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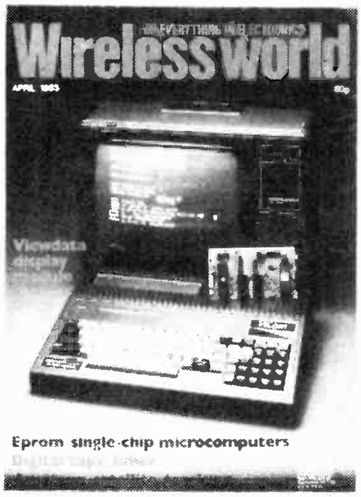

Cover shows viewdata display module described in this issue together with ViCom experimental videotext computer by Deaconhouse Ltd. ViCom executes telesoftware which is first captured in the ram that forms part of the videotext display module that could be located in ViCom or the tv receiver.

NEXT MONTH

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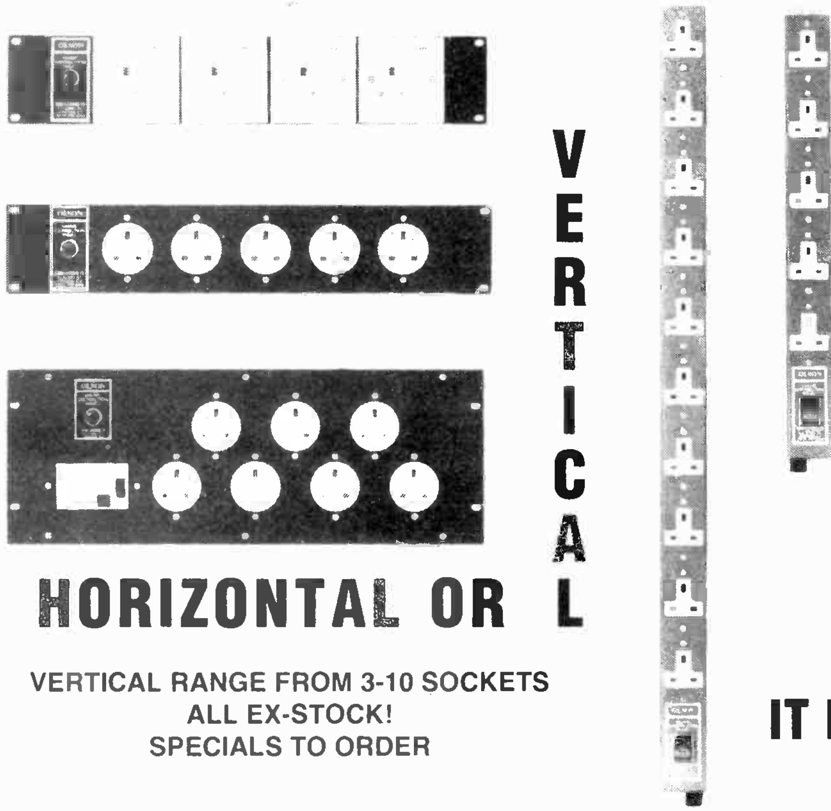

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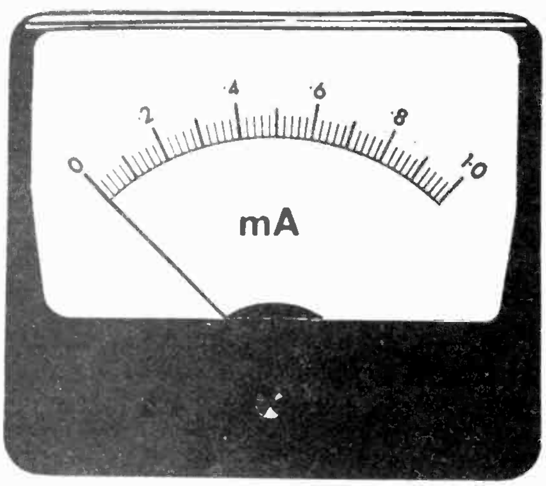

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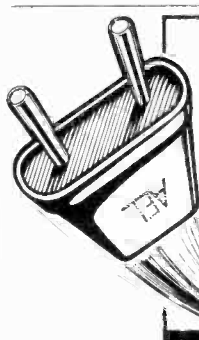

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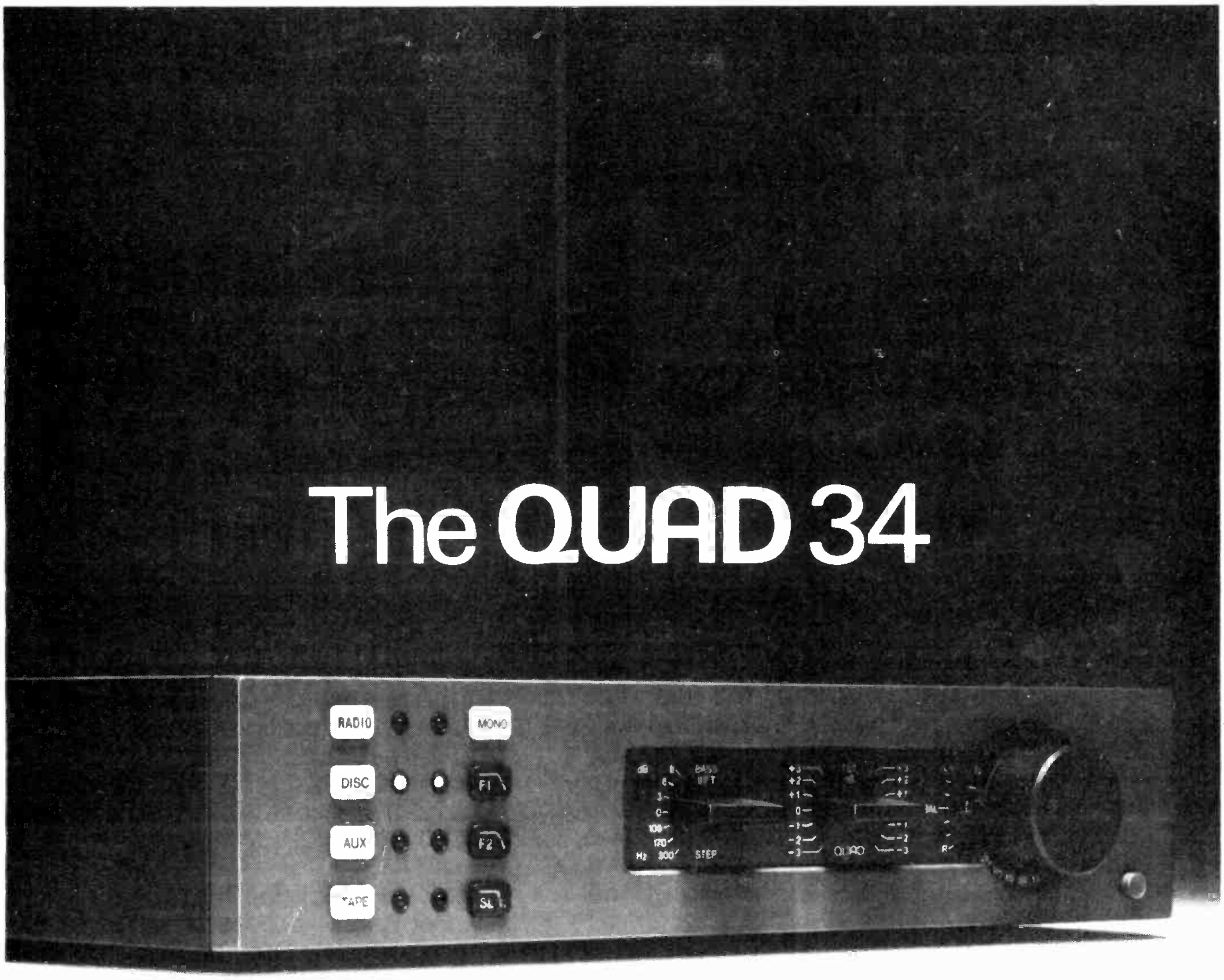

