements probably with minor modifications. The battery charging current is nominally 2mA max. but could be altered by changing one resistor (R3)

The BANSHEEE is controlled from the main unit by switching the polarity of the supply and this facility was designed into the WARLOCK main unit described in July. Cutting or shorting the supply wires between the main unit and the BANSHEEE results in the alarm sounding from the internal battery.

The components forming the BANSHEEE project are quite small and could easily be mounted inside the base of a large siren or bell.

The Circuit

The circuit of this project is very simple in principle. In normal use the alarm control unit supplies 12V DC to the BANSHEEE such that SK1a is positive in this case the relay is energised but no significant voltage appears at the sounding device terminals. In this condition the internal battery is charged from the supply to keep it ready for action.

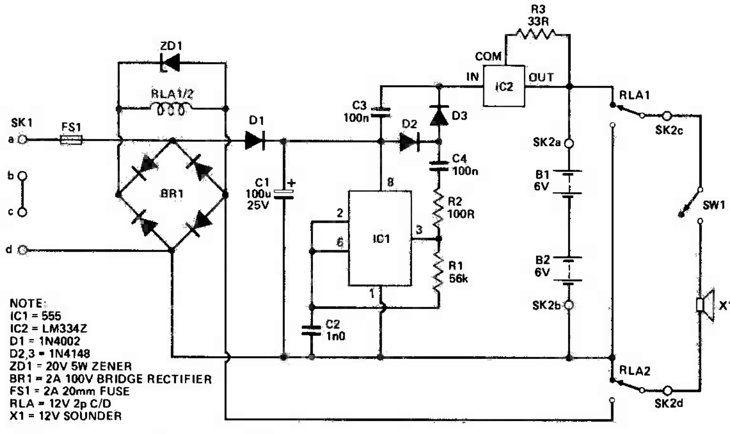


Fig. 1 Circuit diagram of the Bansheee.

HOW IT WORKS

This circuit has three modes of operation. The first we shall consider is when no voltage is applied to SK1a and d. In this case the relay will not be energised and its contacts will connect the siren or bell directly across the battery B1. This will sound to raise the alarm and indicate that the wires to the unit have been cut or shorted.

The second case to consider is where about 12 volts is applied to SK1a and d with SK1a negative. This will cause the relay to pull in and connect the alarm sounder across one diode of the bridge rectifier. In the particular condition we are considering almost all the input voltage will be applied to the sounder to raise the alarm. Note that in this case, the power to do this will come from the alarm main unit and not from the internal battery.

The third case to consider is where 12 volts is applied to the unit but this time with SK1a positive. This will again cause the relay to pull in and connect the alarm sounder across a diode in the bridge rectifier but this time the diode will be conducting and only about 0.7 volts will be applied to the sounder and even this in the wrong polarity. Thus the alarm will not sound.

Additionally in this third mode D1 will conduct and supply power to IC1 and its associated circuit. IC1 is connected as a free-running astable multivibrator driving a voltage doubler circuit. It should operate at somewhere in the region of 10kHz but this is not critical. The configuration of this oscillator is not the usual 555 connection but saves a resistor at the expense of accuracy. When it is low, the output of IC1 charges C4 via D2 and R2 to nearly the supply voltage. When the output goes high, some of the charge on C4 will be transferred to C3 via D3 and R2. R2 acts as a current limiting device only.

The voltage on C3 is added to the supply voltage and is used to charge the battery B1. The current into the battery is limited by IC2 to about 2mA. This is necessary in case the supply voltage is much in excess of 12 V due to some fault or other cause. This rather complicated charging circuit is needed so that B1 will be charged even when the input voltage is equal to or somewhat below the terminal voltage of B1.

D1 is present to prevent reverse supply polarity damage to IC1, etc. and C1 is there to smooth out switching spikes and short term supply variations.

If the alarm is to sound then the control unit changes the polarity of the supply. The relay remains energised but now almost the full supply voltage is applied to the sounder which will now operate. If for any reason the power from the main unit fails the relay will no longer be energised and its contacts will apply the internal battery to the sounder and cause it to operate. This ensures that the alarm will be given if the wires are cut or shorted. In normal operation the unit should take about 60mA. This is mostly taken by the relay coil. In active mode this will increase by the amount taken by the sounder.

The length of time the alarm will sound when in self-powered mode is determined by the battery capacity and the current drain of the sounder as the rest of the circuit is then inactive. Some protection from over-voltage is given by ZDI and FS1. If a high voltage is present on the line ZD1 should conduct and cause the fuse to blow. Note that this is not a normal occurrence and the input voltage should not normally exceed 16 V maximum.

Construction

There are many possibilities in the construction of this project especially if there is room inside your alarm sounder device. In our case we used a small siren unit which was too small to permit this approach so we put the PCB and the battery into a small plastic box made by Bicc-Vero. As you can see this makes a very compact unit. Construction of the PCB should not present many problems provided that the normal care is taken to make sure that polarised components are inserted correctly.

If you are using the 6 V batteries then they should be taped together before linking across. Make the connection as neatly as possible as there is not a great deal of head-room.

The PCB is fitted into the box by first putting M3×25mm screws through from the component side and securing them with nuts under the board. These bolts then pass through holes drilled in the bottom of the box and can be fastened with more nuts on the outside. The remaining length can be used to fix the unit to a bracket or back panel.

In our prototype we put two small brackets between the first

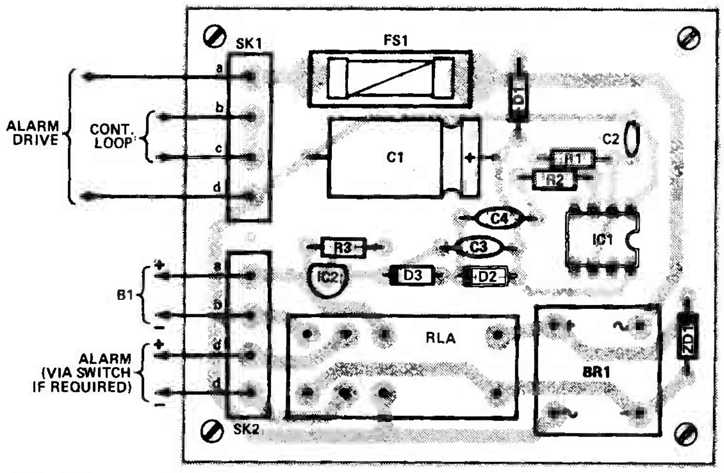
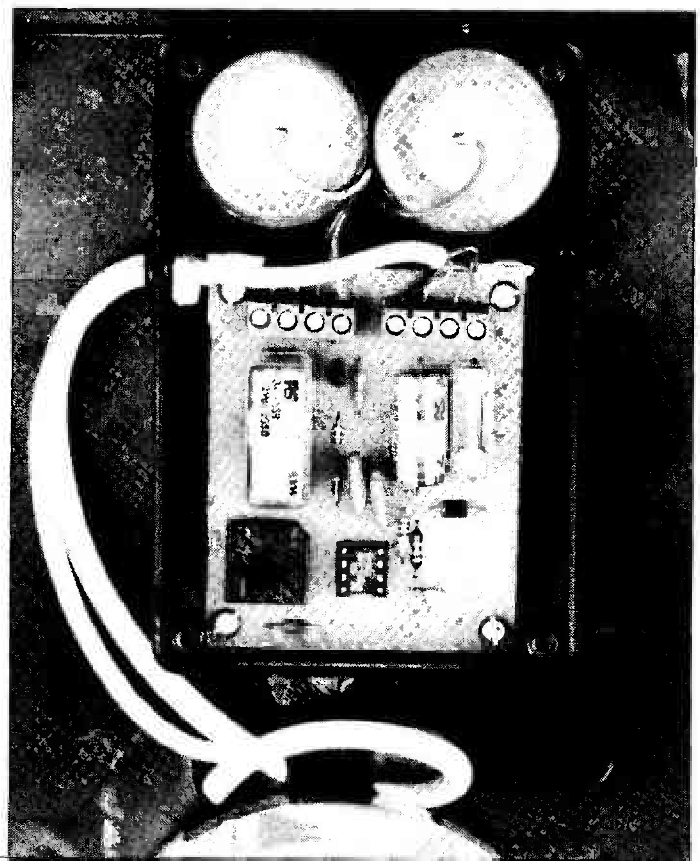


Fig. 2 Overlay diagram of the PCB.

PARTS LIST

RESISTORS	(¼ W 5% carbon film)	MISCELLANEOUS	
R1	56k	RLA	12V 205 ohm coil, 2 pole changeover 5A contacts relay
R2	100R	SK1,2	4 way PCB screw terminals
R3	33R	X1	12V siren or bell
CAPACITORS		FS1	20mm 1A fuse and PCB holder
C1	100µF 25V axial electrolytic	SW1	1 pole keyswitch (optional)
C2	1nF ceramic	PCB	(see buylines)
C3,4	100nF ceramic	B1	12V Ni-Cd battery (2 × 6V 280 mAH in series)
SEMICONDUCTORS		Box	Bicc-Vero 826-21390
BR1	200V 2A bridge rectifier	Grommets, screws, nuts etc.	
D1	1N4002		
D2,3	1N4148		
IC1	555		
IC2	LM334Z		
ZD1	18V 1W3 zener diode (or higher power rating if possible)		



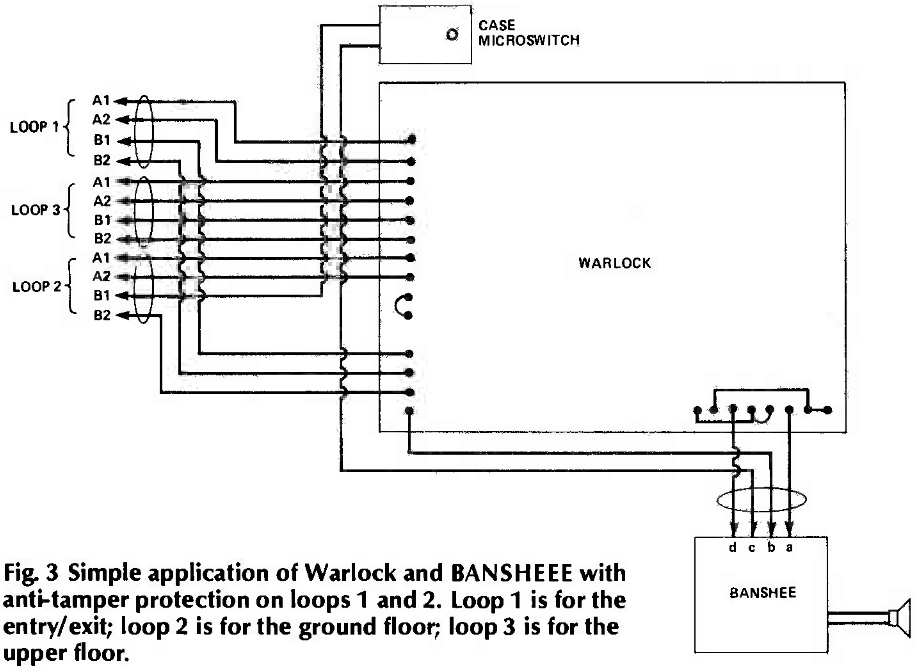


Fig. 3 Simple application of Warlock and BANSHEEE with anti-tamper protection on loops 1 and 2. Loop 1 is for the entry/exit; loop 2 is for the ground floor; loop 3 is for the upper floor.

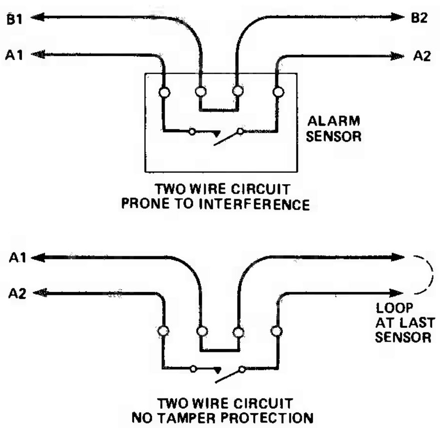


Fig. 4 Two wire circuits.

BUYLINES

Just one potential problem here, the relay. The one we used was an RS type (order code number 349-658). However, Maplin sell a very similar type which should present no difficulties in use. The PCB is, as ever, available from us.

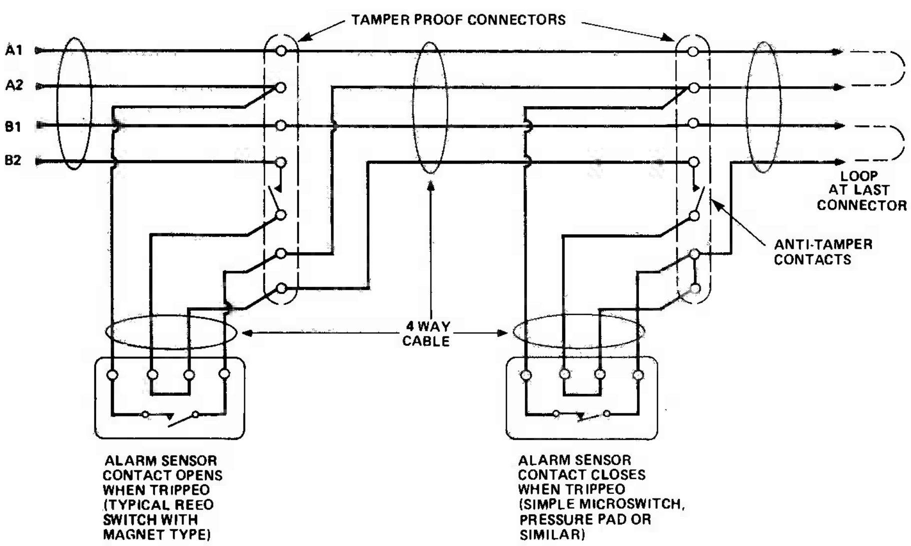


Fig. 5 Wiring alarm sensors with anti-tamper loop. A1 and A2 are main circuit wires preferably at supply rail potential. B1 and B2 are anti-tamper circuit wires preferably at 0V potential. If necessary the potentials may be reversed but they should be complementary on each cable run. If no anti-tamper protection is needed, B1 and B2 can be replaced by the other sense circuit of the main loop.

nuts and the inside of the box. When covered with sleeving these serve to prevent the batteries colliding with the PCB.

Access to the PCB mounted terminals is made through grommets in the side of the box. Alternatively, the box may be mounted on the side or back of the sounder device and wires taken in directly.

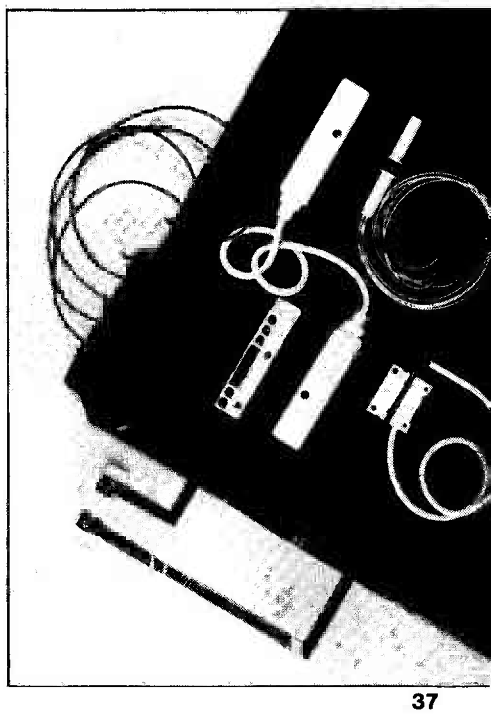
Use

The ETI BANSHEEE should be fitted so that it is out of easy reach and the wires between the circuit and the sounder are as inaccessible as possible. If possible use a housing for both the sounder and Bansheee which has a security microswitch to detect unauthorised interference. Wiring between the BANSHEEE and the main unit (Warlock if used) could be 2 core if necessary but 4 core would allow the use of the anti-tamper facility of the Warlock system.

The diagram shows how the units may be interconnected with the usual alarm sensors to give a security system for small premises. It is possible to use the system with two-wire sensor circuitry but this may then be subject to false triggering. If a loop is run right round a large area you will lose the anti-tamper facility.

ETI

Below: some of the hardware you might need for a complete alarm system, including door contacts, tamper-proof connectors, window-tape and a pressure mat.



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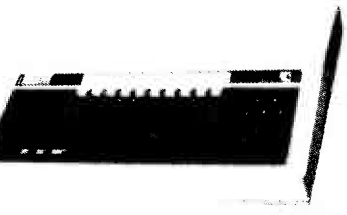

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Disc Lockable Case 60/70 .... £27.00b

SOFTWARE:

ACORN/MERLE BUSINESS SOFTWARE
Invoicing, Stock Controk, Accounts Payable, Accounts Receivable, Order Processing, Mailing System .... Each £22.65d
GEMINI Leisure — Full Range ....
ACORNSOFT — Full Range ....
ACORN LANGUAGES including BCPL, LISP
FORTH with Manuals ....
BBCSOFT — Full Range ....
PROGRAM POWER — Full Range ....
BEEBUGSOFT — Full Range ....

TORCH Z80 DISC PACK

Designed with a tital expansion capability
The Torch upgrade will give you a sophisticated business/professional system. Why not contact us for your requirements?

TORCH Z80 DISC PACK

The proven upgrade for the BBC Micro Comprising 2 x 400K disc drive, Z80 processor with 64K or memory, and a CP/M compatible operating system The system is supplied complete with the PERFECT software range including PERFECT WRITER, PERFECT SPELLER, PERFECT CALC and PERFECT FILE. Full TORCHNET software is also supplied allowing sophisticated networking between other units.

NEW TORCH Z80 PACK PRICE £699
SOFTWARE PACKAGE INCLUDES Z80 BASIC

The TORCH Z80 SECOND PROCESSOR CARD — for those who already have suitable disc drives. The card is supplied with all the free software, as detailed above, presenting a very attractive package. **£299.**

ACORN IEEE INTERFACE

A full implementation of the IEEE-488 standard, providing computer control of compatible scientific & technical equipment, at a lower price than other systems. Typical applications are in experimental work in academic and industrial laboratories. The interface can support a network of up to 14 other compatible devices, and would typically link several items of test equipment allowing them to run with the optimum of efficiency. The IEEE Filing System ROM is supplied. **£282.**

BUZZBOX

A full spec pocket size direct modem with both Originate and Anower modes. This BT approved modem conforms to CCITT V21 300/300 Baud Standard. Battery/Mains powered plugs directly into telephone line. Modem **£69** head £3.50 Ext PSU £8.00

BOOKS

We have a large selection of books on the BBC and other titles. Please ask for details. No VAT on books.

'TIME-WARP' REAL-TIME-CLOCK/CALENDAR FOR THE BBC

A low cost unit that opens up the total range of 6 Real-Time applications. With its full battery backup, possibilities include an Electronic Diary, continuous display of 'on-screen' time and date information automatic document dating, precise timing & control in scientific applications, recreational use in games etc — its uses are endless and are simply limited by one's imagination. Simply plugs into the user port — no specialist installation required — No ROMS. Supplied with extensive applications software. **Please phone for details. £29.00 + £2.50 carriage.**

★★ ATTENTION ★★

All prices in this double page spread are subject to change without notice.