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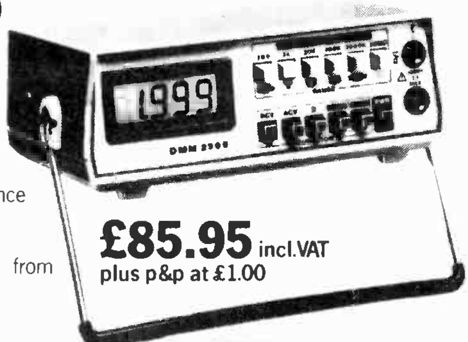

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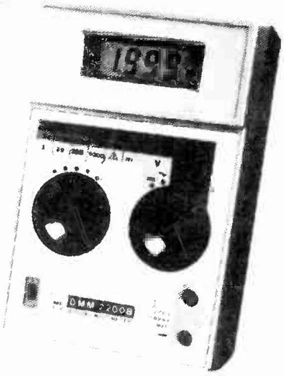

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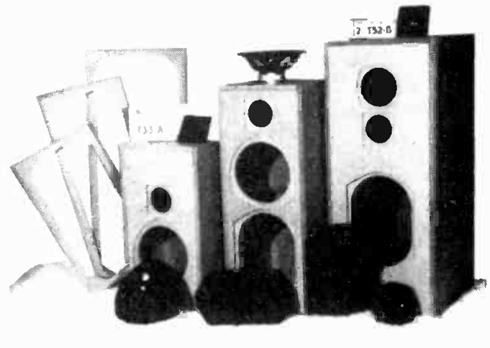

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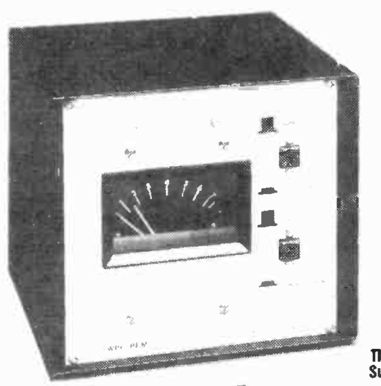

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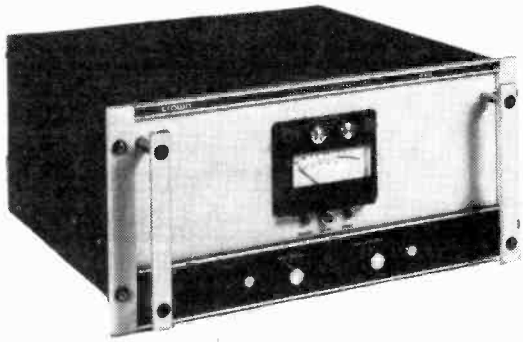

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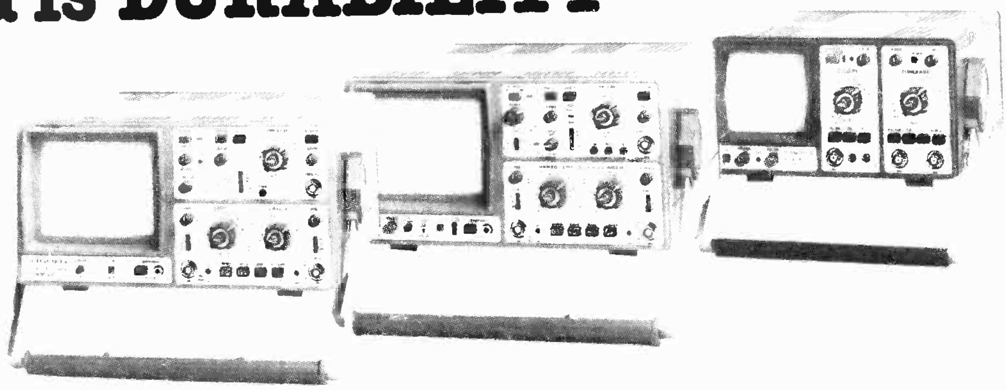

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10KΩ-500KΩ dual gang **110p**
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CERAMIC CAPACITORS 50V:
Range: 0-5pF to 10nF **4p**. 15nF; 22nF; 33nF; 47nF **5p**. 100nF/30V **7p**. 200nF/6V **8p**

PRESET POTENTIOMETERS
0.1W 50Ω–5MΩ Miniature Vertical & Horizontal **7p**
0-25W 100Ω–3-3MΩ horiz. larger **10p**
0-25W 200Ω–4-7MΩ vert. **10p**

POLYSTYRENE CAPACITORS:
10pF to 1nF **8p**; 1.5nF to 12nF **10p**

ACCESS
Orders
Just phone your order through. We do the rest
Tel: 0923 50234

SILVER MICA (Values in pF)
2, 3.3, 4.7, 6.8, 8.2, 10, 12, 15, 18, 22, 27, 33, 39, 47, 50, 56, 68, 75, 82, 85, 100, 120, 150, 180pF **15p each**; 200, 220, 250, 270, 300, 330, 360, 390, 470, 600, 800, 820 **21p each**; 1000, 1200, 1800, 2200 **30p each**; 3300, 4700pF **60p each**

RAM FOR BBC MICRO 4816AP 100ns 225p

MINIATURE TRIMMERS Capacitors
2-6pF, 2-10pF **22p**; 2-25pF, 5-60pF **30p**; 10-88pF **35p**

RESISTORS – Carbon Film High Stability. 5% Miniature.

	RANGE	VAL	1-99	100+
1/4W	2Ω2–4M7	E24	2p	1p
1/2W	2Ω2–4M7	E12	2p	1p
1W	2Ω2–4M7	E12	6p	4p
2% Metal Film		E24	6p	4p
1% Metal Film		E24	8p	6p

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

RESISTORS Network S.I.L.
7 Commoned: (8 pins) 100Ω, 680Ω, 1K 2k2, 4K7, 10K, 47K, 100K **25p**.
8 Commoned: (9 pins) 150Ω, 180Ω, 270Ω, 330Ω, 1K, 2k2, 4K7, 10K, 22K, 47K, 100K **26p**.