PRINTERS

EPSON FX-80 .... £325.00a
EPSON RX-80 FT £250.00a
EPSON FX-100 .... £480.00a
EPSON DX-100 .... £375.00a
Printer Sharer + Cable Set £88.00c
JUKI 6 100 Daisy wheel £350.00a
MCP40 Col. Printer/Plotter £110.00a
Gralpad Graphics Tablet £125.00c

ACCESSORIES

Parallel Printer Lead £10.00d
Serial Printer Lead £8.00d
Epson Serial Interface 2K8148 £50.00c
Epson Serial Interface 8143 .... £35.00c
FX80 Dust Cover £4.00d
Epson Paper Roll Holder £17.00c
FX-80 Tractor Attachment £37.00c
PAPER Fanfold 2000 sheets £13.50b
Ribbon MX80/HX80/FX80 .... £6.50c
Ribbon MX/RX/FX100 .... £12.50c

MONITORS

Microvitec 1431 14" RGB Std Res. £195.00a
Microvitec 1431 14" RGB/PAL +Sound £225.00a
Microvitec 1451 14" RGB Med Res. £295.00a
Microvitec 1441 14" RGB Hi Res. £420.00a
Microvitec 2031 20" RGB Std Res. £287 00a
KAGA Vision EX 12" RGB Med Res £195.00a
KAGA Vision II Hi Res £260.00a
KAGA Vision III 12' RGB Super Hi Res £358.00a
KAGA 12" Green Hi Res £106.00a
SANYO DM8112CX 12" Green Hi Res £99.00a
KAGA RGB Lead £6.50d
BNC Green Screen Monitor Lead £3.00d

CASSETTE RECORDERS

SANYO DR101 Data Recorder £30 00b
Datex Slim Line £20.00c
BBC Tape Recorder £28.50b
Cassette Lead £3 00d
Computer Grade C-12 cassette £0.45d
Computer Grade Cassette 10 off £4 00c
Phillips Mini-data cassette £3.00d

SOFTY II

This low cast intelligent eprom programmer can program 2716, 1516, 2532, 2732, and with an adaptor, 2564 and 2764. Displays 512 byte page on TV — has a serial and parallel 1/0 routines Can be used as an emulator, cassette interface.
Softy II **£195** (b) Adaptor for 2764/2564 **£25.00** (c)

SMARTMOUTH FOR THE BBC

The original 'infinite speech'. Still the best.
A ready built totally self contained speech synthesiser unit, attractively packaged with built-in speaker, AUX output socket etc — no installation problems! It allows the creation of any English word, with both ease and simplicity, while, at the same time being very economical in memory usage. You can easily add speech to most existing programs. Due to its remarkable infinite vocabulary, its uses spread throughout the whole spectrum of computer applications — these include industrial, commercial, educational, scientific, recreational etc. No specialist installation — no need to open your computer, simply plugs into the user port — and due to the simple software, no ROMS are needed. SMARTMOUTH is supplied with demo and development programs on cassette, and full software instructions. **£37 + £2.50 carriage.**

UV ERASERS

UV1T Eraser with built-in timer and mains indicator.
Built-in safety interlock to avoid accidental exposure to the harmful UV rays.
It can handle up to 5 eproms at a time with an average erasing time of about 20 mins. **£59 +£2 p&p.**
UV1 as above but without the timer.
£47 +£2 p&p.
For Industrial Users, we offer UV140 & UV141 erasers with handling capacity of 14 eproms. UV141 has a built in timer. Both offer full built in safety features UV140 £61, UV141 £79, p&p £2.50.

PRODUCTION PROGRAMMER

P8000
P8000 provides reliable gang programming of up to 8 EPROMS simultaneously with device sizes up to 16K x 8 bytes rail versions. Simple menu driven operation ensure easy eprom selection and reliable programming in minimum programming times. **£695 + £6 carriage.**

EP8000.
This CPU controlled Emulator Programmer is a powerful tool for both Eprom programming and development work. EP8000 can emulate and program all eproms up to 8K x 8 bytes, can be used as stand alone unit for editing and duplicating EPROMS, as a slave programmer or as an eprom emulator £695 (a).

EPROM II

Our current version of the highly popular Eprom programmer is now being enhanced to provide more and better facilities for easy programming by the user. The software will maintain its superiority over all currently availabel similar programmers. The range of eproms handled has widened, to include the eproms with lower programming voltage and eproms which can be programmed using algorithm. Control of all operations has been moved to the keyboard. The screen display has been improved to give more information. The screen editing facilities have also been modified to simplify the data entry.

★ The new Eprom Programmer will not program 2516, 2532, 3564, 2716, 2732, 2764, 27128 and 27256 + 15v eproms, and all but the 27256 in a single pass.

★ The programmer will be supplied with integral power supply and interfaces with the BBC via the 1 MHz bus. It is fully buffered and complies with Acorn protocols. There is no power drain from the computer.

Please telephone for further details.

CONNECTOR SYSTEMS

I.D. CONNECTORS

(Speedblock Type)

No of ways	Header Plug	Receptacle	Edge Conn
10	90p	85p	120p
20	145p	125p	195p
26	175p	150p	240p
34	200p	160p	320p
40	220p	190p	340p
50	235p	200p	390p

D CONNECTORS

No. of ways	9	15	25	37
MALE				
Solder	80p	105p	160p	250p
Angled	150p	210p	250p	365p
FEMALE				
Solder	105p	160p	200p	335p
Angled	165p	215p	290p	440p
Hoods	90p	85p	90p	100p

IDC 25-way plug **385p**. Socket **450p**

TEXTOOL ZIF

SOCKETS
24-pin **£5.75**
28-pin **£8.00**
40-pin **£9.75**

DIL SWITCHES

4-way **70p** 8-way **130p**
6-way **100p** 10-way **150p**

JUMPER LEADS

24" Ribbon Cable with Headers

	14-pin	16 pin	24 pin	40 pin
1 end	145p	165p	240p	350p
2 ends	210p	230p	345p	540p

24" Ribbon Cable with Sockets

	20 pin	26 pin	34 pin	40 pin
1 end	160p	200p	280p	300p
2 ends	290p	370p	480p	525p

Ribbon Cable with D Conn
25-way Male **500p** Female **550p**

RS 232 JUMPERS

(25 way D)

24	Single end Male	£5 00
24	Single end Female	£5 25
24"	Female Female	£10 00
24	Male Male	£9 50
24	Male Female	£9 50

DIL HEADERS

14 pin	40p	100p
16 pin	50p	110p
24 pin	100p	150p
28 pin	200p	—
40 pin	200p	225p

AMPHENOL CONNECTORS

36-way plug Centronics Parallel
Solder **£5.25** IDC **£5.25**
36-way socket Centronics Parallel
Solder **£5.50** IDC **£5.50**
24-way plug IEEE Solder **£5** IDC **£4.75**
24-way socket IEEE Solder **£5** IDC **£4.75**

PCB Mtg Skt
Any Pin 24 way Solder **600p**
36 way ZOC **650p**

RIBBON CABLE

(Grey/meter)

10-way	40p
16-way	60p
20-way	85p
26-way	120p
34-way	160p
40-way	180p
50-way	200p
64-way	280p

EURO CONNECTORS

DIN 41612

2 x 32 way St Pin	230p	275p
2 x 32 way Ang Pin	275p	320p
3 x 32 way St Pin	260p	300p
3 x 32 way Ang Pin	375p	400p
1 DC Skt A+B	275p	
A+C	350p	

For 2 x 32 way please specify spacing (A+B, A+C)

TEST CLIPS

14-pin **375p** 16-pin **£4**
40-pin **£10.30**

EDGE CONNECTORS

	0.1"	0.156"
2x6-way (commodore)	—	300p
2x10-way	150	—
2x12-way (vic 20)	—	350p
2x18-way	—	140p
2x23-way (ZX81)	175p	220p
2x25-way	225p	220p
2x28-way (Spectrum)	200p	—
2x36-way	250p	—
1x43-way	260p	—
2x22-way	190p	—
2x43 way	395p	—
1x77-way	400p	500p
2x50-way (S100conn)	600p	—

74 SERIES

7400	100p
7401	60p
7402	100p
7403	60p
7404	100p
7405	60p
7406	POA
7407	POA
7408	100p
7409	60p
7410	100p
7411	60p
7412	50p
7413	75p
7414	90p
7416	POA
7417	POA
7420	60p
7421	100p
7422	60p
7423	60p
7425	75p
7426	60p
7427	60p
7428	60p
7430	60p
7432	POA
7433	60p
7437	60p
7438	100p
7439	50p
7440	60p
7441	120p
7442A	75p
7444	120p
7445	160p
7446A	120p
7447A	120p
7448	120p
7450	60p
7451	60p
7453	60p
7454	60p
7460	75p
7470	75p
7472	75p
7473	75p
7474	60p
7475	100p
7476	80p
7480	60p
7481	160p
7482	120p
7483A	120p
7484A	250p
7485	120p
7486	70p
7489	300p
7490A	75p
7491	70p
7492A	90p
7493A	75p
7494	150p
7495A	90p
7498	100p
7497	250p
74100	220p
74107	75p
74109	75p
74110	90p
74111	55p
74116	220p
74118	200p
74119	300p
74120	180p
74121	90p
74122	100p
74123	150p
74125	100p
74126	100p
74128	120p
74132	100p
74136	90p
74141	180p
74142	450p
74143	480p
74144	480p
74145	140p
74147	2.25
74148	180p
74150	225p
74151A	100p
74153	100p
74154	250p
74155	100p
74156	110p
74157	110p
74159	320p
74160	120p
74161	120p
74162	120p
74163	120p
74164	120p
74165	150p
74166	150p
74167	400p
74170	250p
74172	750p
74173	180p
74174	120p
74175	120p
74176	150p
74177	150p
74178	250p
74179	250p
74180	150p
74181	380p
74182	200p
74184	300p
74185A	300p
74190	140p
74191	140p
74192	90p
74193	140p
74194	140p
74195	100p
74196	140p
74197	140p
74198	250p
74199	250p
74221	150p
74251	150p
74259	250p
74265	100p
74273	270p
74276	350p
74278	370p
74279	150p
74283	170p
74285	350p
74290	140p
74293	140p
74298	225p
74351	225p
74365A	100p
74366A	100p
74367A	100p
74368A	100p
74376	200p
74390	225p
74393	225p
74490	300p

74LS SERIES

74LS00	POA
74LS01	60p
74LS02	100p
74LS03	60p
74LS04	POA
74LS05	70p
74LS08	100p
74LS09	60p
74LS10	100p
74LS11	70p
74LS12	60p
74LS13	75p
74LS14	120p
74LS15	60p
74LS20	60p
74LS21	60p
74LS22	70p
74LS26	70p
74LS27	70p
74LS28	70p
74LS30	60p
74LS32	100p
74LS33	60p
74LS37	60p
74LS38	100p
74LS40	60p
74LS42	100p
74LS47	140p
74LS48	140p
74LS51	60p
74LS54	60p
74LS55	60p
74LS73A	75p
74LS74A	100p
74LS75	90p
74LS76A	75p
74LS83A	120p
74LS85	150p
74LS86	75p
74LS90	90p
74LS91	110p
74LS92	100p
74LS93	90p
74LS95B	100p
74LS96	160p
74LS107	75p
74LS109	75p
74LS112	90p
74LS113	75p
74LS114	75p
74LS122	100p
74LS123	200p
74LS124/629	300p
74LS125	90p
74LS126	90p
74LS132	90p
74LS133	90p
74LS136	75p
74LS138	120p
74LS139	120p
74LS145	150p
74LS147	220p
74LS148	220p
74LS151	100p
74LS153	100p
74LS154	300p
74LS155	140p
74LS156	125p
74LS157	100p
74LS158	100p
74LS160A	140p
74LS161A	140p
74LS162A	140p
74LS163A	140p
74LS164	140p
74LS165A	180p
74LS166A	250p
74LS168	200p
74LS169	200p
74LS170	220p
74LS173A	120p
74LS174	120p
74LS175	120p
74LS181	250p
74LS183	270p
74LS190	130p
74LS191	135p
74LS192	130p
74LS193	130p
74LS194A	130p
74LS195A	130p
74LS196	130p
74LS197	130p
74LS221	140p
74LS240	250p
74LS241	250p
74LS242	140p
74LS243	140p
74LS244	300p
74LS245	350p
74LS247	120p
74LS248	120p
74LS249	120p
74LS251	100p
74LS253	100p
74LS256	200p
74LS257A	120p
74LS258A	100p
74LS259	200p
74LS260	90p
74LS261	120p
74LS266	100p
74LS273	240p
74LS275	175p
74LS279	120p
74LS280	240p
74LS283	120p
74LS290	110p
74LS292	900p
74LS293	125p
74LS295	140p
74LS297	900p
74LS298	150p
74LS299	250p
74LS321	300p
74LS323	250p
74LS324/624	350p
74LS348	250p
74LS352	150p
74LS353	150p
74LS356	220p
74LS363	160p
74LS364	180p
74LS365A	100p
74LS366A	100p
74LS367A	100p
74LS368A	55p
74LS373	POA
74LS374	POA
74LS375	100p
74LS377	180p
74LS378	150p
74LS379	140p
74LS390	140p
74LS393	200p
74LS395A	140p
74LS399	210p
74LS445	180p
74LS465	220p
74LS466	150p
74LS467	220p
74LS490	170p
74LS540	200p
74LS541	200p
74LS608	700p
74LS610	1900p
74LS612	1900p
74LS624	150p
74LS626	350p
74LS628	350p
74LS629	300p
74LS640	300p
74LS640-1	300p
74LS641	250p
74LS642-1	300p
74LS643	250p
74LS643-1	300p
74LS644	350p
74LS645	350p
74LS645-1	400p
74LS668	120p
74LS669	150p
74LS670	225p
74LS674	550p
74LS682	650p
74LS684	650p
74LS687	550p

74S SERIES

74S00	100p
74S02	100p
74S04	120p
74S05	100p
74S08	100p
74S10	100p
74S11	100p
74S20	100p
74S22	100p
74S30	100p
74S32	180p
74S37	180p
74S51	150p
74S74	120p
74S85	450p
74S86	180p
74S112	150p
74S113	120p
74S114	120p
74S124	550p
74S132	120p
74S133	100p
74S138	180p
74S139	180p
74S140	100p
74S151	200p
74S153	200p
74S157	300p
74S158	300p
74S163	400p
74S174	300p
74S175	320p
74S188	180p
74S189	225p
74S194	300p
74S195	300p
74S196	300p
74S200	450p
74S201	320p
74S225	650p
74S240	250p
74S241	300p
74S244	500p
74S251	300p
74S257	300p
74S258	300p
74S260	100p
74S261	300p
74S262	850p
74S283	300p
74S287	225p
74S288	180p
74S289	225p
74S299	650p
74S373	400p
74S374	400p
74S387	225p
74S472	475p
74S474	400p
74S475	450p
74S570	650p
74S571	300p
74S573	500p

4000 SERIES

4000	36p
4001	36p
4002	30p
4006	90p
4007	36p
4008	90p
4009	60p
4010	30p
4011	36p
4012	36p
4013	60p
4014	80p
4015	80p
4016	50p
4017	75p
4018	75p
4019	60p
4020	90p
4021	80p
4022	80p
4023	50p
4024	50p
4025	30p
4026	100p
4027	50p
4028	60p
4029	90p
4030	45p
4031	160p
4032	80p
4033	160p
4034	200p
4035	80p
4036	270p
4037	150p
4038	80p
4039	250p
4040	80p
4041	60p
4042	75p
4043	75p
4044	75p
4045	120p
4046	90p
4047	85p
4048	60p
4049	48p
4050	48p
4051	80p
4052	80p
4053	80p
4054	90p
4055	90p
4056	100p
4059	450p
4060	90p
4063	90p
4066	45p
4067	290p
4068	30p
4069	30p
4070	30p
4071	30p
4072	30p
4073	30p
4075	30p
4076	90p
4077	30p
4078	30p
4081	30p
4082	30p
4085	60p
4086	70p
4089	125p
4093	48p
4094	100p
4095	90p
4096	90p
4097	290p
4098	90p
4099	90p
4501	40p
4502	60p
4503	60p
4504	90p
4505	400p
4506	120p
4507	45p
4508	160p
4510	75p
4511	75p
4512	75p
4513	140p
4514	130p
4515	130p
4516	75
4517	200p
4518	75p
4519	75p
4520	75p
4521	125p
4522	90p
4526	90p
4527	90p
4528	75p
4529	90p
4531	75p
4532	80p
4534	400p
4536	220p
4538	90p
4539	90p
4541	90p
4543	100p
4553	220p
4555	60p
4556	70p
4557	250p
4560	120p
4566	200p
4568	300p
4569	200p
4572	50p
4583	75p
4584	48p
4585	65p
4599	290p
4724	150p
14411	900p
14412	850p
14416	300p
14419	300p
14490	550p
14495	450p
14500	700p
14599	350p
22100	350p
22101	700p
22102	700p
40014	48p
40085	90p
40097	75p
40098	75p
40100	120p

LINEAR ICs

AD7581	£15
ADC0808	1190p
AM7910DC	730p
AN103	200p
AY-1-5050	99p
AY-3-1270	750p
AY-3-1350	350p
AY-3-8910	400p
AY-3-8912	500p
CA3019A	100p
CA3028A	150p
CA3046	70p
CA3059	350p
CA3060	350p
CA3080E	80p
CA3086	80p
CA3089E	250p
CA3090AQ	3.75
CA3130E	90p
CA3130T	110
CA3140E	60p
CA3140T	110
CA3160E	100p
CA3161E	150p
CA3162E	450p
CA3189E	300p
CA3240E	120
CA3280G	225
D7002	450p
DAC1408-8	200p
DAC0808	200p
DG308	300p
HA1366	190p
HA1388	250p
ICL7106	700p
ICL7511	95p
ICL7650	400p
ICL7660	250p
ICL8038	300p
ICM7216B	£24
ICM7217	900p
ICM7555	100p
ICM7556	140p
LC7120	300p
LC7130	325p
LC7137	350p
LF347	150p
LF351	60p
LF353	100p
LF355	100p
LF356P	100p
LF357	130p
LF13331	350p
LM10C	325p
LM301A	25p
LM307	45p
LM308CN	75p
LM310	120p
LM311	70p
LM318	150p
LM319	160p
LM319N	160p
LM324	30p
LM334Z	90p
LM335Z	140p
LM339	40p
LM348	65p
LM358p	60p
LM377	225p
LM380N-8	100p
LM380	120p
LM381AN	180p
LM382	180p
LM386	90p
LM387	120p
LM389	220p
LM391	180p
LM392	60p
LM393	100p
LM394CH	350p
LM709	50p
LM710	50p
LM711	70p
LM725C	300p
LM733	75p
LM741	20p
LM747	70p
LM748	40p
LM1011	480p
LM1014	150p
LM1801	300p
LM1830	250p
LM1871	300p
LM1872	300p
LM1886	700p
LM1889	450p
LM2917	300p
LM3302	100p
LM3900	50p
LM3909	140p
LM3911	200p
LM3914	350p
LM3915	350p
LM3916	350p
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75150P	120p
75154	140p
75159	220p
75161	350p
75162	400p
7536	150p
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75480	150p
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TIP33C	80p
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TIP35C	140p
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2N3553	240p
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2N3706/7	16p
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2N4036	65p
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2N4123/4	27p
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2N4401/3	25p
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2N4871	50p
2N5087	27p
2N5089	27p
2N5172	27p
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2N5245	40p
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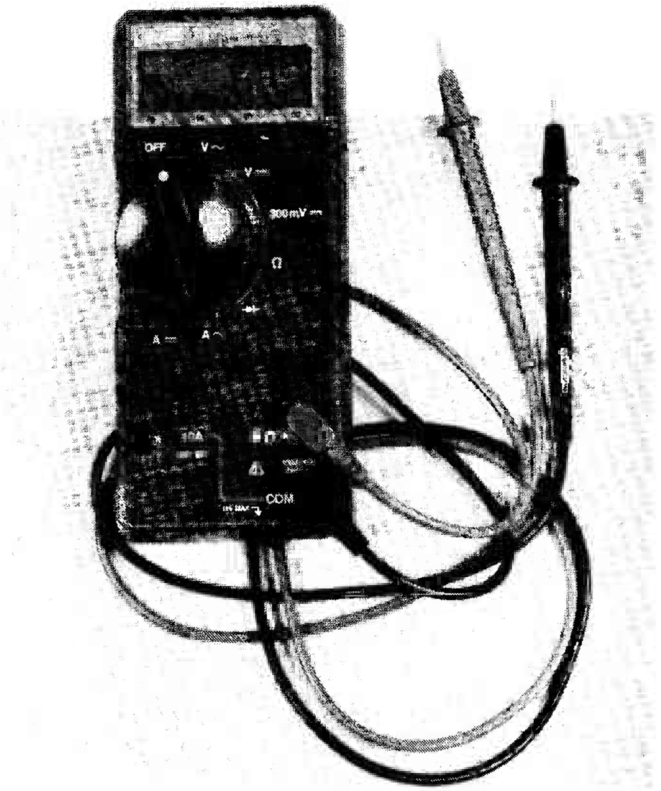
FLUKE 73 DMM

Fluke have introduced a range of meters which combine the advantages of digital and analogue instruments at a price which puts them (just) within reach of the hobbyist. Dave Bradshaw puts one through its paces.