DIODES

AA119	15
AA129	20
AAY30	15
BA100	15
BAX13	20
BY100	24
BY126	12
BY127	12
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
IN5408	19
1S44	9
1S921	9
6A/100V	40
6A/400V	50
6A/800V	55

BRIDGE Rectifiers

1A/50V	18
1A/100V	20
1A/400V	25
1A/600V	34
2A/50V	30
2A/200V	40
2A/400V	48
2A/600V	65
6A/100V	83
6A/400V	95
6A/600V	125
10A/200V	215
10A/600V	298
25A/200V	240
25A/600V	395
BY164	56
VM18 DIL	50

ZENERS

Range: 2V7 to 39V 400mW **8p each**
Range: 3V3 to 33V 1.3W **15p each**

75 SERIES

75107/8	95
75110	90
75114/5	150
75121/2	130
75150	125
75154	150
75182/3	99
75188/9	55
75322	140
75324	360
75361/3	150
75365	150
75450	86
75451/2	52
75454	85
75491/2	85

SCR Thyristors

5A/40V	32
5A400V	40
5A600V	48
8A300V	60
8A600V	90
12A100V	78
12A400V	95
12A800V	188
BT106	150
BT116	180
C106D	38
TIC44	24
TIC45	29
TIC47	35
2N5062	32
2N5064	38
2N4444	130

TRIACS

3A200V	54
3A400V	56
8A100V	60
8A400V	69
8A800V	115
12A100V	78
12A400V	82
12A800V	135
16A100V	103
16A400V	105
16A800V	220
25A500V	220
25A800V	295
T2800D	120

DIAC

ST2 25

NOISE Diode

Z5J **195p**

VARICAPS

BA102	50
BB105B	40
BB106	40
BB109B	45
MVAM2	165

COMPUTER ICs

68B54	780
1702	350
1802CP	650
2114L-200n	95
2147	425
2532	300
2564	£8
2708	225
2716-5V	225
2732	350
2764	475
3242	590
4116-150n	85
4116-200n	80
4118-250n	325
4164-200n	425
4532-3	350
4532-4	350
4816-100n	215
5101-450	220
6116-150n	350
6116L-120	550
6117-100n	490
6502A	450
6502CPU	325
6503	600
6504-250	550
6505	600
6520PIA	100
6522VIA	295
6530	£11
6532	570
6545RTC	899
6551ACIA	650
6592PC	£20
6800	220
6802	250
6803	850
6804	160
6805	670
6808	520
6809	630
6810	115
6821	110
6840	375
6843	£12
6845	650
6847	650
6850	110
6852	250
6854	599
6875	500
68000	£78
68821	220
74C922	420
8080A	250
8085A	350
8088	£18
8118-10	225
8123	125
8155	350
8156	350
81LS95	80
81LS96	80
81LS97	80
81LS98	85
8202	£25
8205	225
8212	110
8214	425
8216	100
8224	110
8225	£11
8226	250
8228	220
8243	270
8250	850
8251A	250
8253	400
8255	225
8256AC	£35

8257-5	400
8259	395
8271	£32
8279	385
8282	450
8283	450
8284	350
8285	365
8288	£10
8P8304BN	250
8T26A	99
8T27	150
8T28A	120
8T31	350
8T95	90
8T97N	90
9364AP	550
9602	220
AM26LS31C	125
AM26LS32A	125
AM26LS33A	125
AY-3-1015	300
AY-5-1350	388
AY-5-2376	600
COM8017	275
COM8116	700
DM8131	275
DS3691N	320
DS88LS120N	275
OS8820	110
DS8830	110
DS8831	125
DS8832	250
E9365	£38
E9366	£38
FD1771	£15
FD1791	£22
FD1793	£23
FD1795	£28
FD1797	£28
FD1799	£28
IM6402	380
INS8060N	1050
INS8154N	£9
MC1488	55
MC1489	55
MC14411	690
MC14412	725
MC3446	250
MC3447P	315
MC3486	175
MC3487	175
MC6846	625
MM1702A	300
MM5280D	695
MM5303	635
MM5307	1275
MM5387A	475
MM58174	700
MM74C922	420
RO-3-2513L	650
RO-3-2513U	650
SFF9634E	800
SPO256AL2	£18
TMS2716-3V	725
TMS4416-2	475
TMS4500	£14
TMS4532-3	350
TMS5100	600
TMS9927	£14
TMS9928	£20
TMS9929	£20

TMS9995	£12
ULN2003	75
UPD7002	425
Z80CPU 2.5	299
Z80ACPU 4M	300
Z80 CTC	250
Z80A CTC	260
Z80B	£11
Z80 DART	495
Z80A DART	550
Z80 DMA	675
Z80 PIO	260
Z80A PIO	275
Z80 SIO-1	850
Z80A SIO	£9
ZN419	180

LINEAR ICs

555CMOS	80
702	75
709C 8 pin	35
710	48
741 8 pin	14
747C 14 pin	65
748C 8 pin	36
753 8 pin	185
810	159
9400CJ	350
AD7581	£11
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	438
Booklet for AY-3-890	150
AY-3-8912	450
AY-5-1230	450
AY-5-1317A	630
AY-5-1350	388
CA3011	130
CA3012	175
CA3014	275
CA3018	86
CA3019	80
CA3020	210
CA3023	210
CA3028A	95
CA3035	255
CA3036	270
CA3043	275
CA3045	365
CA3046	70
CA3048	220
CA3059	285
CA3075	213
CA3080E	70
CA3081	190
CA3086	48
CA3089E	215
CA3090AQ	375
CA3123E	165
CA3130	90
CA3140	40
CA3160	95
CA3161	160
CA3162E	450
CA3189	200
HA1336W	240
HA1388	255
ICL7106	690
ICL7107	975
ICL7611	99
ICL7660	248

TRANSISTORS

AC126/7	35
AC141/2	30
AC176	28
AC187	32
AC188	32
ACY19/21	75
ACY22/41	75
AD142	120
AD149	79
AD161	42
AD162	42
AF115/6	60
AF118	80
AF124/26	70
AF139	40
AF178	75
AF186	70
AF239	55
BC107	10
BC107B	12
BC108	10
BC108B	12
BC109	10
BC109B	12
BC109C	12
BC114/5	22
BC117/8	20
BC137/9	40
BC140	30
BC142/3	30
BC147	9
BC147B	10
BC148	9
BC148B	10
BC149	9
BC149C	10
BC153/4	27
BC157/8	10
BC159	11
BC160	45
BC167A	10
BC168C	10
BC169C	10
BC170	15
BC171/2	11
BC173	11
BC177/8	16
BC179	20
BC181	20
BC182L	10
BC186/7	26
BC212	10
BC212L	10
BC213	10
BC213L	10
BC214	10
BC214L	10

BC237/8	14
BC256B	30
BC307B	14
BC308	16
BC318	30
BC327/8	15
BC337/8	15
BC441/61	34
BC477	40
BC516/7	40
BC547/8	15
BC549C	14
BC556/7	15
BC558/9	15
BCY30	68
BCY34	85
BCY41/42	14
BCY45	50
BCY58/59	35
BCY70/71	16
BCY72	20
BCY78	24
BD112	125
BD121	95
BD124	115
BD131/32	48
BD133	70
BD135	45
BD136/37	40
BD138/39	40
BD140	40
BD144	190
BD158	55
BD205/6	110
BD222	85
BD245	45
BD378	70
BD434	56
BD517	75
BD645	80
BD695A	125
BD696A	125
BDY56	180
BDY60	160
BF115	35
BF154/8	25
BF167	29
BF173	27
BF177	25
BF178	30
BF196/7	12
BF198/9	18
BF200	80
BF224A	25
BF224B	29
BF245	30
BF256A	35

BF256B	45
BF257/8	32
BF259	35
BF274	42
BF336/7	40
BF394	27
BF451	35
BF494/5	30
BF594/5	30
BFR39/40	23
BFR41/79	23
BFR80/81	25
BFR98	105
BFX29	28
BFX81	45
BFX84	28
BFX85/6	28
BFY18	50
BFY50/51	23
BFY52	23
BFY53	32
BFY55/6	32
BFY64	35
BFY81	120
BFY90	80
BRY39	40
BSX20	20
BSX26/29	34
BSX78	45
BSY26	30
BSY95A	25
BU105	170
BU205	190
BU206	200
BU208	200
BUY69C	225
E421	250
MD8001	250
MJ491	175
MJ2955	70
MJE170	150
MJE180	150
MJE340	54
MJE370	100
MJE371	100
MJE520	95
MJE521	95
MJE2955	99
MJE3055	70
MPF102	40
MPF103	30
MPSA08	25
MPSA12	32
MPSA55	30
MPSA56	30
MPSA70	30
MPSU02	58
MPSU05	55
MPSU06	55
MPSU52	65
MPSU55	50

MPSU56	80
MPU131	52
OC26	170
OC28/35	220
OC36/41	75
OC42	50
OC70	40
OC71/72	40
OC75/76	40
OC81/82	50
DC83/84	40
OC170/71	50
OC200	50
TIP29A	32
TIP29C	38
TIP30A	35
TIP30C	37
TIP31A	38
TIP31B	39
TIP31C	39
TIP32A	38
TIP32C	42
TIP33A	65
TIP33C	78
TIP34A	74
TIP34C	88
TIP35A	110
TIP35C	128
TIP36A	130
TIP36C	140
TIP41A	50
TIP41B	52
TIP42A	55
TIP42B	58
TIP120	70
TIP121/2	73
TIP141/2	105
TIP147	120
TIP2955	60
TIP3055	60
TIS43	32
TIS44/5	45
TIS46	45
TIS48	50
TIS59/74	50
TIS88A	50
TIS90/91	30
UC734	65
VK101	80
VN10KM	55
ZTX107/8	11
ZTX109	12
ZTX212	28
ZTX300	13
ZTX301	16
ZTX302	16
ZTX303	25
ZTX304	17
ZTX314	25
ZTX326	30
ZTX341	30

ZTX451	23
ZTX500	14
ZTX501/2	15
ZTX503	18
ZTX504	25
ZTX531	25
ZTX550	25
2N697	23
2N698	40
2N699	48
2N706A	19
2N708	19
2N918	35
2N1131/2	24
2N1302	45
2N1671B	160
2N2160	296
2N2217	45
2N2218A	25
2N2219A	28
2N2220A	28
2N2221A	26
2N2222A	25
2N2303	45
2N2368	26
2N2369A	18
2N2476	50
2N2483/4	27
2N2646	45
2N2904/5	28
2N2906/7	26
2N2907A	26
2N2926G	10
2N3011	28
2N3053	26
2N3054	58
2N3055	48
2N3252	46
2N3302	30
2N3441/2	140
2N3706/7	10
2N3708/9	10
2N3710/11	10
2N3713	140
2N3771	179
2N3772	195
2N3773	210
2N3819	22
2N3820	38
2N3822/3	45
2N3824	65
2N3866	90
2N3903/4	15
2N3905/6	15
2N3906	17
2N4037	46
2N4058	10
2N4061/2	10
2N4064	115
2N4234/6	48
2N4264	24

2N4286	15
2N4289	18
2N4314	78
2N4400	18
2N4427	80
2N4871	56
2N4898	135
2N4901	175
2N4921	55
2N4922	70
2N5135/6	20
2N5138	18
2N5172	18
2N5179	45
2N5180	45
2N5190/1	75
2N5194	80
2N5305/8	30
2N5457/8	30
2N5459	30
2N5485	36
2N5777	45
2N5879	190
2N6027	32
2SA671	250
2SA715	60
2SC495	70
2SC496	70
2SC1061	250
2SC1096	85
2SC1162	30
2SC1173	125
2SC1306	100
2SC1307	150
2SC1945	225
2SC1953	90
2SC1957	90
2SC1969	140
2SC2028	85
2SC2029	210
2SC2078	170
2SC2091	85
2SC2314	85
2SC2166	165
2SC2335	225
2SC2547	30
2SC2612	225
2SD234	74
2SK45	90
2SK288	225
2SJ83	225
2SJ85	225
3N128	112
3N140	112
40315	90
40316	95
40324	100
40326/7	70
40347	90
40348	120
40360	60

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

1μH, 2μ2, 4μ7, 10μ, 22μ, 33μ, 47μ, 100μ, 220μ, 330μ, 470μ **30p**
1mH, 1m5, 2m2, 4m7, 10mH **35p**
22m, 33m, 43m **60p**
100m **75p**

ICs

ICL8038CC	300
ICL8211A	150
ICM7205A	1150
ICM7207	475
ICM7215	1050
ICM7216AJ	£22
ICM7216B	£22
ICM7216C	£22
ICM7217	750
ICM7224	785
ICM7240	300
ICM7555	80
ICM7556	150
LA3350	250
LA4031P	340
LA4032	295
LA4400	350
LA4422	320
LC7120	300
LC7130	340
LC7137	395
LF347	150
LF351	48
LF353	95
LF355	85
LF356	95
LF357	110
LF398	475
LM10	325
LM301AO	24
LM308T	95
LM311	70
LM318N	150
LM319	215
LM324A	30
LM334Z	90
LM335Z	128
LM339	47
LM348	64
LM349	115
LM358	60
LM377	175
LM379	480
LM380	75
LM381N	145
LM382	115
LM384	160
LM386	90
LM387	120
LM389	95
LM393	100
LM558	75
LM725CN	325
LM733	70
LM1458	45
LM1871	325
LM2917	195
LM3302	75
LM3900	50
LM3909N	85
LM3911	125
LM3914	250
LM3915	250
LM3916	250
LM13600	110
LS7220	280
M253AA	1150
M51513L	230
M51515L	320
M51516L	475
MB3712	220
MB3756	440
MC1204	250
MC1301	79
MC1303	98
MC1304P	260
MC1310P	150
MC1445	250
MC145106	695
MC1469	300
MC1494	694
MC1495	350
MC1496L	70
MC1596	225
MC1648	290
MC1709G	90
MC3302	90