Ever since digital meters first appeared there has been dispute about their advantages when compared with analogue meters. Digital meters are easier to read than their analogue counterparts, both because they allow figures to be read directly rather than requiring the position of a pointer to be gauged against a graduated scale and also because they remove the confusion introduced by the presence of several different scales. They are also, in general, more accurate than moving-coil meters because it is easier to produce good quality voltage reference and conversion circuitry at low cost than it is to control the vagaries of the moving-coil mechanism and the accuracy of the printed scale.

Against this is the fact that digital meters have to sample the input quantity and then process it to produce a display, all of which takes a finite time. It is possible to make the sampling rate very high, but because of the difficulty involved in reading a quickly-changing display the rate is usually kept very low, a few samples a second being typical. Moving-coil instruments by comparison respond continuously to changes in the input quantity and therefore give a more useful representation of slowly changing input quantities. Their mechanical damping also helps to even out ripple or other regular fluctuations present on DC voltages. A digital meter under the same circumstances will merely display a sequence of different figures, and since the samples will have been taken at virtually random points on the fluctuation cycle there is no guarantee that these figures will accurately reflect either the limits or the centre value of the changing input.

One way of combining the advantages of both types of display in one instrument is to add a bar-graph to a digital meter. An LED or LCD bar-graph does not have the mechanical damping of a moving coil display but by dispensing with the need to read figures the bar-graph allows higher sampling rates to be used and hence gives a higher degree of fidelity to a changing input quantity. Such displays have been available on more expensive meters for some time but not on instruments likely to be within financial reach of the hobbyist.

A new series of meters from Fluke may well change that. The three meters in the 70 series, the 73, 75 and 77 all feature an LCD display which includes a bar-graph and the most expensive of them still manages to scrape in at under one-hundred pounds excluding VAT. These hand-held DMMs measure volts, amps, ohms and continuity, are autoranging, and instead of the 1999 full-scale reading usually offered by meters in this class they have a full-scale reading of 3200 which gives much better resolution. Suitably impressed by all of this, I decided to have a look at the cheapest meter in the series to see if it actually lives up to its promise.

Construction

The case of the new Fluke 73 is quite small, and would fit comtortably into all but the tiniest of adult hands. The main colour is gun-metal grey, with white and salmon pink annotation on the range knob. This is not the best choice for legibility in low-light levels, and the range knob annotation becomes illegible long before it becomes impossible to read the display. However, this is perhaps splitting hairs since the annotation is legible in any light level one would contemplate using a test meter in.

I particularly liked the connections to the test leads; these are fully shrouded so you're unlikey ever to get a shock from the connections between the lead and the meter. This is an improvement upon the arrangement adopted in some cheaper meters, where it's all too easy to touch potentially live parts even with the plug fully inserted.

I was less happy with the other end of the leads, the test probes. These have approximately 15mm of bare metal spike protruding which seems rather more than necessary. In use, this type of probe is rather inconvenient as there is no way to attach one lead to, for example, the earth point of a piece of gear while probing around with the other.

A special test-probe set is available, which has insulated alligator clips and one spring-loaded hook-tip probe, as well as spade terminals and more leads. Whilst this is all very well, what puzzles me is that the standard probes appear to have been designed so that special croc clips can be attached to them, yet there is no mention of these in the literature.

My personal preference is for the type of probes supplied as standard with the (admittedly, much more expensive) Avo 8, where insulated clip probes can be exchanged for rather fearsome croc clips. In fact, I find that the insulated clips will do for just about every job, and they have only about 1mm of bare metal exposed when used for probing.

Inside the case is a single PCB onto which all the components are mounted, and this includes the 9 volt battery. On the reverse of the PCB are two ICs, both in flat-pack form, with lead-outs at 0.03" spacing — very little room for error there!

One interesting point to emerge from a cursory glance is that current measurement is made by a true four-terminal method. That is, the resistance inserted into the current path is actually a four-terminal device with two leads at either end, one for current in (or out) and one for voltage sensing.

In Use

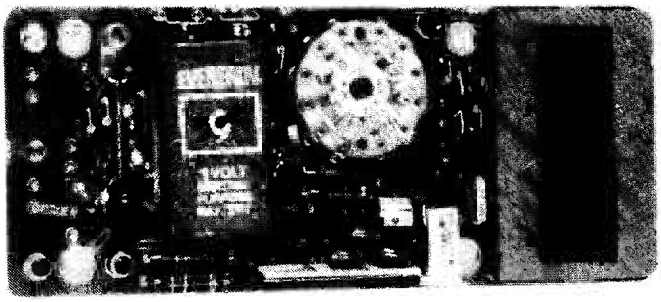
The meter is turned on by moving the single function switch to the desired range. The first function is V AC followed by V DC, 300mV DC, ohms, diode test, A AC and A DC. For the first few seconds all the segments of the display, including the 'analogue' section, are on while the meter carries out a 'self test' routine (though what this involves isn't made clear in the literature).

The V AC, V DC and ohms functions are all fully autoranging, the only exception being the 300mV DC range which is only accessible using the switch (there is no 300mV AC range). One thing worth repeating is that the maximum displayed number is 3200; this contrasts with the 1999 display common on 3½ digit meters, so perhaps the Fluke should be designated a 3¾ type.

The V AC range has a habit of giving an apparently random, fluctuating reading of anything up to 400 mV when the circuit is open. This would appear to result from static pick up since the effect varies with temperature and humidity. The V DC range showed no equivalent effect.

A more serious problem was encountered on the ohms and diode test range. On the ohms range, the count would start out high and simply carry on counting up regardless of what was attached to the test probes. A close inspection of the PCB revealed that there was a tag from the function switch that was not attached to its hole on the PCB. It had failed to get inserted or soldered, and once it had been bent into a suitable position and soldered the meter worked perfectly. It had presumably passed its quality control test because the fault was intermittent. (We 'phoned Electronic Brokers who lent us the test sample and told them of the fault, and their reply was that if we could see what was wrong with the meter we should go ahead and repair it.)

There is only one AC and one DC current range, both nominally 10A (although in the literature it is stated that they can be used at up to 20A for a maximum of 30 seconds). These are obtained by selecting the required function and also moving the test probe



connector to the '10A' position. It is always a nuisance to have to fiddle about with plugs and sockets to change ranges, and it's inevitable that, even when you are familiar with the meter, you are bound to spend some time wondering why the meter isn't registering when you've actually forgotten to move the plug. However, it does mean that the impedance of the current range switch contact resistances aren't added to the meter impedance, resulting in a maximum voltage burden at FSD of 0.5V.

The maximum resolution of both current ranges is only 10 mA so the meter is not of much use for measuring small currents. Most small moving-coil meters will happily measure down to a few microamps DC, but it is not unusual for digital meters to offer only higher ranges. If you regularly need to make low-level AC and DC current measurements you would be better off with one of the other, more expensive meters in the series, both of which have 300 mA AC and DC current ranges (300 mA gives a resolution of 100μA).

Accuracy

Unfortunately, our editorial budget does not run to the standard of instrument it would require to test the accuracy of this particular meter! What I was able to do was to test the meter against itself for consistency in its own readings, on a limited number of ranges.

First, the DC volts. I took a couple of nine volt batteries and measured their terminal voltages, then checked to see what the meter read as the sum of their terminal voltages when connected in series. This was then repeated with the test probes reversed, using the negative range of the test meter. As you can see from the results in Table 1, there was no detectable error, any discrepancies in the results being well within rounding errors.

	Measured Battery 1 Voltage	Measured Battery 2 Voltage	Measured Series Voltage
Meter + to battery +	9.47	9.39	18.88
Meter − to battery +	9.60	9.40	18.88

Table 1 Self-consistency on volts.

MEASURED RESISTANCE 1	MEASURED RESISTANCE 2	MEASURED SUM OF 1 AND 2
1.1	1.2	2.3
9.8	9.8	19.7
9.98k	9.99k	19.98k
10.03M	10.05M	20.09M

Table 2 Self-consistency on ohms.

A similar excercise on the resistance range led to the results in Table 2. Here it was noted that the least significant digit took a second or so to stabilise, and frequently continued after this to fluctuate from one figure to the adjacent one. Also, I must point out that 0.1 ohm is the limit of the meter's resolution; figures quoted in the table are exactly as displayed, but with leading zeros ignored.

The maximum voltage that the ohms range can apply is, according to the specifications, 3V to an open-circuit. This is sufficient voltage to make a PN junction conduct. But will this happen in practice?

My experiments with the meter indicate that below about 300k measurement, the voltage put on the test terminals remains below 0.4 volts, which is insufficient to turn on a silicon junction but sufficient for a germanium one. Above 300k, the voltage rises to the maximum 3V, as the constant current generator tries to push its current through the resistor under test. Thus, below about 300k, resistance measurements on in-circuit resistors will be reasonably accurate (given that the junction will be turning on slightly and lowering the figure by a few per cent) for silicon circuits, but no such assumption can be made for germanium circuits.

Finally, to round off this section, I was complaining about our inability to do full accuracy tests to an engineer involved in testing and calibration. His response was that if the instrument was made by Fluke, testing its calibration would be a waste of time.

The 'Analogue' Display

The digital display is updated quite slowly, at 2½ times per second, which should give ample time to take in the numbers. The bar-graph is updated 10 times faster at 25 times a second.

We compared the impression of the input waveform given by a conventional meter (the trusty office Avo) and the Fluke 73. With the Fluke, it was possible to distinguish between a sine wave and a square wave from the way the bar-graph display behaved at frequencies up to around 2 to 3Hz. The Avo, on the other hand, couldn't give any useful indication of this at frequencies over a few tenths of a hertz. (Actually, we were shifting the zero point of the wave-forms, so that both went only slightly negative; the Avo otherwise spent much of its time with the needle hard against the end-stop.)

One problem that became apparent concerned the autoranging function. There is no way of stopping the autoranging on the 73, although the other two models in the series have manual range-hold. Thus the bar-graph would rise to a maximum as a voltage rose, then go rapidly to a point close to zero when a range-change occured. However, it was obvious when a range-change occured because the main display would flash 'OL' (on a change up) or blank (on a change down). Because of this, the meter cannot be accused of giving a misleading impression but it does mean that in some circumstances it gives no useful impression at all. It's a great pity that the 73 does not have the manual range-hold facility found on the other two meters in the series as without it, the bar-graph display is far less useful than it might otherwise be.

Conclusion

The Fluke 73 digital multimeter is an instrument that inspires confidence, is very nice to use, and, despite a few short-comings and a relatively high price, is worth considering. The 'analogue' display is not as useful as it might be but is certainly more than just a gimmick.

Accuracies are ±(% of reading + no. of digits).
Specified for one year.

ACCURACIES (% + digits)	73	75	77
320mV - 320VDC	0.7+1	0.5+1	0.3+1
1000VDC	0.8+1	0.6+1	0.4+1
VAC (note 1)	3.0+2	2.0+2	2.0+2
320 R	1.0+2	0.7+2	0.5+2
3200R-3M2	1.0+1	0.7+1	0.5+2
32M	3.0+1	2.5+1	2.0+1
Diode test V	1.0+1	1.0+1	1.0+1
A AC (note 1)	3.0+2	3.0+2	3.0+2
A DC (note 2)	2.0+2	1.5+2	1.5+2

Notes: (1) VAC accuracy is for frequency range 45Hz to 1 kHz (45Hz to 500Hz on 3.2V range).
(2) For the 75 and 77, accuracy is 2.0%+2 digits on the 320mA range.

BASIC SPECIFICATIONS OF SERIES

VOLTAGE	Sensitivity, DC	0.1mV (320mV range)
	Overload protection	1000V DC (500V 320mV range) 750V RMS AC
	Sensitivity, AC	1mV
	Input impedance	10M/50p
RESISTANCE	Sensitivity	0R1
	Open circuit voltage	3V max
	FSD terminal voltage	440mV (note 3)
	Overload protection	500V RMS
DIODE TEST	Range	0 - 2V
	Overload protection	500V RMS
CURRENT	Sensitivity	100µA(10mA 73)
	Overload protection	630mA fuse 32mA and 320mA ranges; 10A range unfused (note 4)
	Voltage burden at FSD	0.16V on 32mA; 2.0V on 320mA; 0.5V on 10A
TEMPERATURE COEFFICIENT		0.1 x specified accuracy/deg C from 0 to 18 and 28 to 50 deg C

Notes: (3) FSD terminal voltage is 1.4V on the 32M range.
(4) 73 has 10A range only.

Table 3 The manufacturer's specifications, guaranteed for the first year.

The Fluke 70 series meters are all available from Electronic Brokers Ltd, 61 - 65 Kings Cross Road, London WC1X 9LN, tel 01 - 278 3461. The model 73 costs £65.00 plus VAT, the model 75 costs £79.00 plus VAT, and the model 77 costs £99.00 plus VAT. Postage and packing is £3.00 on all items.

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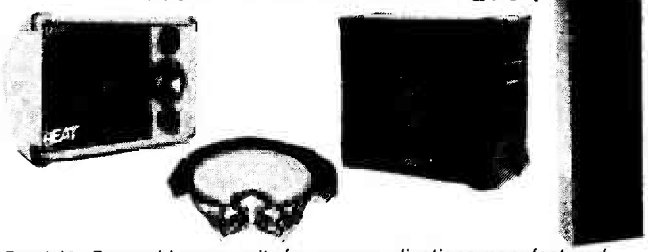

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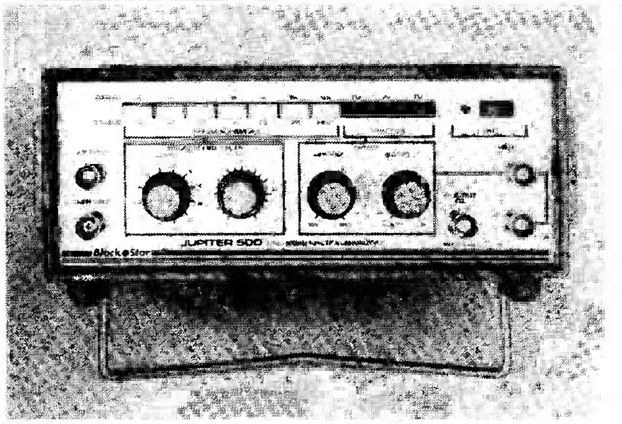

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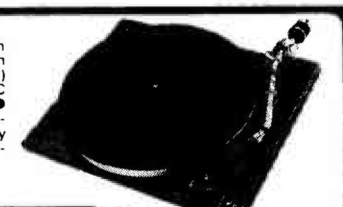

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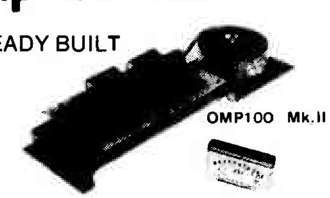

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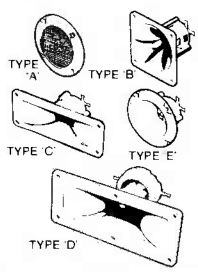

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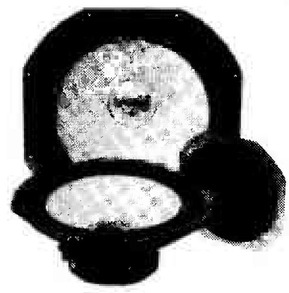

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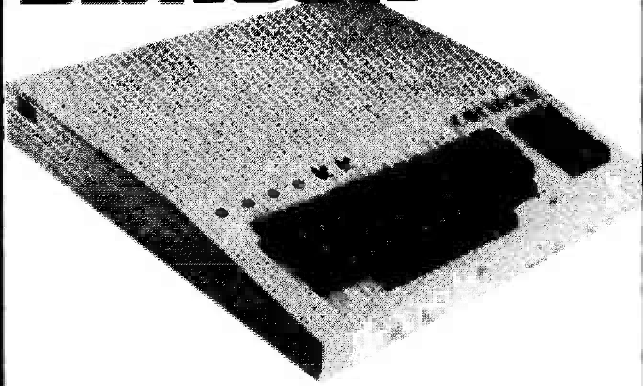

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ACTIVE-8 LOUDSPEAKER

Following on from his modular pre-amplifier project and his article on loudspeaker design, Barry Porter takes us step-by-step through the design and construction of a two or three unit active loudspeaker.

Designing and constructing your own high quality audio equipment can be a very rewarding pastime, with some items in the reproduction chain representing a greater challenge than others. Loudspeaker building may appear to be quite simple and straightforward, but in practice this is not the case. The biggest problem confronting the Do-It-Yourself speaker builder is the need to take frequency response measurements. Audio manufacturers invest many thousands of pounds (or at least, claim they do!) in sophisticated measuring equipments, calibrated microphones, anechoic chambers and computer controlled analysers, and those that do not have their own test facility will spend many long hours in a hired laboratory during the design of a new speaker.

Obviously, the home constructor cannot hope to compete on equal terms with this, so what can be done when you are overcome with enthusiasm and the desire to create something that will justify your impulsive purchase of a complete Black and Decker outfit in 1976? If you are sane, you will take up fishing, so this is dedicated to non-angling, audiophile lunatics everwhere.....

The Active-8 has been designed as an active system, and no consideration has been given to producing a passive version. Throughout the following, sufficient details are given to allow the suggested dimensions to be modified or different drive units to be used. The less energetic may apply the principles to activating some existing speakers, but don't complain if the resulting guarantee invalidation brings on temporary insomnia or hot flushes. The design uses two drive units so that each speaker can be driven by a stereo power amplifier, but details of a tri-amplified version are also given.

It has long been accepted that active loudspeakers have many advantages over their passive brethren, some of which are listed here:

(a) electronic crossover filters may be constructed with much greater accuracy than passive networks, and may be configured to produce amplitude and phase characteristics that are often impossible to implement with passive filters;

(b) high level distortion is likely to be lower, as there are no inductors to drive into saturation;

(c) the direct coupling of amplifier outputs to drive units maintains maximum damping, thereby reducing unwanted resonance to a minimum;

(d) amplifier overload effects are greatly reduced because low frequency clipping is only reproduced by the bass unit, and often passes unnoticed;

(e) differences in drive unit sensitivities can be allowed for without introducing attenuation between the amplifier and driver simply by adjusting the gain in the signal path;

(f) low frequency equalisation can be introduced to extend the response, giving bass output equivalent to that of a larger speaker;

(g) time delay can be used to compensate for the positioning of the acoustic centres of the drive units in different vertical planes, thus preventing a directivity shift in the crossover region.

There are other advantages that are less easily defined, but subjectively, a good active system appears to handle wide dynamic range material with an ease that is not apparent with a similar, passive unit. Transient response is much better and stereo imaging more precise, possibly due to the lack of crosstalk.

Bearing in mind their potential superiority, it is perhaps surprising that so few good examples of active speakers are available. One possible reason for this is that loudspeaker and electronics designers are, almost without exception, totally separate breeds of animal. Few speaker designers are at home with present day filter and amplifier technology, whereas to most electronics designers, a loudspeaker is the result of a fair amount of mumbo-jumbo and an intravenous injection of BAF wadding. At a commercial level, loudspeaker manufacturers tend to be wary of anything that plugs into the mains as they are convinced that this is likely to bring about the instant destruction of their handiwork, and amplifier manufacturers, who are often "Cottage Industry" based, dare not think about the additional real estate required for the storage of lots of wooden boxes or the price of installing an anechoic chamber.

The few active speakers on the market that are both electronically and acoustically well engineered are invariably expensive, although there are examples around that would be better utilised by removing the drive units and turning the cabinets into condominiums for gerbils.

Before deciding to "Go Active", you may wonder if it is going to be worth the expenditure of energy, grazed knuckles and sawdust on the Axminster. The answer, from one who has been active for the past ten years or so, is a resounding YES, so brush up your 'O' level woodwork, comandeer the dining room table for a couple of weeks, and prepare yourself for the forthcoming revelation....