MC3340P	120
MC3360P	120
MC3401	65
MC3403	75
MC3405	150
MC3423	180
MC4016	00
MF10	350
MFC6040	75
MK50398	635
ML924	275
MSM5526	820
NE515	275
NE529	225
NE531	140
NE534	150
NE543K	225
NE544	210
NE555	16
NE556	45
NE560	325
NE561	398
NE562B	410
NE564	420
NE565A	120
NE566	155
NE567V	140
NE570	410
NE571	400
NE5532	145
NE5534A	150
OM335	750
RC4136D	60
RC4558	45
S566B	225
SAB3209	425
SAB3210	325
SAB3271	485
SAB4209	595
SG3402	295
SL490	350
SN76013	350
SN76023ND	240
SN76131	125
SN76227N	95
SN76477	420
SN76488	480
SP8629	299
TA7120	125
TA7130	150
TA7204	175
TA7205	90
TA7222	150
TA7310	160
TAA621AX1	295
TAA661A	190
TAA700	275
TAA900	395
TAD100	159
TBA120S	70
TBA540Q	275
TBA550Q	330
TBA641BX or BX11	290
TBA651	190
TBA800	80
TBA810	95
TBA820	80
TBA920Q	200
TBA950	300
TBA990Q	350
TBA540	275
TC9109	775
TCA220	350
TCA270Q	350
TCA280A	220
TCA940	175
TCA965	145
TDA1004	290
TDA1008	310
TDA1022	499
TDA1024	115
TDA1034	350
TDA1490	350
TDA2002	325
TDA2003	198
TDA2004	495

TDA2006	330
TDA2020	320
TDA2030	295
TDB0701	420
TL170	50
TL430	65
TLO61CP	40
TLO62CP	60
TLO64CN	98
TLD71CP	24
TLO72CP	45
TLD74CN	100
TLO81CP	24
TLO82CP	45
TLO83CP	75
TLO84CN	90
TLO91CP	55
UA2240	120
UA78540	230
UAA170	170
UAA180	170
ULN2003	75
ULN2004	75
ULN2283	100
UPC575	275
UPC1025H	375
UPC1182	330
UPC1156H	275
UPC1366	195
XR2206	300
XR2207	375
XR2211	575
XR2216	675
XR2266	360
ZN414	80
ZN419	180
ZN419E	180
ZN423	130
ZN423E	130
ZN424E	130
ZN425E	345
ZN426E	300
ZN427E	600
ZN428E	410
ZN429E	210
ZN459	570
ZN1034E	200
ZN1040E	665
ZNA234E	850

TTL 74

7400	11
7401	11
7402	11
7403	12
7404	13
7405	15
7406	20
7407	20
7408	14
7409	14
7410	14
7411	16
7412	18
7413	18
7414	24
7416	20
7417	20
7420	15
7421	20
7422	20
7423	20
7425	18
7426	18
7427	15
7428	26
7430	14
7432	22
7433	22
7437	25
7438	22
7440	15
7441	55
7442	32
7443	90
7444	90
7445	55

7446	60
7447	40
7448	45
7450	16
7451	16
7453	16
7454	16
7460	16
7470	35
7472	24
7473	26
7474	20
7475	25
7476	25
7480	48
7481	120
7482	65
7483	38
7484	70
7485	60
7486	20
7489	170
7490	20
7491	35
7492	25
7493	25
7494	35
7495	35
7496	35
7497	90
74100	80
74104	50
74105	55
74107	20
74109	25
74110	35
74111	55
74112	170
74116	50
74118	55
74119	60
74120	60
74121	25
74122	35
74123	35
74125	35
74126	35
74128	35
74132	30
74136	28
74141	55
74142	175
74143	210
74144	210
74145	50
74147	75
74148	60
74150	50
74151	40
74153	40
74154	55
74155	40
74156	40
74157	30
74159	80
74160	60
74161	48
74162	40
74163	40
74164	40
74165	48
74166	48
74167	150
74170	125
74172	250
74173	60
74174	54
74175	55
74176	40
74177	45
74178	80
74179	80
74180	40
74181	115
74182	60
74184	90
74185	95
74188	250
74190	48
74191	46

74192	46
74193	45
74194	40
74195	40
74196	46
74197	40
74198	80
74199	84
74221	54
74246	120
74247	120
74248	120
74249	120
74251	65
74259	150
74265	55
74273	150
74276	120
74278	100
74279	50
74283	50
74284	155
74285	155
74290	105
74293	80
74297	236
74298	100
74351	195
74365	30
74366	30
74367	30
74368	30
74390	75
74393	90
74490	95

74C

74C244	195
74C245	195
74C373	240
74C374	245
74C922	420
74C923	500

74S

74S00	30
SO2	30
SO3	30
SO4	30
SO5	60
SO8	60
S20	40
S32	70
S74	75
S86	65
S112	80
S114	80
S132	110
S133	60
S138	100
S139	115
S157	225
S158	210
S188	140
S189	140
S194	195
S195	195
S201	250
S225	240
S241	250
S244	290
S251	170
S257	170
S262	850
S287	225
S288	210
S289	200
S301	350
S412	380
S470	325
S471	620
S472	1150
S475	800
S571	620

74LS

LS00	11
LS01	11
LS02	11
LS03	12
LS04	12
LS05	13
LS08	12
LS09	12
LS10	13
LS11	13
LS12	13
LS13	20
LS14	26
LS15	13
LS20	13
LS21	12
LS22	12
LS26	14
LS27	13
LS28	14
LS30	13
LS32	13
LS33	15
LS37	15
LS38	15
LS40	13
LS42	28
LS47	35
LS48	45
LS49	50
LS51	14
LS54	14
LS55	14
LS63	120
LS73	18
LS74	18
LS75	20
LS76	18
LS78	18
LS83	36
LS85	42
LS86	16
LS90	24
LS91	60
LS92	32
LS93	23
LS95	40
LS96	95
LS107	40
LS109	23
LS112	22
LS113	20
LS114	22
LS122	36
LS123	36
LS124	90
LS125	24
LS126	25
LS132	30
LS133	30
LS136	24
LS138	25
LS139	28
LS145	70
LS147	100
LS148	75
LS151	40
LS153	40
LS155	30
LS156	36
LS157	25
LS158	30
LS160	32
LS161	37
LS162	35
LS163	35
LS164	43
LS165	50
LS166	52
LS168	84
LS170	70
LS173	50
LS174	36
LS175	36
LS181	90
LS183	105
LS190	36
LS191	36

LS192	36
LS193	37
LS194	35
LS195	35
LS196	45
LS197	45
LS200	275
LS202	275
LS221	55
LS240	55
LS241	55
LS242	55
LS243	55
LS244	55
LS245	70
LS247	50
LS248	55
LS249	55
LS251	30
LS253	32
LS257	30
LS258	35
LS259	55
LS260	22
LS261	100
LS266	20
LS273	54
LS275	125
LS279	30
LS280	90
LS283	40
LS290	40
LS293	40
LS295	75
LS298	80
LS299	150
LS300	175
LS302	175
LS320	200
LS323	160
LS324	168
LS325	295
LS326	240
LS327	240
LS347	95
LS348	90
LS352	62
LS353	62
LS362	750
LS363	150
LS364	150
LS365	30
LS366	32
LS367	30
LS368	35
LS373	65
LS374	65
LS375	50
LS377	85
LS378	80
LS379	110
LS384	395
LS385	250
LS390	50
LS393	45
LS395	125
LS399	150
LS445	100
LS471	620
LS490	200
LS541	120
LS640	180
LS641	180
LS845	180
LS668	125
LS669	120
LS670	100
LS673	550

SWITCHES

TOGGLE 2A 250V

SPST	33p
DPDT	44p

SUB-MIN TOGGLE

SPST on/off	54p
SPDT c/over	60p
SPDT centre off	85p
SPDT biased both ways	105p
DPDT 6 tags	75p
DPDT centre off	88p
DPDT biased both ways	145p
DPDT 3 positions on/on/on	185p
3-pole 2 way	205p

SLIDE 250V

DPDT 1A	14p
DPDT 1A c/off	15p
DPDT 1/2A	13p

PUSHBUTTON 6A with 10mm Button

SPDT latching	99p
DPDT latching	145p
SPDT moment	99p
DPDT moment	145p

Mini Non Locking

Push to Make	15p
Push to Break	25p

DIL SWITCHES
(SPST) 4-way 70p; 6-way 85p; 8-way 90p; 10-way 145p.
(SPDT) 4-way 190p.

ROTARY SWITCHES (Adjustable Stop type)
1 pole/2 to 12 way; 2p/2 to 6 way; 3 pole/2 to 4 way; 4p/2 to 3 way 45p

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

ROTARY: (Mak-a-switch) Make a multi-way 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: 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

Decade Switch Module	220p
B.C.D. Switch Module	275p
Mounting Cheeks (per pair)	75p

VEROBOARD 0.1in

	clad	plain
2½-3¼"	85p	–
2½-5"	100p	–
3¾-3¾"	100p	–
3¾-5"	115p	–
3¾-17"	390p	98p
4¾-17"	495p	275p
Pkt of 100 pins	55p	
Spot face cutter	150p	
Pin insertion tool	185p	

VQ Board	180p
DIP Board	350p
Vero Strip	95p

PROTO DECs

Veroblock	405p
S-Dec	350p
Eurobreadboard	520p
Bimboard 1	575p
Superstrip SS2	1350p

VERO WIRING PEN + Spool 340p
Spare Spool 75p
Combs 6p

DALO ETCH RESIST PEN Plus Spare Tip 90p

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

ULTRASONIC TRANSDUCER 40kHz 325 pr

COPPER CLAD BOARDS

Fibre glass	Single sided	Double sided	S.R.B.P. 9.5"x8.5"
6"x6"	90p	110p	95p
6"x12"	150p	195p	

IDC CONNECTORS

	PCB Plugs with latch Pins Strt	Angle	Female Hdr. Plug	Female Card Edge Conn
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	169p	320p
40 way	220p	250p	190p	340p
50 way	235p	270p	200p	395p
60 way			230p	495p

EURO CONNECTORS

	Female Socket Strt Pins	Angle Pins	Male Plug Strt Pins	Angle Pins
DIN41617 31 way	170p	–	–	175p
DIN41612 2x32 A+B	275p	320p	220p	285p
DIN41612 2x32 A+C	295p	340p	240p	300p
DIN41612 3x32 A+B+C	360p	385p	260p	395p

PANEL METERS

FSD 60×46×35mm
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" 450p each

RELAYS

Miniature enclosed PCB mount
SINGLE POLE Changeover
RL6-91 205Ω Coil; 12V DC, 10V5 to 19.5V). 10A at 30V DC or 250V AC 185p

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

AMPHENOL PLUGS
IEEE 24 way 550p
Centronics Parallel 36 way solder 530p
Centronic Parallel 36 way IDC 495p

BUZZERS: miniature, solid-state 6V, 9V & 12V 70p
PIEZO TRANSDUCERS PB2720 55p

LOUDSPEAKERS
Miniature 0.3W 8Ω
2in, 3¼in, 2½in, 3in 80p
2½in 40Ω, 64Ω or 80Ω 80p

ASTEC UHF MODULATORS
Standard 6MHz 280p
Wideband 8MHz 480p

CRYSTALS

32.768kHz	100
100kHz	235
200kHz	268
455kH	370
1MHz	275
1.008M	275
1.28MHz	392
1.6MHz	395
1.8MHz	395
1.8432M	200
2.0MHz	225
2.4576M	200
3.278M	150
3.5794M	98
3.6864M	300
4.0MHz	150
4.032MHz	290
4.19430M	200
4.433619M	100
4.80MHz	200
5.0MHz	160
5.185MHz	300
5.24288M	390
6.0MHz	140
6.144MHz	150
6.5536MHz	200
7.0MHz	150
7.168MHz	250
7.68MHz	200
8.0MHz	150
8.08333M	395
8.86723M	175
9.00MHz	150
10.0MHz	175
10.24MHz	200
10.7MHz	150
12.0MHz	175
12.528M	300
14.31814M	170
16.0MHz	200
18.0MHz	180
18.432M	150
20.0MHz	200
19.968MHz	150
24.0MHz	170
24.930MHz	325
26.69M	150
27.648M	170
27.145M	190
38.66667M	175
48.0MHz	170
100.0MHz	295
116.0MHz	250

DIL 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	99p

EDGE CONNECTORS

	.1	.156
2×15 way	–	140p
2×18 way	180p	145p
2×22 way	199p	200p
2×23 way	175p	–
2×25 way	225p	220p
2×28 way	190p	–
2×30 way	245p	–
2×36 way	295p	–
2×40 way	315p	–
2×43 way	395p	–
2×75 way	550p	–

DIL PLUG (Header)

	Solder	IDC
14 pin	40p	99p
16 pin	49p	105p
24 pin	88p	178p
40 pin	250p	255p

RIBBON CABLE price per foot

	Grey	Colour
10 way	15p	28p
16 way	25p	40p
20 way	30p	50p
24 way	40p	65p
34 way	60p	85p
40 way	70p	90p
50 way	100p	135p