The Active-8

The design procedure of any loudspeaker may be divided into a number of distinct stages. In brief these are:
(a) decide cabinet size, drive units, bass loading etc;
(b) build prototype cabinet and take frequency response measurements of drive units mounted in place (No crossover network is involved at this stage);
(c) plot desired response of each unit, and by deducting this from the previous measurement, establish the required crossover network response;
(d) design the crossover filters and unit equalisation to be as near as possible to the target response established at (c);
(e) measure the complete system and correct any equalisation errors to achieve an output that is as flat as possible over the audio band;
(f) listen to lots of music — if subjective performance is below par, return to (a) (bit like snakes and ladders, isn't it?);
(g) when satisfied, invite all your friends along for a quick listen before your enthusiasm brings on acute turning of the volume knob, leading to terminal overdrive of one or more of the units.

Obviously, the steps that require response measurements are the most difficult for the home constructor, so for the Active-8 these have been done for you. If you decide to use drive units other than those recommended you have a problem, although some unit manufacturers are quite helpful at supplying anechoic response curves of their products in different sizes of enclosure. These can be reasonably accurate for bass units, but high frequency units should really be measured while fitted to a baffle of the right size as diffraction caused by the cabinet extremities can have a marked effect on the response. If you are activating an existing speaker, a good indication of the crossover response can be obtained by applying a 20 Hz-20 kHz sine wave to the speaker input and plotting the drive unit terminal voltages. This assumes that the overall response is acceptable in the passive mode, as any shortcomings will be repeated in the active network unless accurate acoustic measurements can be made.

Drive Unit Choice

Being a two unit design limits the bass driver diameter to 200mm, as anything larger would be distinctly unhappy operating up to the 2.5 — 3kHz region which is necessary to avoid overloading the high frequency unit.

Several low frequency units were considered, and four were selected for detailed examination and testing, these being from Peerless, Kef, Seas and Volt. The Peerless and Volt units were rejected for various technical reasons, leaving the Kef B200G and the polypropylene coned Seas PZ1 REX as main contenders for the job, with very little to choose between them.

Various high frequency units were tried, with the Kef T33A and Skanspeak D2008 coming out on top. The Kef T52 was not far behind, being preferred for its performance in the 2.5 — 5kHz region, but falling down at higher frequencies. In order to make the final choice cost and availability were entered into the equation, and the final design is based on the Kef B200G and T33A.

This all sounds quite simple, but of course the various combinations of bass and high frequency drivers all had to be mounted into cabinets, crossovers had to be designed and built and measurements made. To avoid littering up the love-next with dozens of cabinets, a single pair were used, and the front baffles were duplicated with the necessary mounting holes for each pair of drivers. This meant that A-B comparisons could only be carried out between single combinations of units, but after a great deal of midnight oil had been burned, it was clear that the Kef units offered the best overall performance, although the Seas — Skanspeak combination handled transients with somewhat greater clarity. If you decided to use drive units of your own choice, make sure that you can obtain the necessary technical data for them. For the bass unit you will require the following parameters: free air resonance (f_S), driver Q (Q_{TS}) and suspension compliance (V_{AS}). For both units, you will require frequency response curves derived from anechoic or free-field measurements.

Bass Loading

A great deal of consideration was given to the type of bass alignment employed, resulting in what we in the trade call a "sonic breakthrough" which is what the rest of humanity recognises as a compromise that avoids having to make a difficult decision. The Active-8 has been designed as a reflex system, but with provision to blank off the tuning vent, plug in a circuit board and turn it into a closed box with active correction of the low frequency response.

The information necessary to carry out the bass alignment calculations was given in Bass for Beginners in the April issue of ETI (You have, of course, got a copy!) So it will not be repeated here.

As a guide, the Active-8 in its reflex guise is happiest when used in a room of 60-100m³. In a room smaller than 60m³, the vent should be blanked off so that the extended bass is not over-emphasised by the additive effect of room reflections. If you are fortunate enough to have a living room of more than 100m³, the equalised closed box will probably be preferable, but the final decision should be made after extended listening periods.

Cabinet Size

The B200G data sheet reveals the following information:

f_S = 27Hz
Q_{TS} = 0.37
V_{AS} = 90 litres.

Referring again to the aforementioned article, it can be calculated that the B200G requires a reflex cabinet volume of

V_B(enclosure volume)
= 67.66 litres

but for closed box operation, with a system Q(Q_{TC}) of 0.707 to give the flattest low frequency response:

$$V_B = \frac{V_{as}}{\left[\left(\frac{1}{\frac{1}{Q_{TC}} - 0.2}\right) \bullet \frac{1}{Q_{TS}}\right]^2 - 1}$$

= 22.77 litres

Unless you intend to pioneer a new type of expanding speaker

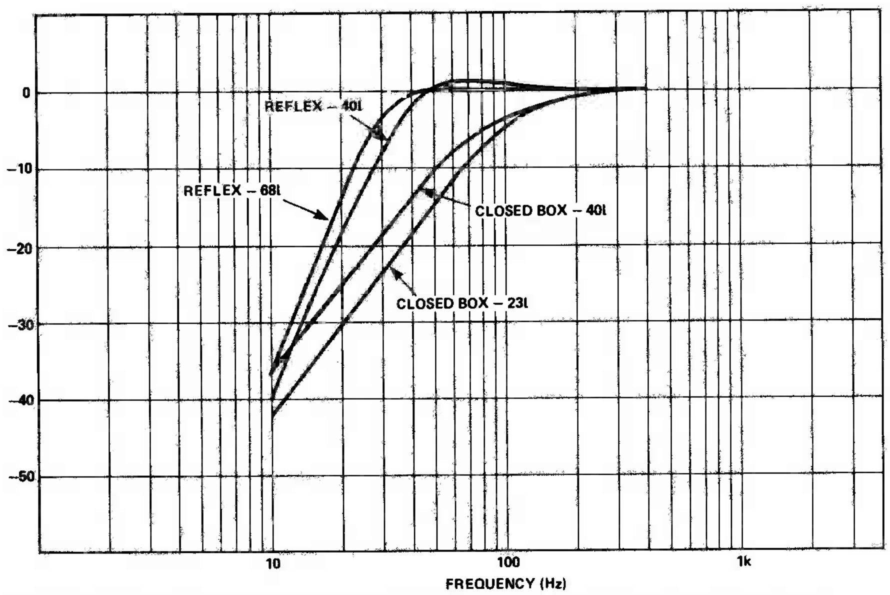

Fig. 1 LF response of the Kef B200G in optimum sized enclosures and in the Active-8 cabinet.

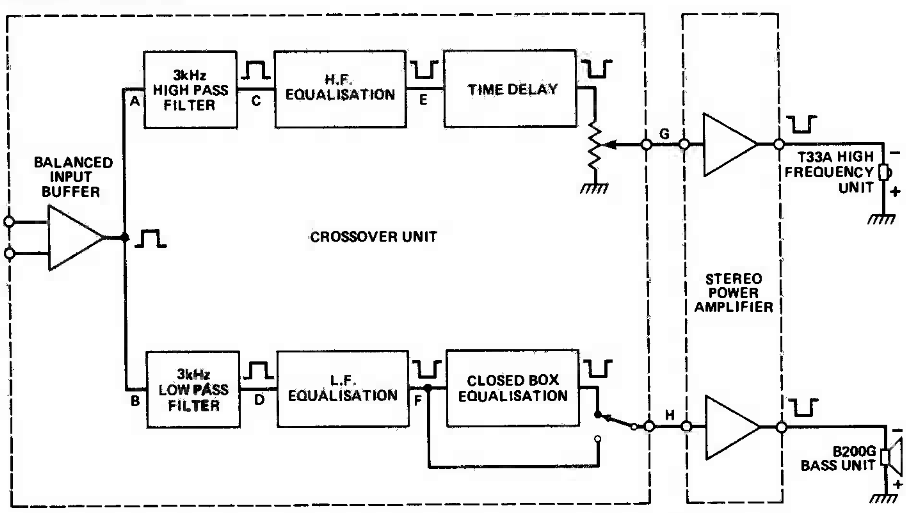

Fig. 2 Block diagram of the signal-handling stages of the Active-8 system.

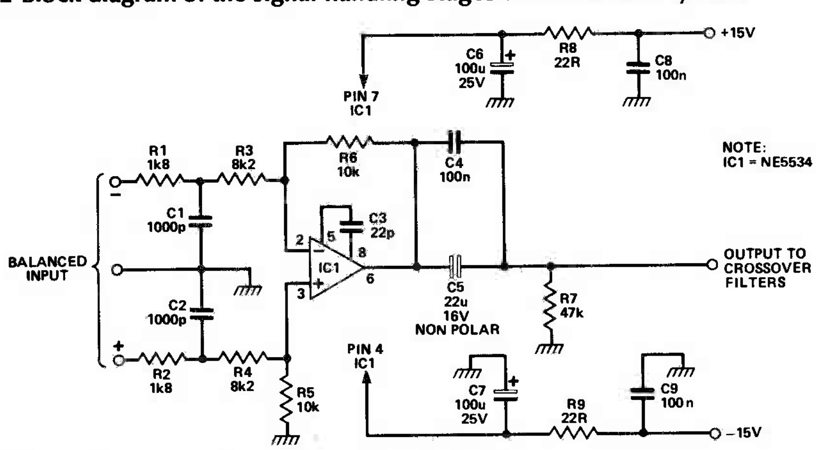

Fig. 3 Circuit diagram of the balanced input buffer.

cabinet, it is obvious that the Active-8 enclosure volume will have to be somewhere between these two extremes. The effect will be a hump in the response just above the low frequency roll-off point, whereas a larger than optimum closed box will have a Q_{TC} of less than 0.707, and will consequently exhibit an early roll-off with a gentle, rounded response shoulder.

After much calculating and plotting, the Active-8 enclosure volume was fixed at 40 litres. This gives a reflex response with a hump of:

$$R = 20\log\frac{Q_{TS}\left(\frac{V_{AS}}{V_B}\right)^{0.31}}{0.4}$$

$$= 1.5\,\text{dB}$$

which is not likely to be objectionable. With closed box operation the system Q becomes:

$$Q_{TC} = \frac{1}{\left(\frac{1}{Q_{TS}\sqrt{\left(\frac{V_{AS}}{1.2V_B}\right)+1}}\right)+0.2}$$

$$= 0.557$$

Figure 1 shows a comparison between the Active-8 low frequency response and the same bass driver in optimum sized enclosure. It will be seen that the 40 litre curves are not far away from the optimum ones, so the choice is obviously about right.

The tuning vent should be a length of plastic rainwater pipe with a 75mm internal diameter (D_V). The cabinet is tuned to a frequency given by:

$$f_B = f_S\left(\frac{V_{AS}}{V_B}\right)^{0.31}$$

$$= 34.7\text{ Hz}$$

which requires that the vent length is:

$$L_V = \frac{2340}{F_B^2 V_B} \bullet D_V^2 - 0.731\,D_V$$

$$= 218.5\text{ mm}$$

The Crossover Filters

A block diagram of the complete 'Active-8' system is shown in Fig. 2. It will be seen that each section of the crossover unit consists of a filter and an equaliser. Additionally, the high frequency path contains delay ciruitry to compensate for the acoustic centre of the T33A being about 38mm in front of that of the B200G, and the low frequency path has the facility to add bass equalisation for closed box use.

At the input of the crossover

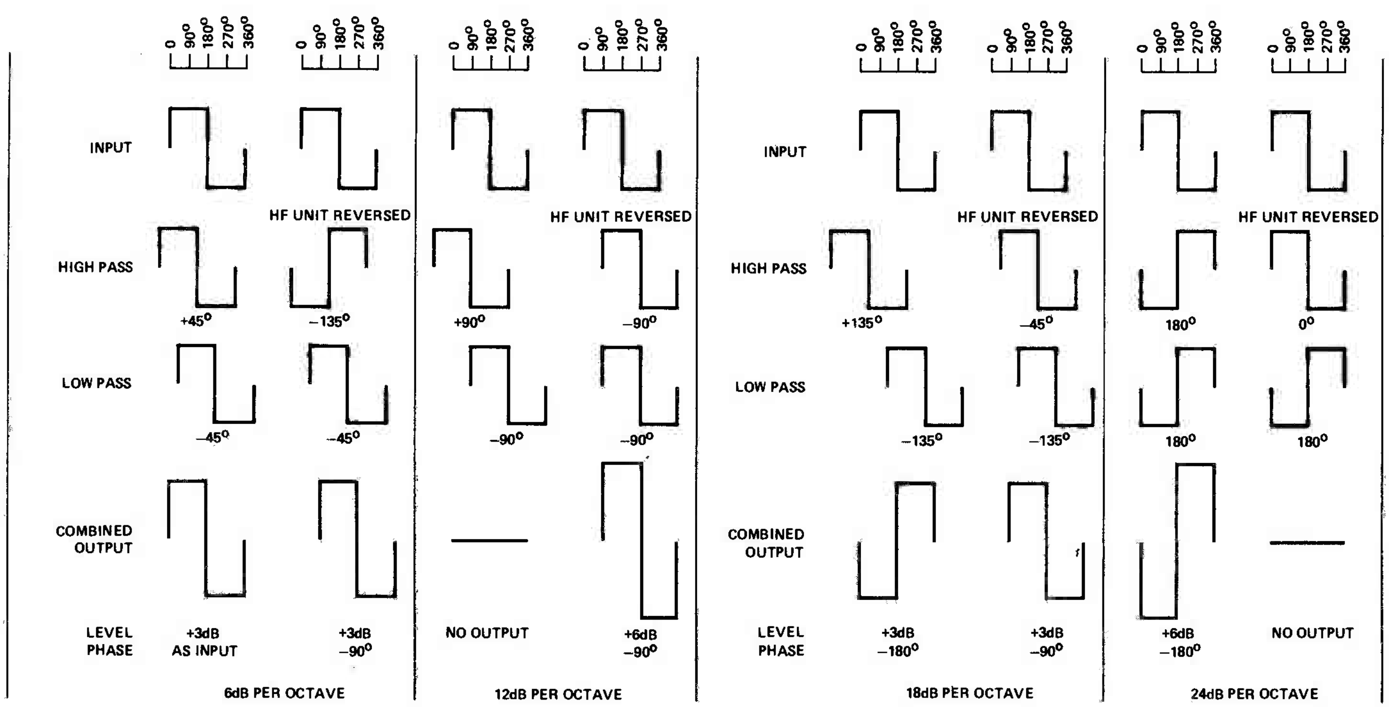

Fig. 4 The effect of 6, 12, 18 and 24 dB per octave filters on signal level and phase.

unit is a balanced unity gain buffer stage, shown in Fig. 3. Until recently, only professional equipment had balanced interconnections but as operational amplifiers have become acceptable in top quality domestic equipment, some manufacturers have begun to appreciate the benefits of balancing and are making provision for balanced lines between pre and power amplifier or pre-amplifier and active speakers. (For more about balanced operation plus the circuit of a balanced output stage, see ETI January 1984)

The input of the balanced buffer amplifier contains a degree of protection against radio-pick up by the connecting leads. Resistors R1 and R2 and capacitors C1 and C2 form a filter with its −3 dB point at 88,4 kHz — providing the signal source has a low output impedance. If used with a pre-amplifier with a high output impedance — say 10k ohms — this high frequency roll-off will move down into the audio range, so the value of the capacitors will have to be reduced to 150 pF to avoid this.

The buffer amplifier output is AC coupled to the high and low pass crossover filters by C4 and C5. The non-polarised electrolytic is by-passed at high frequencies by C4 which should be a polycarbonate or polypropylene type. Carefully controlled listening tests have shown that polarised aluminium electrolytics, which are often used for inter-stage coupling, can cause effects which, although virtually impossible to measure, can be heard when an impeccable music source is used. During these tests, a bypassed non-polarised capacitor could not be detected, and for this reason, is used in the Active-8 whenever a large value component is necessary.

The traditional crossover filter is a 12 or 18 dB per octave Butterworth stage, which has a number of shortcomings that have been eliminated in the Active-8 network.

The problem is this: the crossover should ensure that the combined output of both drive units remains constant at all frequencies. The effect of using 6,12,18 and 24 dB per octave filters is illustrated in Fig. 4. It is important that both drivers are in phase through the crossover region, as any phase difference between them will cause their combined radiation pattern to tilt downwards, leading to colouration from increased floor reflections. This rules out the 6 and 18 dB per octave slopes; the 12 dB per octave filter with reversed connection of one drive unit or the 24 dB per octave version both have the desired phase relationship between their outputs, but suffer from a 3 dB jump in their combined response. In order to add two in-phase signals and arrive at a unity output, each signal must be 6 dB down at the crossover frequency. This is easily accomplished with both 12 and 24 dB per octave stages by placing two 6 or 12 dB per octave filters in series. Both types are illustrated in Figure 5.

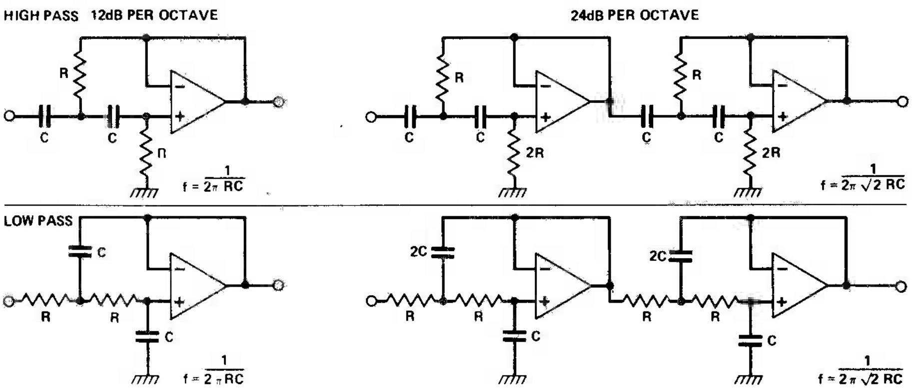

Fig. 5 Circuit diagrams of 12 and 24 dB per octave high and low pass filters.

This discussion of the design process will be completed next month, after which we will move on to describe the construction of the Active-8. **ETI**

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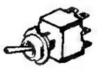

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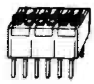

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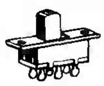

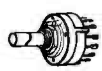

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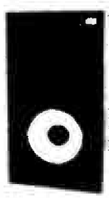

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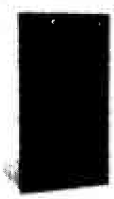

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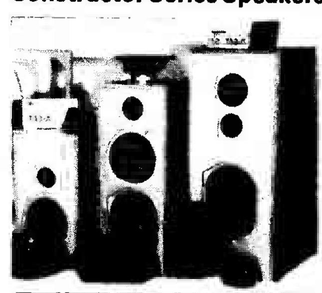

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Some "Friendly" Criticism

Dear ETI,

Don't read on if you can't take some friendly criticism. OK, so you think you can, or you're just too curious to stop or your garbage can has not been emptied. Anyway, you certainly have been warned!

Well, for some time I have been looking for a simple and inexpensive Z80-based controller-type microcomputer, and even if Marvin (August to October 1983 issues of ETI) didn't appeal too much to me, I decided to give it a try. My mixed feelings about Marvin arose not really from the system itself but from the lack of information about the system in the ETI articles. For example, the O.S. EPROM listing was not given, and although a sample program for generating an output sequence to a stepper motor was listed, you left your faithful readers out in the cold on such matters as data/program transfer protocol between Marvin and another computer (for prototyping), and how to use O.S. routines for keypad scanning, seven-segment display, and specifications for keypad and display, etc, etc. However, we were told that full details would be supplied together with the O.S. EPROM from Ark Electronics.

This, it seems to me, is bad practice. The obvious thing to do when you publish a project is to give all the details necessary for a competent reader to build it on his own if he wishes to. Very few of your readers, I guess, enjoy being dependent upon one sole distributor. For your readers overseas this is even more important as the supplier will be located in the U.K.

OK, then, I had to turn to Ark Electronics, and so I did, asking for details on all of the Marvin system, ie., also on the boards mentioned but not described in the October 1983 issue of ETI like the speech board, A/D & D/A boards, light dimmer, a possible keypad and display board and other boards.

One week later, at the beginning of June this year, I received a rather disappointing answer telling me to forget the whole thing! No information about the system could be given and no parts could be sold to me; why, I was not told.

You will probably say something about being sorry for the incovenience, and that things like that do happen. I already know, since almost exactly the same thing happened to me last time I tried to build an ETI microprocessor project (the Microtutor from Tangerine). That project also was far from completely described in ETI, and quite a few weeks went by from the day I placed the order until the day I received a letter telling me that the product had been discontinued. And, as this time, no information was published in ETI about parts/kits not being obtainable anymore.