ZIF DIL SOCKETS

24 pin	575p
28 pin	820p
40 pin	975p

ETI PROJECTS We stock most of the parts

JUMPER LEADS (Ribbon Cable Assembly)

Length	14 pin	16 pin	24 pin	40 pin
Single ended DIP (Header Plug) Jumper				
24 inches	145p	165p	240p	325p
Double ended DIP (Header Plug) Jumper				
6 inches	185p	205p	300p	465p
12 inches	198p	215p	315p	490p
24 inches	210p	235p	345p	540p
36 inches	230p	250p	375p	595p

IDC Female Header Socket Jumper Leads 24"

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

ANTEX SOLDERING IRON

C-15W	455p	CX17W	475p
CCN-15W	495p	CX25W	510p
Spare tips, assorted sizes			65p
Spare Elements			210p
Iron stand with sponge			165p

SIL Socket 0.1" pitch 20 way 65p

D CONNECTORS: Miniature

	9 way	15 way	25 way	37 way
MALE				
Solder lugs	80p	105p	160p	250p
Angle pins	150p	210p	250p	365p
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	90p	85p	90p	100p

IDC 25 way D Plug 365p; Socket 450p

TRANSFORMERS:

3-0-3V; 6-0-6V; 9-0-9V; 12-0-12V; 15-0-15V @ 100mA 98p

pcb mounting Miniature Split Bobbin
3VA: 2×6V-0.25A; 2×9V-0.15A; 2×12V-0.12A; 2×15V-0.1A 200p
6VA: 2×6V-0.5A; 2×9V-0.3A; 2×12V-0.25A; 2×15V-0.2A 270p

Standard Split Bobbin type
6VA: 2×6V-0.5A; 2×9V-0.4A; 2×12V-0.3A; 2×15V-0.25A 220p
12VA: 2×4.5V-1.3A; 2×6V-1A; 2×9V-0.6A; 2×12V-0.5A; 2×15V-0.4A; 2×20V-0.3A 295p (35p p&p)
24VA: 2×6V-1.5A; 2×9V-1.2A; 2×12V-1A; 2×15V-0.8A; 2×20V-0.6A 330p (60p p&p)
50VA: 2×6V-4A; 2×9V-2.5A; 2×12V-2A; 2×15V-1.5A; 2×20V-1.2A; 2×30V-0.8A 465p (60p p&p)

Specially wound for Multirail Computer PSUs 50VA: Outputs: +5V/5A; +12V; +25V; −5V, −12V×1A 575p (60p p&p)
100VA: 2×12V-4A; 2×15V-3A; 2×20V-2.5A; 2×25V-2A; 2×30V-1.5A; 2×50V-1A 920p
(75p p&p charge to be added over and above our normal postal charge).

VOLTAGE REGULATORS

1A T0220 Plastic casing

	+ve		−ve	
5V	7805	40p	7905	45p
12V	7812	40p	7908	60p
15V	7815	40p	7912	45p
18V	7818	40p	7915	45p
24V	7824	40p	7918	45p
			7924	45p

100mA T092 Plastic package

	+ve		−ve	
5V	78L05	30p	79L05	60p
6V	78L06	30p		–
8V	78L08	30p		–
12V	78L12	30p	79L12	60p
15V	78L15	30p	79L15	60p

LM300H	170p	TDA1412	150p
LM304H	170p	78HO5 +5V/5A	550p
LM305H	140p		
LM309K	135p	78H12 +12V/5A	580p
LM317K	320p		
LM317KP	99p	78HG +5V to +25V/5A	599p
LM323K	450p		
LM337	175p	79HG +2.25V to 24V5A	685p
LM723 Var.	36p		
TAA550	50p		

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

ALUM BOXES

3x2x1"	65p
4x2½x2"	85p
4x2¾x2½"	103p
4x4x2"	105p
4x4x2½"	120p
5x4x1½"	99p
5x4x2½"	120p
5x2¾x1½"	90p
5x2¾x2½"	130p
6x4x2"	120p
6x4x3"	150p
7x5x3"	180p
8x6x3"	210p
10x4x3"	240p
10x7x3"	275p
12x5x3"	260p
24x8x3"	295p

25 way 'D' CONNECTOR (RS232)
Jumper Lead Cable Assembly

18" long, Single end, Male	495p
18" long, Single end, Female	525p
36" long, Double ended, M/M	1025p
36" long, Double ended, F/F	1050p
36" long, Double ended, M/F	995p

★ SPECIAL OFFER ★

2532	285p	6116	375p
2764	550p	6522	280p

'WEMON' New Version WATFORD'S Ultimate Monitor IC

A 4K Monitor chip specially designed to produce the best from your Super board Series I & II. Enhanced Super board & UK101. As reviewed by Dr A. A. Berk in Practical Electronics, June 1981.
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16K Memory (8×4816AP)	£18
Printer User I/O Port Kit	£8.20
Complete Printer Cable 36"	£12
Disc Interface Kit	£43
Analogue I/O Kit	£6.75
Serial I/O Kit	£7.50
Expansion Bus Kit	£6.50
Complete Upgrade Kit from Model A to Model B	£45

We supply complete range of BBC Plugs, Sockets, Leads, Peripherals, Software, etc. Send SAE for list.

CMOS

4000	10	4075	13	4543	70
4001	10	4076	50	4544	150
4002	12	4077	13	4548	40
4006	50	4078	15	4549	375
4007	14	4081	13	4553	245
4008	32	4082	13	4554	190
4009	24	4085	50	4555	36
4010	24	4086	60	4556	35
4011	10	4089	125	4557	320
4012	16	4093	20	4558	120
4013	20	4094	70	4559	395
4014	46	4095	95	4560	160
4015	40	4096	70	4561	104
4016	20	4097	290	4562	495
4017	32	4098	75	4566	165
4018	45	4099	110	4568	250
4019	25	4160	95	4569	175
4020	42	4161	99	4572	36
4021	40	4162	99	4580	460
4022	40	4163	99	4581	250
4023	13	4174	99	4582	99
4024	32	4175	105	4583	90
4025	13	4194	105	4584	40
4026	80	4408	790	4585	60
4027	20	4409	790	4597	330
4028	39	4410	725	4599	290
4029	45	4411	675	40085	90
4030	15	4412	775	40097	45
4031	125	4415	480	40098	42
4032	80	4419	280	40100	215
4033	125	4422	770	40101	130
4034	140	4435	850	40102	140
4035	45	4440	999	40103	175
4036	275	4450	350	40104	95
4037	115	4451	350	40105	105
4038	110	4490	350	40106	35
4039	250	4500	675	40107	60
4040	40	4501	28	40108	198
4041	40	4502	60	40109	80
4042	40	4503	40	40110	198
4043	40	4504	75	40114	240
4044	40	4505	185	40161	194
4045	105	4506	35	40163	50
4046	46	4507	35	40174	45
4047	40	4508	130	40175	50
4048	40	4510	46	40181	220
4049	25	4511	45	40182	90
4050	25	4512	50	40192	75
4051	45	4513	199	40193	70
4052	60	4514	115	40194	70
4053	50	4515	115	40195	75
4054	85	4516	55	40244	195
4055	85	4517	275	40245	195
4056	85	4518	40	40257	195
4057	1915	4519	30	40373	160
4059	435	4520	50	40374	160
4060	45	4521	90	45106	598
4061	1195	4522	125		
4062	995	4526	70		
4063	85	4527	85		
4066	24	4528	70		
4067	245	4529	150		
4068	14	4530	90		
4069	16	4531	130		
4070	13	4532	70		
4071	13	4534	400		
4072	13	4536	275		
4073	15	4538	80		
		4539	90		
		4541	140		