The conlusion is obvious: give complete information on all projects published and be more critical and demanding of kit/crucial part suppliers! Besides subscribing to ETI I also subscribe to Wireless World and Elektor. Will you ever forgive me if I tell you that you have a lot to learn from the Elektor projects? So you won't........ well then, let me tell you that my impression of a lot of the bigger projects that have appeared in ETI in the last few years is that they have suffered from a lack of information, and, to tell you the truth, some of them seem to have been just free advertisements for kits from manufacturers such as Powertran and Tangerine/Microtanic. So why do I still subscribe to ETI after all these years? Well, my subscription has to be renewed this summer, but I'm not going to do anything about it until you've answered this. In the past, I have enjoyed your smaller, simpler more innovative projects and this, really, is where you appeal to me. So I guess that in a year or two I will still be one of your faithful readers but, let me tell you this, don't push me!

You also have a refreshing style and a sense of humour which I appreciate, and having read all of this you might perhaps still allow me one wish: I am very interested in ZX81 add-ons (you remember the ZX81 — there are thousands and thousands of them around). I really need a kind of motherboard which plugs into the rear of the ZX81 on a cable and which is fitted with bus drivers, 16K of RAM and will accept the usual ZX81 add-ons as plug-ins. This will allow me to use several add-ons (ZEPROM, I/0 board, interface board, speech board, music board, hi-res graphics, etc) simultaneously, add-ons that otherwise would have to be plugged into the rear of the ZX81 one at a time.

All the best from your faithful (oh yes!) reader,

Rolf Ingebrigsten,
Oslo,
Norway

We have spoken to Ark and they have agreed to continue to supply the PCBs for the various sections of Marvin, along with both versions of the EPROM. Prices have been forced up due to circumstances beyond their control, and the prices are now:

4MHz EPROM £8.00
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P&P on the above £0.50p (UK).

Due to rises in the prices of semiconductors, it is no longer economic for Ark to supply full kits.

Ark also tell us that they did initially supply the other boards mentioned in the article, but the demand for them was so low that they found it uneconomic to continue.

The EPROM listing was not given because it would have been so long. For example, on page 25 is the EPROM listing for the keyboard Interface, which uses 256 locations. The Marvin listing would need 2048 locations, and so would occupy at least 5 pages, all of solid code!

Turning to the Microtutor, again the EPROM listing would be much too long for us to print, and it would be almost impossible for constructors to distinguish between

hardware faults and wrongly entered code. However, we were quite unhappy with the way our readers were treated by Tangerine, who simply lost interest in the Microtutor and the Microtan 65; we were relieved when Microtanic took over both products. And we did print notes to say that the supply of the Microtutor had been discontinued and to say that it was once more available but through Microtanic.

However, there is one underlying problem that we — and all the other electronics magazines — have to face, and that is that the fees we pay to authors cannot meet the 'commercial' cost of developing designs. So, either we rely on enthusiasts who do the design and development for their own enjoyment and are glad to get some return, albeit not the £20 per hour that a 'professional' would charge (not that some of our contributors are anything less than professional in their approach!). Or we find a kit supplier who is willing to finance the development — and quite often a kit supplier will be a small business like Ark.

We try to persuade the kit suppliers to let us publish full detail of projects, including EPROM listings and PCB foil patterns, which, by and large, we are allowed to do. However, as with the two cases above, it is sometimes impractical for us to publish full details.

Finally, your suggestion for a ZX81 mother board has been noted!

Electronic Piano...

Dear Sirs,

I appreciate your magazine very much and have been reading it for ten years. I especially like your music projects. What I would very much like to see is a project on a really good electronic piano, touch sensitive and preferably with 'Fender sound'. Please tell me if such a project is planned, and also if you have ever done a review of the Clef piano.

Sincerely,
Peter Annmo
Vastra Frolunda,
Sweden

No electronic piano project is planned at present but we will certainly keep it in mind. Of course, if anyone out there has designed such an instrument we would be interested to hear from them. We have never reviewed a Clef piano but we would be happy to do so if there were sufficient interest among our readership. Perhaps other readers would like to send us their comments on the suggestion?

... Or Printer Buffer

Dear Sir,

I would like to suggest that you produce a design for a Printer Buffer as a future project. This would have the advantage of being suitable for use with any computer that has a Centronics or Serial output to a Printer.

Commercial Printer Buffers are available but they appear to be inordinately expensive.

Yours faithfully
Michael Lowe,
Loughton,
Essex

Shhh! Don't tell any of the other electronics mags, but there may just be one on its way from us!

ETI

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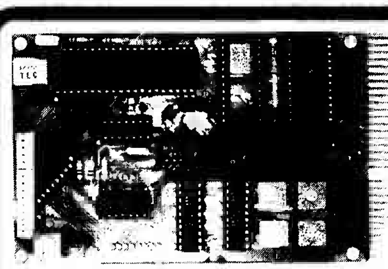

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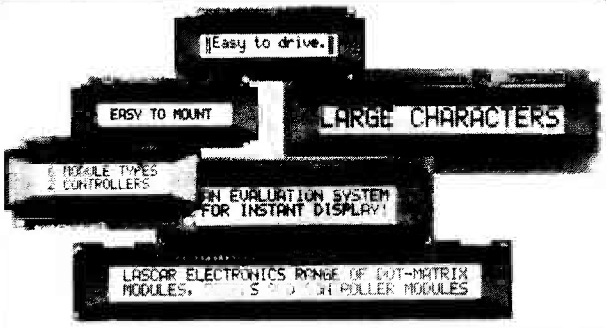

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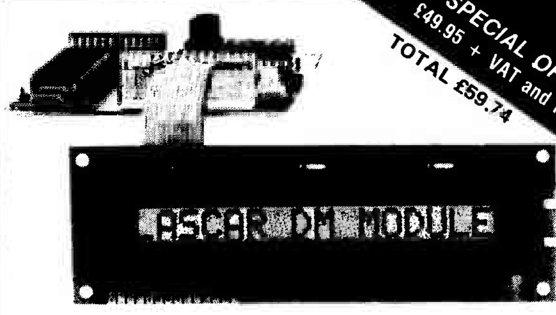

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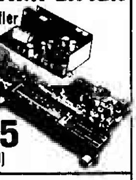

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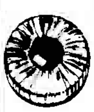

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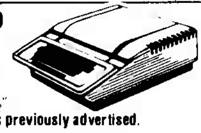

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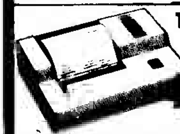

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DRY CELL CHARGER

Bored with batteries running down? Too skint for NiCads? Here's a project from Vivian Capel that's worth a try!

Recharging dry cells isn't supposed to be possible. Using a conventional charger may apparently rejuvenate a cell, but as soon as a load is connected, the cell voltage will drop away quite quickly.

The usual solution is to use NiCads, but these, and the charger needed for them, are expensive, and may be uneconomic in applications where only occasional, small currents are drawn. The circuit has been rejuvenating dry cells for some years with a high rate of success.

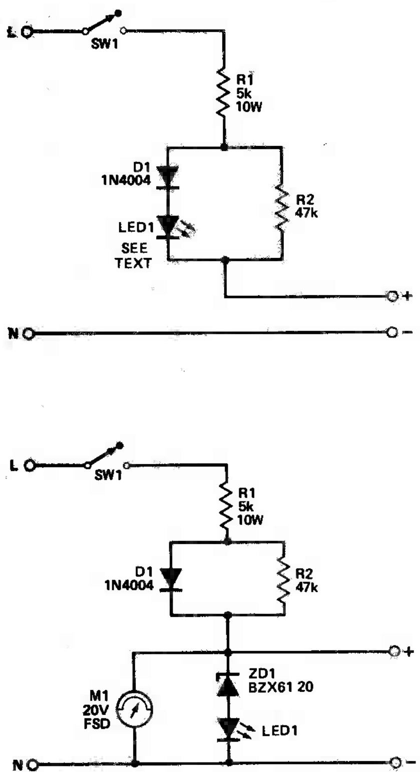

Fig. 1 Two circuit diagrams: (a) (top) the 'standard' version; (b) (bottom) the de-luxe version.

The AC Component

The secret of this charging unit, if such it may be called, is to apply a small amount of AC along with the normal DC (actually, rectified AC) charging current. What this does is not clear, but it does make the charging work (at least, most of the time). A possible explanation is that in recharging, metallic zinc which has been removed from the negative electrode during discharging by electro-chemical action, is re-formed onto it; in some types of electro-plating processing, it has been found that applying an AC current along with the DC produces smoother plating.

A mechanical analogy for this process is that the charging proceeds in a series of jerks, the jerks forward being much stronger than the jerks backward.

A Drop In The. . .?

To keep costs down, the charger unit here uses a dropper resistor rather than the more usual mains transformer. The current drawn is low, and the heat generation in the resistor is probably no more than the losses in a small transformer supplying a similar current.

Furthermore, the use of a dropper resistor bestows the unit with greater flexibility than a transformer unit would have, in that it will supply a constant charging current which is virtually independent of the battery terminal voltage, and of the number of cells connected in series.

Two possible circuit options are available: the 'basic' and the 'de-luxe'. The latter incorporates a meter to monitor the battery's progress. The 20V meter suggested will be suitable for batteries of 6,9,12 or 18 volts; however, when used with several batteries in series (as opposed to a number of cells in one battery), the meter does not give a particularly useful indication, as it simply gives the total of the terminal voltages.

Construction

Because this project uses the mains, and **none** of the circuitry is isolated from the mains, a good deal of care must be exercised in the construction and housing. Furthermore, in use but with an open circuit, the + battery terminal will be at full mains potential, so the switching of the unit must be arranged so that it cannot be operated while any

HOW IT WORKS

The circuit itself is simple enough: a dropper resistor, R1, reduces the voltage of the mains down to the battery voltage. Actually, using a large value resistor is a way of providing a (virtually) constant current source, because the voltage of the battery will be small in comparison to the mains voltage: any change in battery voltage will only make a very small change to the voltage across the resistor.

The normal charging path is through D1 and LED1 (in Fig. 1) or just D1 (Fig. 2). R2 provides a reverse current for the section of the mains supply for which the L line is negative.

LED1 in Fig. 1 indicates that the charging current is flowing — this is quite useful when charging a number of cells in series, because it is quite easy to get a bad contact.

In Fig. 2, a meter has been added so that battery voltage may be monitored. It is necessary to protect the meter from over-voltage, as potentially harmful currents could flow through it in the event of an open circuit at the battery; ZD1 does this, and LED1 may now be placed in series with ZD1 to indicate a fault condition.

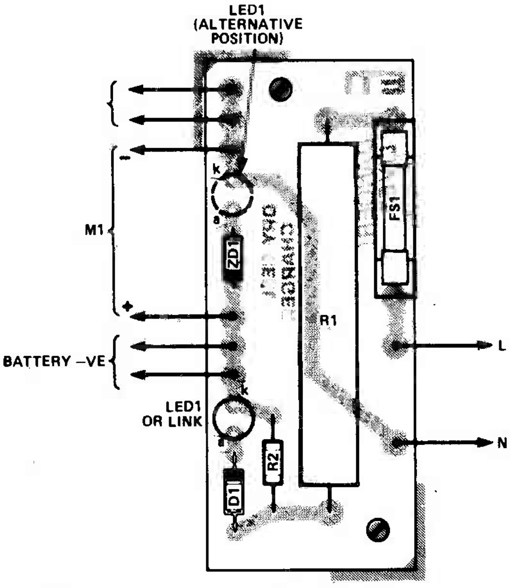

Fig. 2 The component overlay; for the standard version, omit ZD1 and connections to meter; for the de-luxe version, link across the lower LED1 position and use the upper position (shown dotted) for the LED itself.

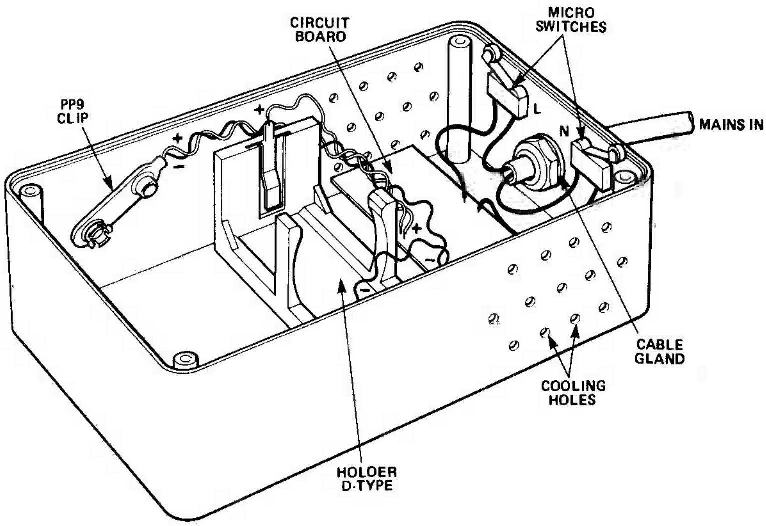

Fig. 3 The suggested method of assembly into the case. Note that we have added another switch in series with the neutral line for additional safety.

PARTS LIST

RESISTORS

R1	4k7, 5W
R2	47k, ½W

SEMICONDUCTORS

D1	1N4004
LED1	LED to choice
ZD1	BZX61 20V zener (1.3 W)

MISCELLANEOUS

M1	20V FSD meter (or to choice)
FS1	200mA fuse (20mm) and holder

Plastic case to suit (eg BICC-Vero 826-21391A); battery holders and/or clips, to choice; PCB; mains cable and gland.

sections of the circuit or the batteries are exposed.

The suggested method is shown in Fig. 3, with the charger mounted in a plastic box. Two microswitches are used to switch the mains lines off as soon as the lid is opened. A single, double-pole microswitch could have been used, but the only type we could find was hideously expensive.

All the screws used to connect through the box walls must be plastic, including those holding the hinges, but especially those securing the PCB. If for any reason you decide to use a metal case, it must be earthed and all live parts including the batteries themselves, must be well insulated from it. Finally, don't skimp on the cable gland — this would be false economy.

It may seem a bit over the top to use a PCB for a circuit so simple (see Fig. 2) but conventional circuit boards, with narrow spacings between tracks, are not suitable for mains applications. Of course, you can construct the circuit using good quality tag-strip or some other similar method that will give adequate insulation between the live and the rest of the circuit.

In Use

It cannot be claimed that the capacity of a recharged battery is equal to a new one or that every battery responds well. Nor will a battery last through an indefinite number of charging cycles: we cannot turn a primary cell into a secondary one. However, the normal life of a battery can be considerably extended. Depending on the type of battery, the discharge, and rest periods between use, around half a dozen cycles can be expected before the capacity drops to a point that makes further charging a waste of time.

Large batteries such as lantern batteries, PP9s, and D cells are the most successful, while small ones such as AA cells and PP3s have limited success. Perhaps the loss of capacity is more noticeable with the smaller cells, and the large ones are usually discharged well within their current capability. A further series resistor has been tried, to reduce the current when charging small batteries, but it has not helped much. So try by all means, but do not expect too much from them.

If the cell voltage has dropped to below 1.1V, a successful recharge is far less likely. Do not therefore, discharge your batteries too far before recharging. Make 1.25 the lower limit but preferably charge even before that point. A good practice is to keep them topped up, giving a short charge after a period of use to bring the voltage up to new. Another tip is to charge as soon as possible after discharging, even if a period is to elapse before using again; cells keep better when fully charged than partly discharged.

Do not though allow too long a period to elapse between discharges. If fitted to infrequently used equipment, switch it on for a few minutes at least once a month.

During charging, cell voltage will rise to about 1.6V or a little over. Stop the charge then. In some cases the voltage will climb to around 1.8V or even more if charging is continued, but overcharging can affect the cell's capacity adversely.

To forestall any questions, experience in charging **alkaline** cells has been very limited. One set of AA cells that were accidentally run down in a cassette recorder responded well, but others have not been so successful. Really, it is cheaper to buy zinc carbons and keep them charged!

ETI

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THE OUTS AND INS OF BATTERIES

Choosing the correct type of battery can be a confusing business; Vivian Capel shines a (torch?) light to make it clearer.

When faced with the task of powering a piece of portable equipment, a choice must be made from the bewildering range of batteries that are now available. The wrong choice can be needlessly expensive and be possibly unsuitable. With most commercial equipment, the makers specify a battery that will, in most cases, be the best for the job. In the case of home-constructed items the user must make the choice, and, with commercial instruments, a change of use may make a different powering arrangement desirable.

The first basic decision is whether to use non-rechargeable battery for electronic equipment, but are batteries (secondary cells). Frequency of use, discharge rates and cost all have a bearing.

For example, NiCads are the most common type of rechargeable battery for electronic equipment, but are some three to four times the cost of alkaline cells, which in turn are about three times the price of ordinary zinc/carbon cells. Hence you could buy up to twelve ordinary zinc carbon cells for the equivalent NiCad. So if the drain and frequency of use is such that a zinc battery lasts for six months or more, it would take six years to recover the cost of a rechargeable, ignoring the cost of the charger.

Another consideration is that zinc/carbon batteries are not entirely unrechargeable, but can be given a useful life extension equivalent to several times that of the original capacity. However, more of this elsewhere in this magazine.

Zinc/Carbon Cells

The zinc/carbon cell is based on the Leclanche cell which in its simplest form employs a zinc negative and carbon positive electrode with an electrolyte of ammonium chloride solution. Zinc is eroded during the cell action liberating hydrogen gas. Bubbles of the gas form around the carbon electrode, effectively insulating it and thereby stopping the action until they have cleared. In this condition the cell is said to be polarised. After resting and dissipation of the bubbles, the cell is depolarised and ready for use again.

Manganese dioxide will alleviate the effects of polarisation. This chemical has a strong affinity for hydrogen, and a chemical reaction occurs during which oxygen combines with hydrogen to form water, which slightly dilutes the electrolyte.

Occasional small discharges will result in a surprisingly long life from zinc/carbon batteries, far longer than the normal shelf life, which explains why batteries used in door-bells and multimeters, for instance, tend to last so well.

Even so, the depolariser takes time to absorb hydrogen and the cell can still become polarised with heavy continuous currents. Hence, this type of cell is not well suited for such applications.

There are high power versions of the standard cell which use thin paper separators in the construction, and more depolariser which is especially pure and fast in its reaction. These are, naturally, dearer and do not offer any increase in life or capacity, but will sustain high currents without polarising. For example, a D cell of standard construction will sustain 0.5A for about 18 minutes before polarising whereas a high-power version will run on for over 3 hours.

In the case of small cells such as the AA, discharges are likely to be high in proportion to the cell's capacity, so the standard construction has now been superseded by the high-power type.

Alkaline Cells

For many applications the alkaline battery is worth considering. This is also a primary type, being non-rechargeable, but it has many advantages over the zinc/carbon unit. It provides the same voltage of 1.5V per cell, but uses compressed manganese dioxide as the positive electrode which serves as its own depolariser. Potassium hydroxide is the electrolyte.

Cell capacity is from four to five times that of an equivalent zinc/carbon cell and the cost is around three times that of the carbon. Thus there is a cost/capacity advantage, and less frequent replacement means less inconvenience and possibility of being let down. Shelf life is longer, and long heavy discharges can be sustained; the cell has a low internal resistance and is not affected by extremes of temperature to the extent of the zinc/carbon unit. For smaller batteries, the alkaline type will prove to be better than the standard type in almost every case, but where a large number of D cells are used, the cost can give one second thoughts! (Also, the larger zinc/carbon ones are the most successful candidates for recharging.)

In comparison with zinc/carbon cells, alkaline cells have a much smaller difference between their effective capacities for heavy continuous discharge and for light occasional discharge, the latter yielding a 10 to 20% higher effective capacity than the former. Thus it is possible to give approximate cell capacities for the alkaline battery. These are: D cell — 10,000 mAH; C cell — 5,000 mAH and AA cell — 1,500 mAH. Recently, the Ever Ready Gold Seal range was introduced which, it is claimed, has more active ingredients than other makes and so achieves a capacity increase of between 4 and 23%. (However, Duracell also claim to have recently improved on the figures above by around 20% — Ed.)

Cost is not proportional to capacity, the large D cell being less than twice the cost of the C. So, if space and weight are not major considerations, it pays to use the largest battery that can be accommodated, unless the current is very low.

Layer-Type Batteries

Unit cells can be inconvenient for equipment use, especially when more than 6 volts are required, as a suitable holder must be employed and mounted. A more practical solution is the layer-type in which the cylindrical cells are replaced by stacked rectangular versions. Most common of these is the large PP9, then the intermediate PP6 and the tiny PP3. These are all 9V, as is the much larger and not often encountered PP10, but there is a 6V one too, the PP1.

Designed for the intermittent and fluctuating current required by transistor radios, layer batteries are less suited for continuous currents. Experience has shown that to obtain a reasonable life the following are the maximum continuous currents that should be drawn: PP3, 10 mA; PP6, 25 mA; PP7, 35 mA; PP9, 65 mA; and PP10, 150 mA. As with the torch cells, the cost/capacity ratio improves as the size increases, so it always pays to use the largest that can be accommodated unless the discharge current is very low.

An alkaline version of the PP3 is available and this is very useful, as it combines reasonable capacity and current capability with small size. In most cases it will be more satisfactory than the normal type. It is a pity that one of the larger sizes, say the PP6 is not made in alkaline.

For larger currents there is a 6V hand-lamp battery with screw terminals, and a lantern battery with spiral contacts. The latter has a capacity of about 3,200 mAH and is one of the most cost effective of the zinc/carbon batteries. Connections can be made by unwinding part of the spiral and fitting electrical screw terminal connectors to the straightened ends. For 12-volt applications there is the high power HP1.

Lithium Cells

A more recent development in current use is the lithium cell. It has a very long shelf life, over 6 years, which makes it eminently suitable for volatile memory back-up power as no trickle charging is necessary. It also has a remarkable power-to-weight ratio, typically 148 and watt-hrs/kg, and can be wired directly to printed circuit boards. Nominal voltage is 2.95V per cell. One cylindrical unit somewhat smaller than a C cell has a capacity of 1,000 mAH and a weight of 20g (0.7 oz).

Small Fry

Where small size with low power is required, the button cell is frequently used. As its name implies, the appearance is of a silver button. The most common type is mercury, in which the negative electrode is zinc and the positive is compressed graphite and mercury oxide; potassium hydroxide is the electrolyte.

The off-load terminal voltage is 1.35, dropping to 1.2V at the rated current. Unlike most other types of cell, the voltage remains steady to the end of its life, when it drops rapidly to below 1 volt. This is a useful characteristic where a constant voltage is required, although it means that the state of the cell cannot be determined from the voltage.

Common applications of the button cell are electronic watches, deaf-aids and lapel microphones. However, mercury cells appear in a wide range of formats and sizes including an AA version, with cell combinations to give voltages up to 5.6V. The low internal resistance and absence of polarisation are desirable for many applications including photographic equipment.

Button cells are also made in an alkaline version which has about the same capacity for the size as mercury, but a 1.5V terminal voltage; there are also silver oxide rechargeable button cells.

Rechargeable Cells

Usually described as secondary cells, these can be charged and discharged many times, but not indefinitely. Each type has a life of a certain number of discharge cycles beyond which the cell suffers an increasing loss of capacity.

The oldest and best-known is the lead/acid battery which consists of interleaved plates of lead peroxide (positive) and spongy lead (negative) immersed in the electrolyte, dilute sulphuric acid. Its principal feature is the ability to deliver high currents for sustained periods; it also has a high capacity. Drawbacks are weight and size, and also the danger of acid spillage.

The latter danger can be overcome by using a jelly electrolyte or porous separators between the plates that absorb all the acid. In one method of construction, the plates and separators are compressed together to achieve a better capacity/volume ratio and also retention of the active material on the plates.

With the conventional construction, material flakes off the plates causing loss of capacity, and also forming a conductive sediment at the cell bottom. This grows until it bridges the bottom of the plates causing self-discharge. With some models a sump is formed to accommodate this and delay the bridging, but this reduces the capacity/volume ratio. The porous separators, by retaining plate material, prevent sediment forming. However, the power/volume ratio and power/weight ratio is not quite as good.

NiCads

Although these were patented back in 1901, it took 50 years before successful sealed versions were developed sufficiently for them to become a popular power source. They are made in D, C, AA, PP3 and PP9 sizes, in addition to various rectangular configurations. They can be used as a direct replacement for dry primary cells but the terminal voltage is 1.25V per cell, less than is available from the equivalent zinc/carbon or alkaline cell, which can, occasionally, cause problems.

NiCads are also available in button cells which in

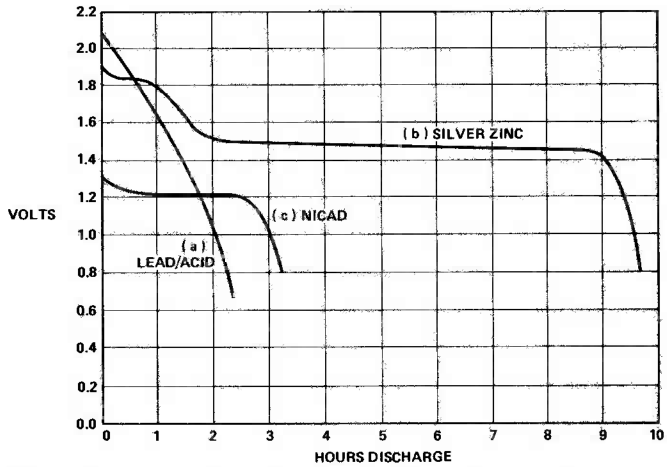


Fig. 1 Discharge characteristic of different types of rechargeable battery of similar weight and discharge rate: (a) lead/acid; (b) silver/zinc; (c) NiCad.

CELL TYPE	TERMINAL VOLTAGE (V)	CAPACITY RANGE (mAH)	MAX CURRENT (A)	CHARGING CYCLES	ENERGY/ WEIGHT RATIO (WH/Kg)	ENERGY/ VOLUME RATIO (WH/litre)
ZINC/CARBON D CELL	1.5	2000	0.5	—	35	48
ALKALINE:						
D CELL	1.5	10000		—	115	242
C CELL	1.5	5000		—	115	185
AA CELL	1.5	1500		—	88	100
PP3	9	300		—	53	120
LITHIUM	2.95	1000		—	148	98
MERCURY OXIDE:						
BUTTON CELLS	1.35	35-1000		—		88-175
AA CELL	1.35	2400		—		157
LEAD/ACID:						
JELLY	2.0-12.0	1-110 AH	80-700	500	30-36	75-84
POROUS SEPARATOR	2.0-12.0	4-90 AH	20-200	500	22-35	42-70
NICAD:						
D CELL	1.2	4000	8	2000	28	77
C CELL	1.2	200	4	2000	30	60
AA CELL	1.2	500	1	2000	24	27
PP3	8.4	110	0.5	2000	24	44
PP9	8.4	1200	1.6	2000	28	36
BUTTON CELL	2.4	110-600	0.2-1.2	—	23	42-47
SILVER ZINC	1.5	1000-10000	40-400	50-150	40-70	65-125

Table 1 Chart of cell characteristics. Selection of the most suitable type for any particular job is a case of listing the required characteristics in order of importance and then using this table to find the type that most closely fits. However, note that these figures are for guidance only, as many factors can affect cell performance.

some cases consist of two very thin sections in series to give a double voltage of 2.4V. Diameter is rather larger so they are not directly interchangeable.

The cost is high: the batteries themselves cost around 12 times the equivalent zinc/carbon types, but on top of that is the cost of a constant-current charger (a constant current source is needed because of the low internal resistance of the cells). So NiCads are probably economic only for equipment which needs frequent replacement of batteries due to high current drain or continual use.

A characteristic which must be considered is the 'memory effect' in the charge/discharge cycle. If the cell is only partly discharged before recharging, the capacity will drop to a value dependent on the previous discharge. The cause of this is crystals which form in the electrolyte. Complete discharge before recharging is therefore essential to preserve full capacity. Some battery makers claim freedom from this effect.

The power-to-weight and power-to-volume ratios are about three-quarters of an equivalent capacity lead/acid cell. Compared to their torch cell counterparts, Nicads have about 1½ times power-to-weight and power-to-volume ratios of zinc/carbon cells, but only a third of those of the alkaline cell.

Other features which make them attractive for particular applications are: the voltage remains within 1.3 — 1.2V from fully charged to discharged; they can be stored indefinitely in any state of charge without damage; they can be charged quickly, and have a wide temperature tolerance; and they have the longest life expectancy amongst rechargeables of up to 2,000 charging cycles.

Safety vents are provided to liberate any gas produced by abuse, but the oxygen produced by the positive electrode is absorbed at the negative so ventilation is not normally required.

Silver/Zinc Cells

This cell has a zinc negative and silver oxide positive set of plates with potassium hydroxide as the electrolyte, which can be free or contained in porous separators. The construction is similar to the lead/acid cell.

It has the highest power to volume and weight ratios of any currently available secondary cell, having around a third of the weight and volume of a comparable lead/acid battery. The output voltage is constant at 1.5V over almost the whole discharge cycle and very high currents can be taken for the size of the cell: a cell can in fact be discharged in a few minutes without damage.

Rapid charging can be employed, although care must be taken not to overcharge. As the voltage rises quickly to over 2V when charging is complete, it is comparatively easy to arrange a voltage-sensitive cut-out on the charger.

The principal disadvantage, apart from cost, is the limited number of discharge cycles which can be expected. Up to 50 is quoted for high discharges, but up to 150 for more moderate use. This is much lower than the anticipated 500 of lead/acid cells, and 2,000 for nickel cadmium. The volume and weight ratios would be the prime considerations for using this type of cell.

The types of cell we have considered are those that are currently available. There are other more exotic types being developed, some of which are under the cloak of secrecy, and which undoubtedly will surface in due course. **ETI**

AUDIO DESIGN

John Linsley Hood finishes up his description of the amplifier and preamplifier with some tidying up.

The Editor of ETI had decided, and this was a decision I gratefully accepted, that if this amp and preamp was to be a contender for the top, then it also must look the part. Since any DIY metalwork would obviously not meet this requirement, a professional case-maker had to be brought in, and through the good offices of ETI, Newrad Instrument Cases Ltd, were called to my help.

This has resulted in a very elegant looking amp, in satin finished metalwork with wooden side panels, but led to the sort of complications which can arise when the circuit designer and manager of the body shop live in offices a hundred miles apart. Fortunately, in the case of the preamp (no pun intended) the circuit boards and metalwork settled down together very happily, as shown in the photograph.

To avoid possible earth loops, I have linked all the earthy sides of the rear phono sockets together, and tied these to the main chassis plate by a very short length of wire at a point adjacent to the pick-up inputs. The earthy side of the phono inputs is also taken directly to the pin on the RIAA Input board, which I have mounted as close as practicable to the pick-up phono sockets.

The power supply board, mounted at the RH rear of the chassis is positioned close to the mains inputs, and as far removed from the inputs as sensible. I have used the + and − 15 volt and 0V points on the PSU PCB as distribution points to take wires to each of the active modules (ie, the active boards are wired for supply purposes to the PSU, not to each other).

Because the PSU and the headphone amp both require to dissipate a small amount of heat, I have tied the case clips of the transistors and voltage regulators, through appropriate insulating hardware, to a 'Z' shaped strip of metal, clamped, in turn, to the main chassis plane. This has proved in practice to be quite adequate to ensure that all devices keep cool.

The small input buffer stage (my apologetic afterthought) is mounted immediately behind the input selector switch, and I have adopted the option of taking all signals through it, so that the whole internal signal wiring is at a low impedance, and therefore largely immune to unwanted pick up.

The LEDs which serve as function reminders are all connected through the appropriate selector switches from 0V to +15V, via a 3k3 resistor in series with each. If one is sitting on the opposite side of the room, it is useful to be able to check that one hasn't inadvertantly left the tone control or rumble filters in circuit after the need has passed.

Because ETI and Newrad have gone to some trouble to ensure that the completed unit is a pleasing assembly, I have tried to keep the wiring neat and have laced it together in bundles, with appropriate colour coding for functions, where there would not be any possiblity of unwanted cross coupling. Do not, for example, lace up inputs and outputs, unless these are carried in screened cables.

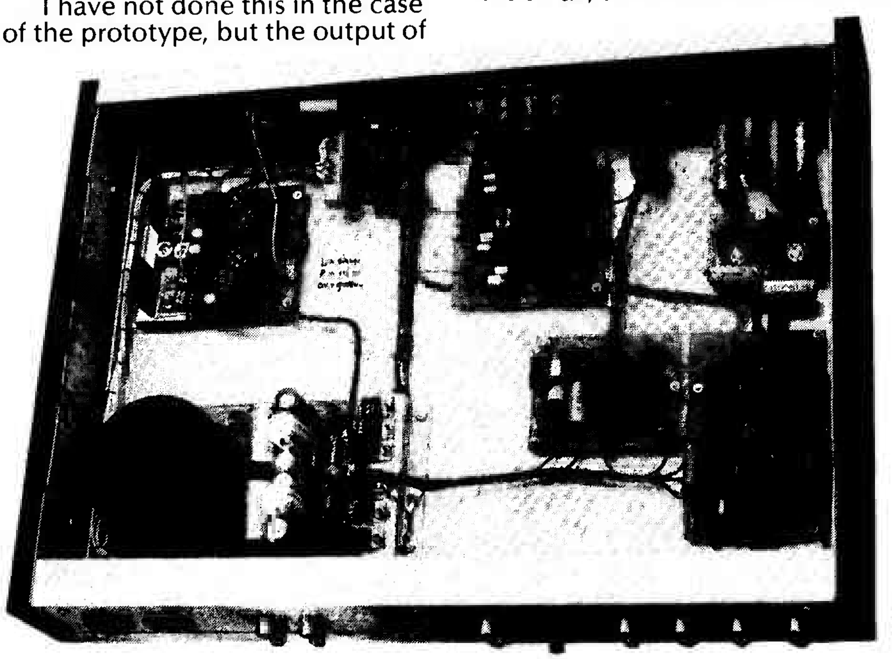
I have not done this in the case of the prototype, but the output of the headphone amp could be taken to the rear of the unit to provide a higher signal level output to a more normal power amp unit.

The headphone amp has its own + and −15V supply, which is separate from that of the rest of the preamp, and it also has a separate connection on the 0V line to the 0V output point on the PSU.

The Proof Of The Pudding

This lies, it is said, in the eating. So, after all this effort, how does this amp and preamp combination sound? Unfortunately, doing all the important things right and getting a good technical specification is not in itself a cast iron guarantee that the sound will be well, if only because no-one can be quite sure that they know all the important things or what is necessary to specify. For these reasons, all power amplifiers and preamplifiers sound very slightly different — from one design to another — though there does, in my experience, tend to be a family likeness between the designs of one particular designer in terms of sound quality.

To be sure, these differences are small, and tend to make them-



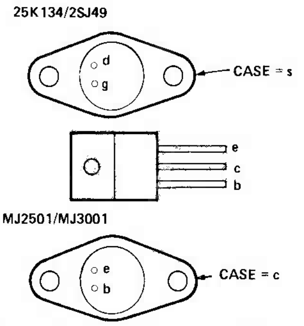


Fig. 1 The pin-outs of some of the off-board transistors.

selves more apparent after a few hours or a few days acquaintance with a new system. This coming to terms is greatly helped if the environment, the music in question, and the ancillaries are familiar. I do not know whether I am speaking for other designers when I say that I am always a little apprehensive on the first trial, to be sure that all is as I hope. In this particular instance I am very well pleased. I have heard a lot of amplifiers. I think that this is the best I have heard yet. Moreover, this opinion is shared by some of my friends whose judgement I value, and I have used as guinea pigs in listening trials. The particular, and unexpected, quality which this design has shown, apart from a surprisingly solid bass (which could be simply the benefit derived from the fully stabilised power supplies — this is the first time I have used one in my domestic amps) is an extraordinary degree of sound detail and 'transparency', of a kind which I have only ever found in the past with headphone amps.

The effect of this is to disclose a wealth of previously unremarked minor aspects and incidental noises from instruments, all of which tend to add to the vividness of the fantasy world created in ones living room by the artistry of the programme or record producer.

Obviously, no author will want to report that his efforts have been unsuccessful, and I am very pleased therefore that I can be both truthful and complimentary. I hope that in time this verdict will be shared by others.

Odds And Ends

A question which inevitably arises with any design is the extent to which active components can be interchanged. In general, within limits, devices should be interchangeable without much overall effect on the performance. These limits are:

1. Working Voltage — don't use a 20V max. transistor where the line voltage is 50V, but the converse is OK

2. Current Gain — if a chosen device has a current gain in the range of 250-400, one with a gain of 40 may give disappointing results; one with a gain of 120 would probably be satisfactory.

3. Noise Figure — some devices are specifically chosen for low noise (these usually have a high current gain too, but this will not, by itself indicate low noise); this is usually important only at the front ends of preamps.

4. Gain Linearity — this is usually important in output devices, and may influence the choice of particular types.

Also in output devices, the HF characteristics will have determined the type of feedback compensation employed. It is usually as well to stick to the author's recommendations here.

In my own case, and I suppose I am typical, I have certain device types which I keep in the boxes in my workshop, and which I buy in 100-off quantities when the stocks need replenishing (because this is cheaper). Therefore, I tend to use these devices in my designs, simply because they are to hand — not necessarily because they are any better. Whether substitutes will work as well I cannot say, and cannot easily test — but I'd guess that they will. Often in the evolution of a design I will have swapped types around a bit, to make sure that my first choice was the best. I do not recall that I have ever found much difference.

Ferrite beads are sometimes advocated as a simple way of cutting out unwanted RF breakthrough. Treat these with care. If no significant current is flowing in the wires around which they are threaded, they will do no harm, but in output stages they can be disastrous. For example, a single ferrite bead around one LS lead will worsen distortion at 10

BUYLINES

Kits are available for the pre and power amplifiers from Newrad Instrument Cases Ltd, Unit 19, Wick Industrial Estate, Gore Road, New Milton, Hants BH25 5SJ (telephone 0425 615774). Prices are as follows: pre-amp, including the modification £98; power amp (including meters, mute and switch-on mute circuitry) £120. Newrad will supply the PCBs alone as follows: preamp £15; power amp £11. Here prices are for a full set of PCBs. Newrad can also supply the components required for the pre and power amps, but we suggest you contact them directly for details. All the prices given here include UK postage but no VAT, so please add 15% for this.

In the power amplifier p.46, July 84, the label of Q3 has been left off the diagram. Also, in the text, the values of C3, C5 and R4 are listed as being the HF stability compensating components. This should have read C3, C5 and R3. In referring to the load stability, the range should have read 8R// 100 nano-F (0.1uF) to 8 R//2.2uF.

Preamp.

I must start my list of errors, here, with a red face! A reader has, very properly, pointed out that my RIAA stage, Fig. 3 (and 2) ETI June 1984, will only work as claimed, (and as I ruefully admit, as calculated and measured) into a load which has effectively an infinite impedance. With the actual load resistances implied by the circuit layout shown in Fig. 1, this condition is not met, and the 75 us second integration characteristic of the RIAA spec is impaired. The best answer to this problem is to feed the RIAA stage into a buffer circuit which does look like an infinitely high impedance. Two possibilities exist for this: 1. to use a pair of FET input ICs as unity gain voltage followers, (a TL072 or a LF353 would do this nicely) or 2. since I prefer at this point to avoid ICs, to make a discrete component buffer stage. These two options are shown in Fig. 2a and b. The small bipolar-FET symmetrical compound source follower circuit works extremely well, with negligible steady-state or transient distortion and I am tempted to suggest that this should follow the input selector switch as shown in Fig. 3, as a universal input buffer, which would allow all the subsequent signal wiring to be at a low impedance.

On the RIAA stage R6 should be 100R (not 100k). I am sorry also that on the description of the headphone amp., the component numbers on the drawing had become out of step with the circuit description. (It is, however, not too difficult a detective job to discover that R11 should read R8, C5 watts and 20KHz from 0.015% to 0.4% ! Just like that!

Finally although I had no idea that the outcome of my series on Audio Design would be that I would end up with the nicest, and best-looking amplifier I have yet owned, I hope that the explanations and calculations I have attempted will have dispelled any beliefs that good results arise from some kind of magic. They are the outcome, all being well, of sensible layout structures and the right answers to the sums which can be made to relate to them. Nothing in this field is sacred, and no-one is ever absolutely right in the choices made. If you know the reasons for the choice and the sums that have been done, you can do the same sums, and maybe improve on the results. **ETI**

CORRECTIONS

should read C6, and that R9, R10 and R12 should have read R9, RV2 and R13. Also C1/C2, C3/C4 should read C2/C3, C4/C5.)

PCBs And Overlays

Some small errors have crept into the PCB designs and the overlays for them. If you have already made your own boards, then the corrections should be quite easy to carry out. The boards sold through Newrad should have all the corrections made to them. The corrections are as follows:

RIAA Stage, P27, June: R2 and R102 have all been left off the overlay; they should be between and parallel to D1 and R5, and D101 and R105 respectively. R6 is 100R, not 100k (this is correct in the parts list but not on the circuit diagram).

Buffer/Filter, P28, June: on the overlay diagram (the LH section) a connection from ICI pin 4 to the −15V supply track down the middle of the ICI has been missed; an extra piece of track has appeared, linking the top ends of C2 and C3, and this should be removed; both these errors appear on the foil pattern on page 69.

Tone Stage, P28, June: The tracks linking R9, 10 and 8, and R11, 12 and 13 should themselves be linked similarly, the tracks linking R109, 110 and 108, and R111, 112 and 113 should be linked (note that the tone stage is the right-hand section of the overlay diagram); these errors appear on the foil pattern on page 69.

Power Amplifier, P49, July: the emitter and labels on the connections on Q9 are reversed, although the body is drawn the correct way round. A piece of PCB track is missing, and it should link ZD1 anode to R16, RV4 wiper, etc; this fault is repeated on the PCB foil pattern on page 67.

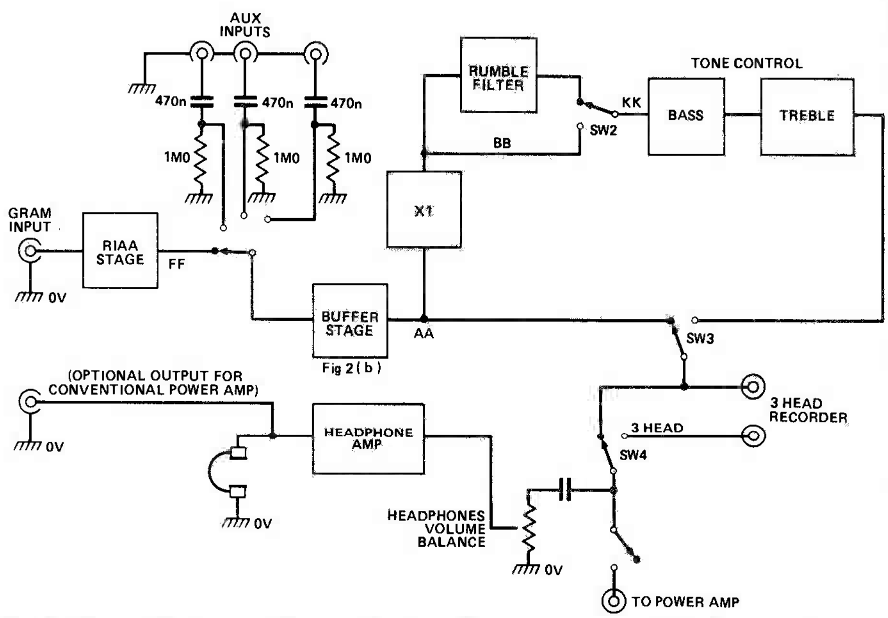


Fig. 3 Alternative lay-out of preamp using discrete component buffer stage.

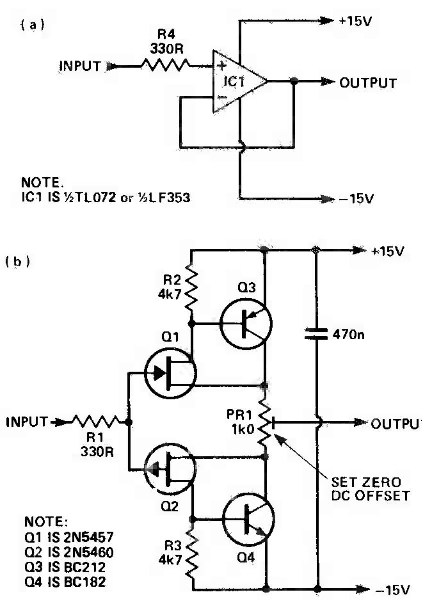


Fig. 2 RIAA stage output buffer options (one channel only shown): (a) using an op-amp, Zin in excess of 1000 Megohms; (b) using discrete components, Zn in excess of 100 Megohms.

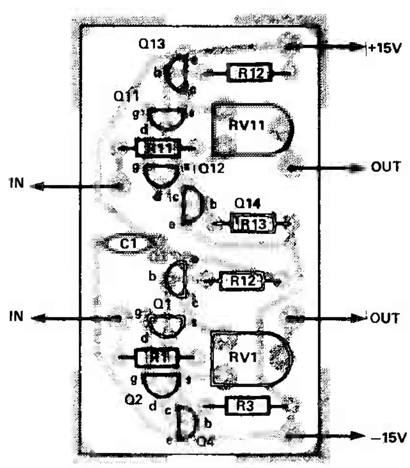


Fig. 4 The overlay diagram of the discrete component buffer.

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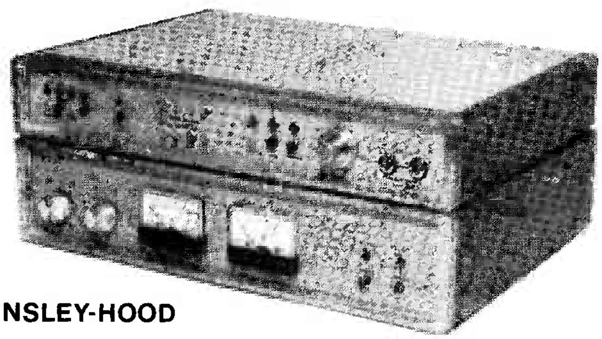

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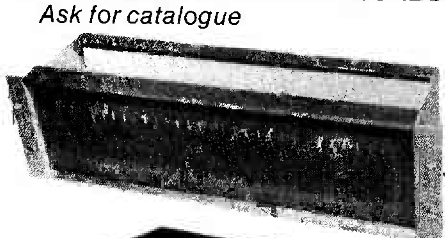

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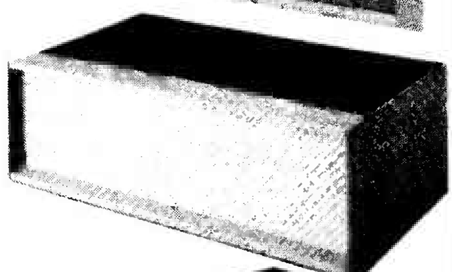

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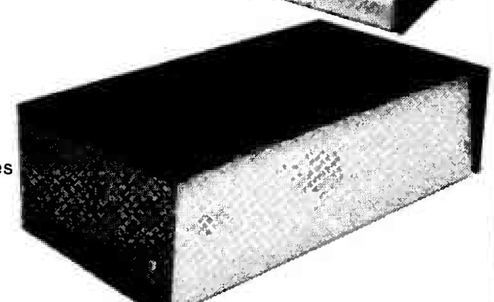

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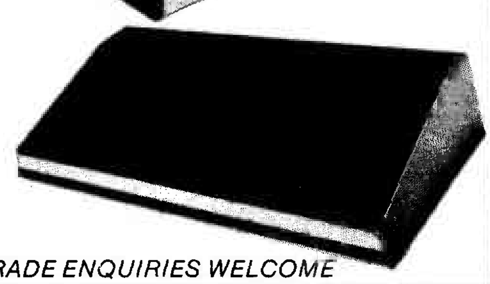

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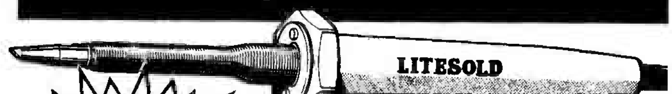

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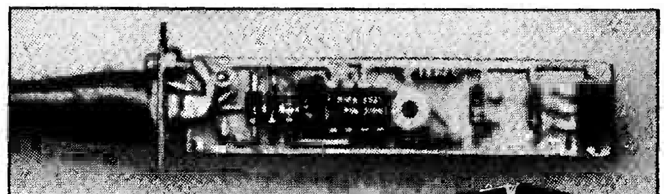

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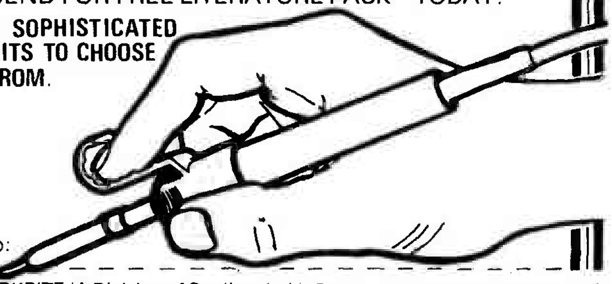

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REVIEW : BRIDAGE OSCILLOSCOPES

The name behind the well-known Scopex range of oscilloscopes is Bridage, and Bridage have a range of their own scopes. Phil Walker takes a look at the single beam SB121 and its dual version, the DB242.

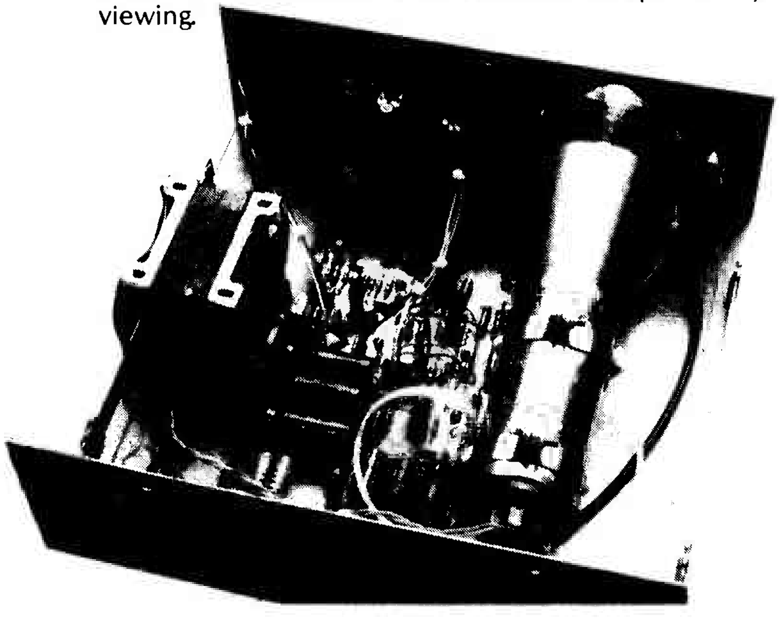
The two units arrived at our offices well protected in cardboard box, polystyrene foam and polystyrene bag. Once we ripped our way into the packages we found two rather nice looking pieces of equipment. This of course did not satisfy the more enquiring minds of the ETI staff and the judicious application of a screw driver soon revealed the inside story. Surprise, surprise — we found them neat and tidy inside as well.

Most of the electronics is on a single PCB in the single trace model with only the mains transformer, tube, front panel controls and a few associated components mounted off the board. In the dual beam version, an extra PCB is added piggy-back to the main one. This board carries out the functions of input amplifier and trace switching to give the dual trace capability.

The CRT is almost invisible inside its magnetic screening and is as far away from the mains transformer as practicable. The main PCB is mounted between the CRT and transformer and, on the whole, there is quite a lot of space inside the cabinet.

The case of the instrument is made in two parts. Each is 'U' shaped and has a pair of brackets welded on which carry the fixings to bolt it to the other. The lower part is enamelled in a fawn colour and contains the whole instrument. The front panel, which is part of the lower section, is screen printed with all the necessary legends in black. This colour combination is quite easy to read and also shows up the connector sockets well.

The top part of the case is treated with black enamel and also carries the strap handle. Underneath the case there are four plastic feet and a fold-down bracket which can be used to tilt the whole instrument up for easy viewing.



Y-AMPLIFIERS	
Sensitivity	50mV/cm to 50V/cm in 1-2-5 sequence
Bandwidth (−3dB)	DC coupled: DC to 5MHz AC coupled: 2Hz to 5MHz
Rise time	100ns
Accuracy	±5%
Input impedance	100k
Maximum input voltage	350V DC
OPERATING MODES (DB242) (selected by mode switch)	
Single beam	Channel A
Dual trace	1. Alternate sweep 2. Chopped (1 70kHz approx)
X MODES (selected by sweep speed switch)	
Normal	Timebase
X-Y	Ext position on switch; input through external X socket
TIMEBASE	
Sweep speeds	1µs/cm to 0.2s/cm in 5 steps plus variable control
Accuracy	±5% at 'cal' position on variable control
EXTERNAL X-AMPLIFIER	
Sensitivity	Fixed at approx 0.5 V/cm
Bandwidth	1Hz to 0.2MHz
Input impedance	100k

Table 1 The manufacturer's specifications.

Also included in the packing we found a mains cable with moulded connector and one or two X1 probes as appropriate. The probes seem to be fairly standard types manufactured by Scopex, a company now owned by Bridage. These probes terminate at the oscilloscope end in banana plugs which have rather novel sprung shrouds

Left: the interior of the SB121.

which prevent accidental shocks when not plugged into the unit.

Testing Time

After we had admired the two units for some time and taken some pictures of the inside and outside, we thought that it would be a good idea to see what they did. So we switched on the Lab. function generator and connected it up to a 56 ohm resistor. This was done to swamp out any loading effects in later tests. The resulting signal across the resistor was monitored by both traces on our Lab. Hameg HM203 oscilloscope, one channel with a X1 probe and the other a X10 with suitable sensitivity settings on the Y amplifiers. With this set-up we could make sure that the test signal was of a reasonable quality before we started.

Having got this all set up, we connected the Bridage units and proceeded to look at the response to sine and square waves over the full range up to the 5MHz limit. Up to about 1 MHz they performed as expected on sine waves but between 1 MHz and 5 MHz there appeared to be a peak in response at about 3MHz. It was not easy to estimate the magnitude of this but it was of the order of 20%. On square waves this showed up as overshoot and damped ringing on the rising and falling edges of frequencies above 500kHz (see oscillograms).

Having investigated the Y deflection system we turned our attention to the X direction. Here we found that the automatic triggering was good if rudimentary at lower frequencies but suffered from an annoying amount of jitter above 1 MHz. This tended to make the trace blurred and dimmer than it might be. Another thing we found here is that the trace normally occupied 1 division at one end of the trace but only about 0.8 at the other. This effect was found at the fastest timebase setting initially but subsequent tests revealed it in lower speeds as well, and on both oscilloscopes.

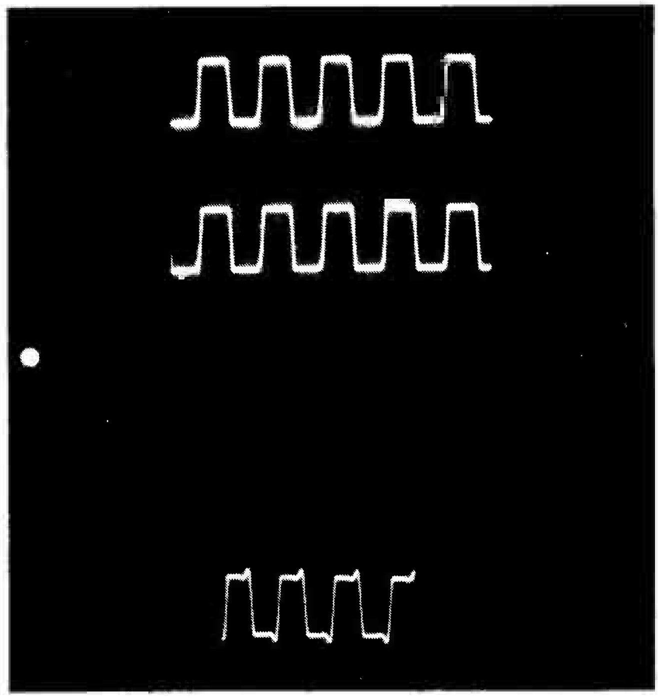
The last thing of note we found while testing was that the brightness control had to be at or near the maximum when used in our workshop.

We found the controls on the single trace model easy to see and accessible but the display mode switch and A channel AC/DC/GND switch on the dual trace unit was partly obscured by the B channel input leads. The Y channel attenuator steps are the normal 1-2-5 sequence and cover 50mV to 50V per division. No variable gain control is provided but there is a shift control. In the X direction there is a stepped control covering 1µs to 10ms per division in decade steps. This seemed a little coarse but is partly offset by the wide range variable control and the use of the shift control, bearing in mind that the trace is twice the screen width. Facilities are also provided for external X input. Triggering is from the A channel only for internal working and can be either positive or negative going. External triggering is also possible but only on negative edges.

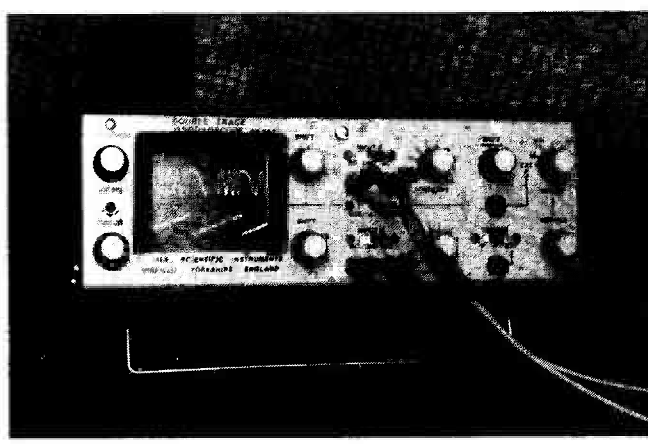
Conclusion

These units will probably find a home with the hobbyist or in schools where a cheap instrument is required for mainly low frequency applications. The screen is not large enough or sufficiently calibrated for great accuracy but will give a wealth of qualitative information. Where ease of use and simplicity is of importance these instruments are worthy of consideration and their limitations can be offset against their price.

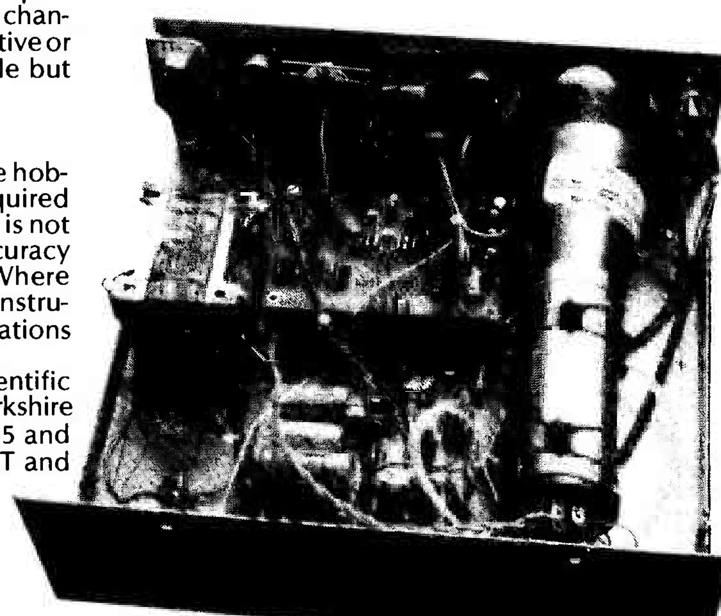
These scopes are available from Bridage Scientific Instruments, 63-65 High Street, Skipton, North Yorkshire BD23 1EF, tel: 0756 69511. The SB121 costs £195 and the DB242 £225; both these prices exclude VAT and p&p (approx £7 per instrument).



Above: oscillograms taken during testing, all from the same 500kHz source; the top two traces are from the lab. Hameg (top, x10 on probe, 50mV/div on scope; lower, x1 on probe, 500mV/div on scope); bottom trace is from the Bridage SB121 on 500mV/div.



Above, the BD242 on test.
Below, the interior of the '242.



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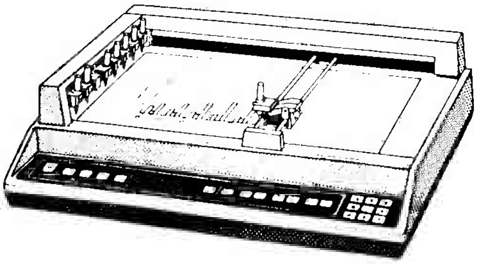

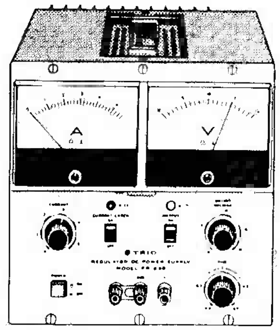

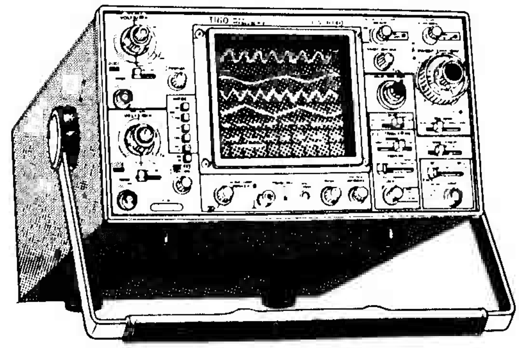

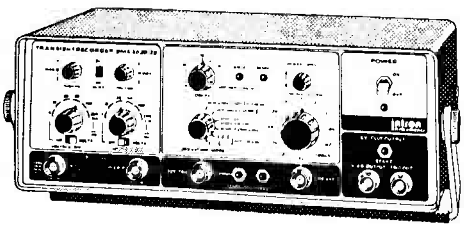

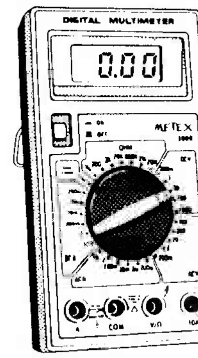

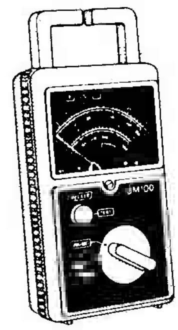

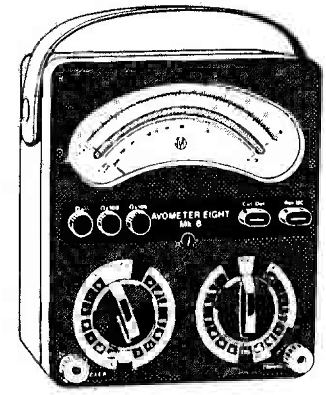

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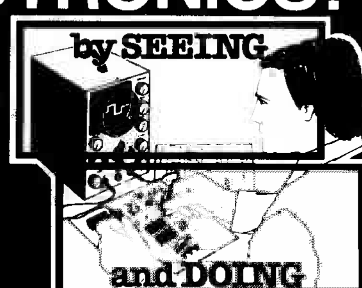

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Microchip manufacturers are forever trying to cram more and more into less and less: more gates and more computing power onto smaller dies using thinner tracks. The photograph shows the latest device to be dubbed the 'miracle microchip'. It's a full 32-bit microprocessor from Motorola, with a specification that would put many of the main frames of not so long ago in the shade. It will be a little while before you will be able to buy a home micro using this device — but it will be making an impact on the professional scene in the none too distant future. So we'll be taking a close look at the device and telling you what's so different about it.

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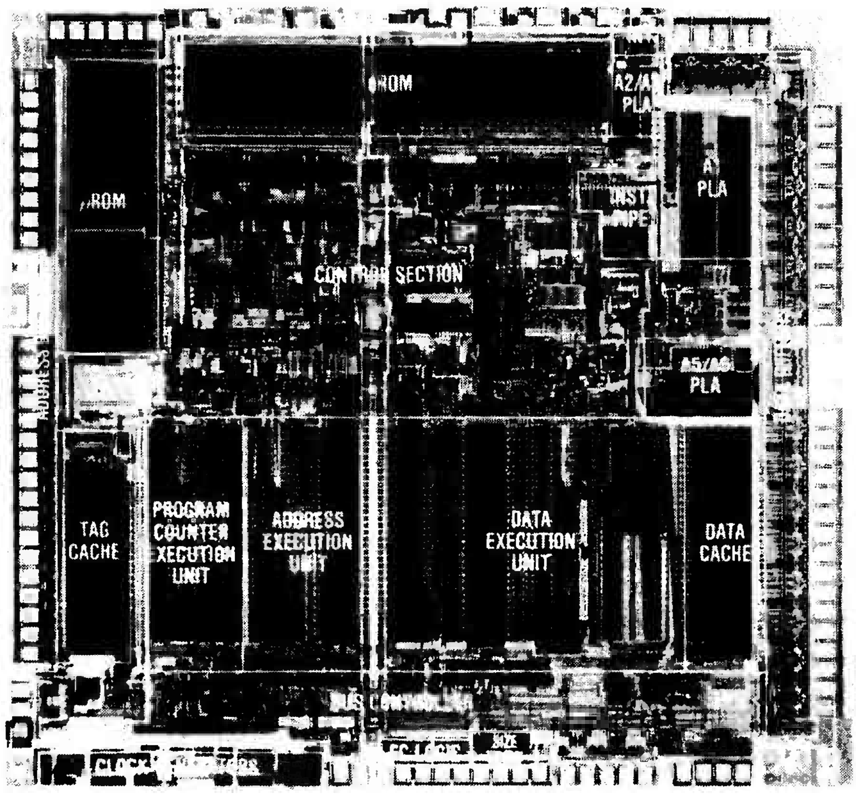

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● We undertake to do our best to answer enquiries relating to difficulties with ETI projects, in particular non-working projects, difficulties in obtaining components, and errors that you think we may have made. We do not have the resources to adapt or design projects for readers (other than for publication), nor can we predict the outcome if our projects are used beyond their specifications;

● Where a project has apparently been constructed correctly but does not work, we will need a description of its behaviour and some sensible test readings and drawings of oscillograms if appropriate. With a bit of luck, by taking these measurements you'll discover what's wrong yourself. Please do not send us any hardware (except as a gift!);

● Other than through our letters page, Read/Write, we will not reply to enquiries relating to other types of article in ETI. We *may* make some exceptions where the enquiry is very straightforward or where it is important to electronics as a whole;

● We receive a large number of letters asking if we have published projects for particular items of equipment. Whilst some of these can be answered simply and quickly, others would seem to demand the compiling of a long and detailed list of past projects. To help both you and us, we have made a full index of past ETI projects and features available (see under Backnumbers, below) and we trust that, wherever possible, readers will refer to this before getting in touch with us.

● **We will not reply to queries that are not accompanied by an SAE** (or international reply coupon). **We are not able to answer enquiries over the telephone.** We try to answer promptly, but we receive so many enquiries that this cannot be guaranteed.

● Be brief and to the point in your enquiries. Much as we enjoy reading your opinions on world affairs, the state of the electronics industry, and so on, it doesn't help our already overloaded enquiries service to have to plough through several pages to find exactly what information you want.

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ETI should be available through newsagents, and if readers have difficulty in obtaining issues, we'd like to hear about it.

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Backnumbers of ETI are held for one year only from the date of issue. The cost of each is the current cover price of ETI plus 50p, and orders should be sent to: ETI Backnumbers Department, Infonet Ltd, Times House, 179 The Marlowes, Hemel Hempstead, Hertfordshire HP1 1BB. Cheques, postal orders, etc should be made payable to ASP Ltd.

We would normally expect to have ample stocks of each of the last twelve issues, but obviously, we cannot guarantee this. Where a backnumber proves to be unavailable, or where the issue you require appeared more than a year ago, photocopies of individual articles can be ordered instead. These also cost £1.50 (UK or overseas surface mail), irrespective of article length, but note that where an article appeared in several parts each part will be charged as one article. Your request should state clearly the title of the article you require and the month and year in which it appeared. Where an article appeared in several parts you should list these individually. If you do not have a copy of the appropriate index in which to look up these details, a set of photocopies of index sheets going back to 1972 is also available for £1.50. Otherwise, you will find the index for 1980 and 1981 in the January 1982 issue, the index for 1982 in the December 1982 issue, and the index for 1983 in the January 1984 issue. Photocopies should be ordered from: ETI Photocopies, Argus Specialist Publications Ltd, 1 Golden Square, London W1R 3AB. Cheques, postal orders, etc should be made payable to ASP Ltd.

Write For ETI

We are always looking for new contributors to the magazine, and we pay a competitive page rate. If you have built a project or you would like to write a feature on a topic that would interest ETI readers, let us have a description of your proposal, and we'll get back to you to say whether or not we're interested and give you all the boring details. (Don't forget to give us your telephone number).

We don't bother with the bureaucracy for Tech Tips — all you do is to send in your idea, stating clearly if you want an acknowledgement or receipt. If possible, please *type* your explanation of why the circuit is different, what it does and how it works, on a separate sheet from the circuit diagram; both sheets should carry your name, address and the circuit title. We'll let you know (within a month or so) if we want to use your Tech Tip.

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OOPS!

Corrections to projects are listed below and normally appear for several months. Large corrections are published just once, after which a note will be inserted to say that a correction exists and that copies can be obtained by sending in an SAE.

Programmable Speech Board — Mini Mynah (February 1984)

The PCB for this project is double sided but only the underside pattern appears on the overlay drawing on page 26 and on the Foil Patterns page. the component side pattern appears on the PCB Foil Patterns page in the March '84 issue. The error does not affect PCBs supplied by our PCB service. There are also a number of errors in the circuit diagram on page 22. Pin 10 and IC11 should be connected to 0V along with pins 1 and 11, not pin 12 as shown; pin 12 should be left unconnected. On the same IC, pin 25 rather than pin 23 should be connected to pin 2 and R12/C4; pin 23 is Vcc and should be connected to the +5V supply. R5 has been missed off of the circuit diagram; it should be shown connecting IC4a pin 8 and IC5 pin 21 to the +5V supply. in each of the above cases the PCB and the overlay diagram are correct.

Adding Colour to the Ace (April 1984)

A full list of corrections to this project appeared on the "Service Sheet" page in the May '84 issue.

ZX81 EPROM Programmer (May 1984)

On the overlay diagram on page 27, the resistance shown between IC9 and IC5 should be R2 not R1, the resitance shown between IC6 and IC7 should be R8 not R5. In the parts list, C1 should be listed as 220uF not 22uF; the circuit diagram gives the value correctly. R3 is marked "see text" but no reference is then made to it: it should be chosen to suit the LED used. LED1 is shown reversed on the circuit diagram on page 28 but the connections shown on the overlay diagram are correct. The first statement in program 1 on page 30 should read "SET PERSONALITY SWITCHES THEN PRESS CONT".

Midi Drum Synth (May 1984)

Two small links on the PCB went missing: between RV5(1) and upper (on PCB) RV4 connection, and between RV1-3 +VE and LED2 CATHODE take-off points. Also, the circuit diagram shows R13 going to −VE; it should go to earth (the PCB is OK).

Spectrum Joystick Interface (June 1984)

The PCB and the circuit diagram do not agree; the circuit diagram is correct, and all PCBs sent out by the PCB service should have been amended. IC3 is 74LS241, as correctly stated in the parts list but incorrectly given in the footnote to the circuit diagram.

CMOS Tester (August 1984)

C3 and C2 are reversed on the overlay: C3 is the electrolytic and C2 the polyester. R33 is 100K, not 1M as given in the parts list, and RV1 is a 1M horizontal skeleton preset. R1-16 are two, eight-resistor SIL packages, the component labelled C14 on the overlay is SK1, and the connections to D2 shown in Fig. 3 are reversed. On the circuit diagram, the eight lines connecting SW9-16 to the inverters are shown in reverse sequence. Some of the inverters have been given the wrong designations; the correct sequence, reading down from the top, is:- IC1f, IC2a, IC2b, IC1e, IC1d, IC1c, IC1b, IC1a, IC2c, IC2d, IC2e, IC3d, IC3a, IC3b, IC3c, IC2f. Finally, the pin numbers are missing from ICs 3e and f; the input of IC3e is pin 11 and its output pin 12, and the input of IC3f is pin 14 and its output is pin 15. The PCB is correct in all respects.

Sharp Joystick Interface (August 1984)

Some of the inverter pins are incorrectly labelled on the circuit diagram. Pins 11 and 10 are shown reversed on IC1b, pins 9 and 8 are shown reversed on IC1c, and the output of IC4d is pin 10, not pin 20. Note that a number of the inverters have been incorrectly shown as non-inverting buffers.

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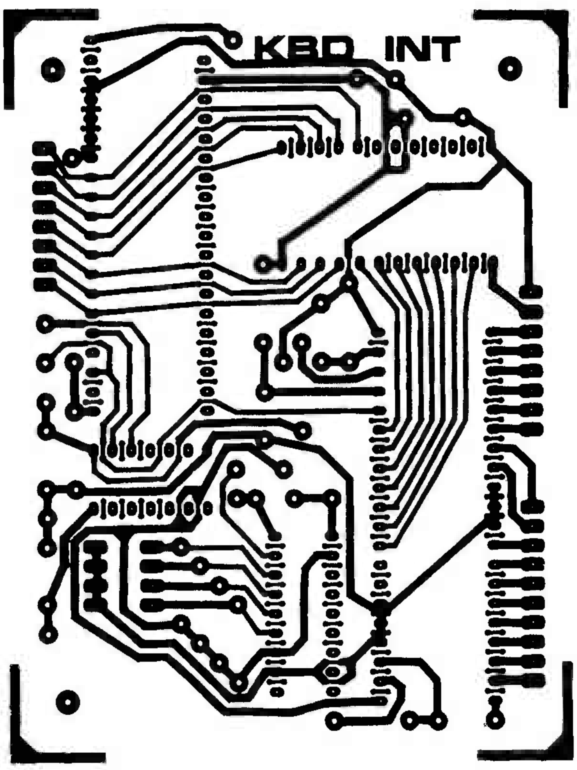

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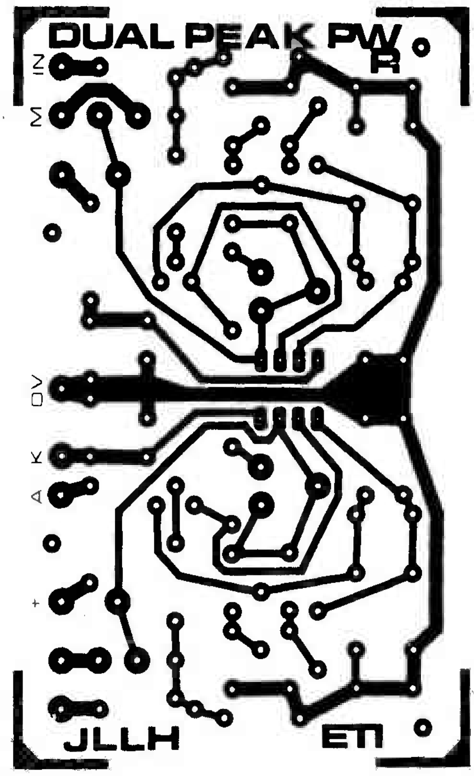

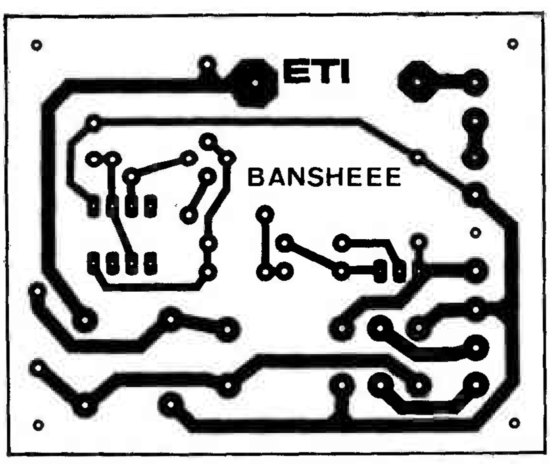

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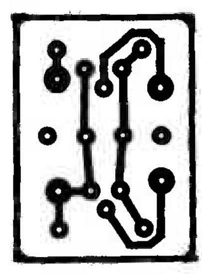

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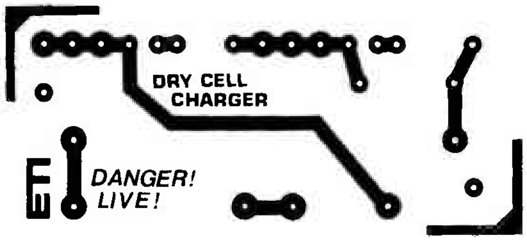

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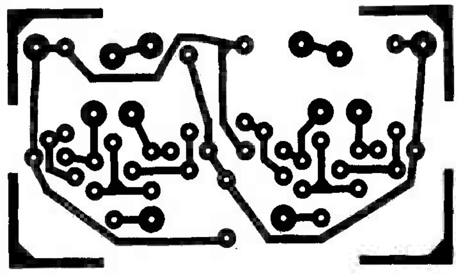

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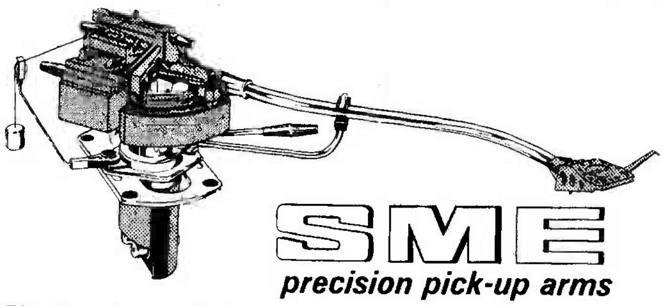

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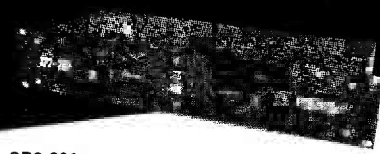

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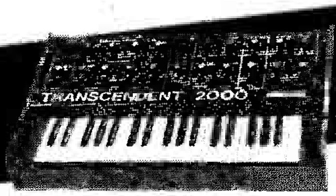

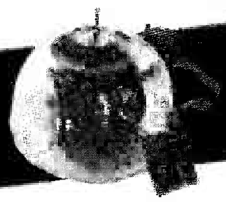

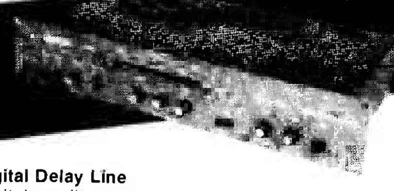

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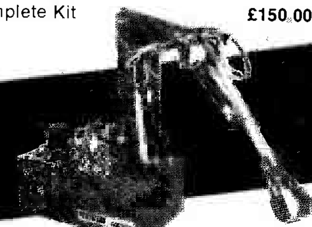

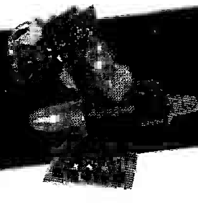

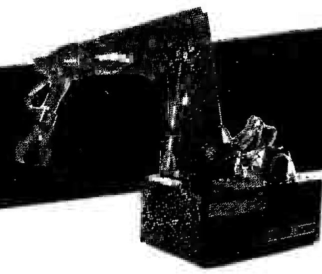

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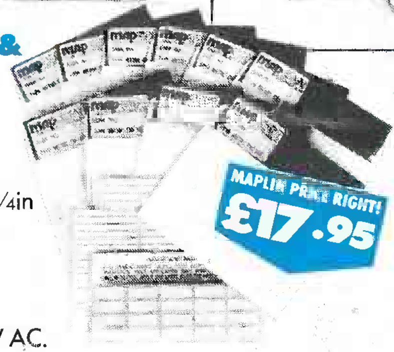

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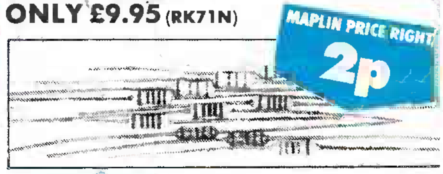

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