OPTO

LS400C	286
OCP71	120
ORP12	88
ORP61	85
2N5777	45
BPX25	195
BPW21	295
BPX65	270

OPTO Electronics

LEDs with Clips

TIL209 Red	10
TIL211 Green	14
TIL212 Yellow	14
TIL220 .2" Red	12
.2" Green, Yellow or Amber	14
0.2" Bicolour Red/Green	65
Green/Yellow	78
0.2" Tricolour Red/Green/Yellow	85
Hi-Brightness Red	59
Flashing Red 0.2" Red	55
Square LEDs, Red, Green, Yellow	30
Rectangle Stackable LEDs Red, Green or Yell.	18
Triangular LEDs Red	18
Green or Yellow	22
LD271 Infra Red	46
SFH205 Detector	118
TIL32 Infra Red	58
TIL78 Detector	60
TIL38	45
TIL100	80
BARGRAPH Red 10 segments	225

ISOLATORS

IL74	55
ILD74	99
ILQ74	185
TIL111/2/4	90
TIL117	125
4N33 Photo Darlington	135

7 Segment Displays

TIL312 3" CA	105
TIL313 3" CC	105
TIL321 5" CA	115
TIL322 5" CC	115
DL704 3" CC	99
DL707 3" CA	99
FND357 Red	120
FND500	115
3" Green CA	150
6" Green CA	215
3" ±1 Red CA	150
3" ±1 Green CA	150
DVM 176	£22
LCD 3½ Digits	495
LCD 4 Digits	530
LCD 6 Digits	625

NEONS

Rectangular, nut fixing Red, Amber, Green	30
3" Green CA	150
6" Green CA	215
3" ±1 Red CA	150
REFLECTIVE Optical Switch type TIL139	170
SLOTTED Optical Switch similar to RS Comps	186

COMPUTER CORNER

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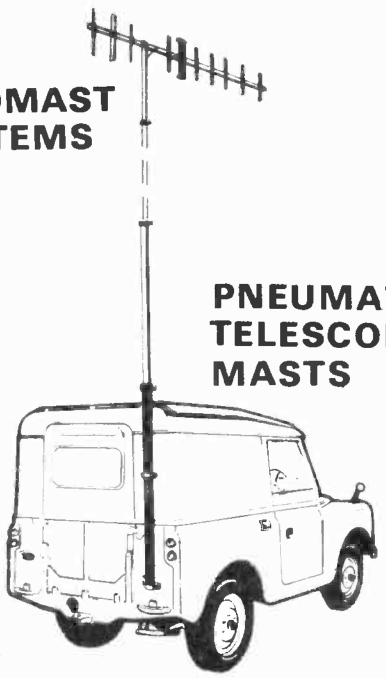

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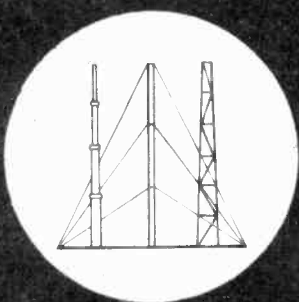

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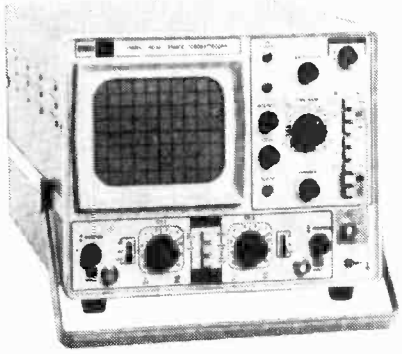

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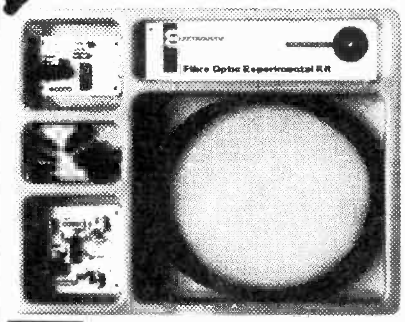

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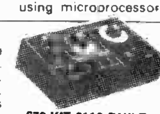

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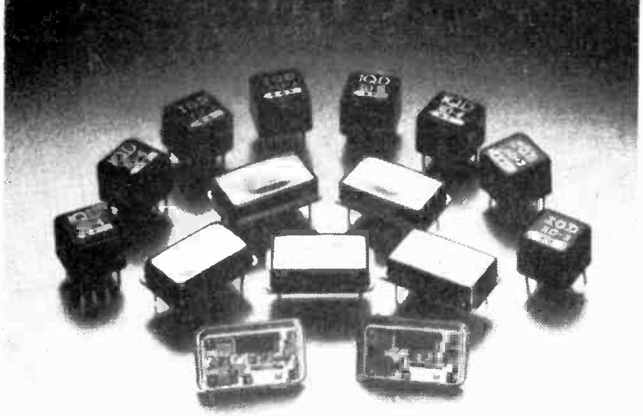

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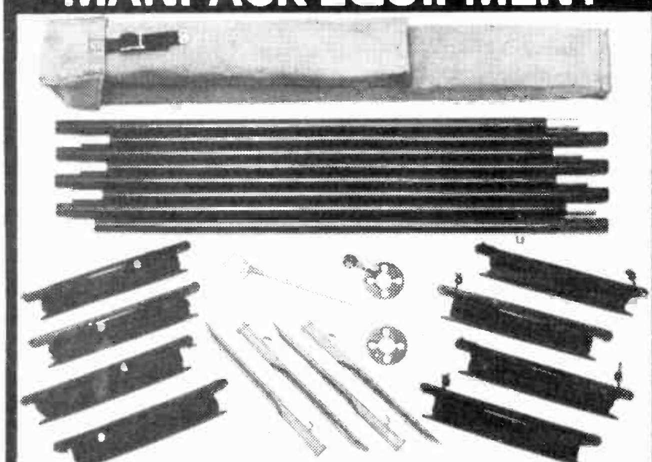

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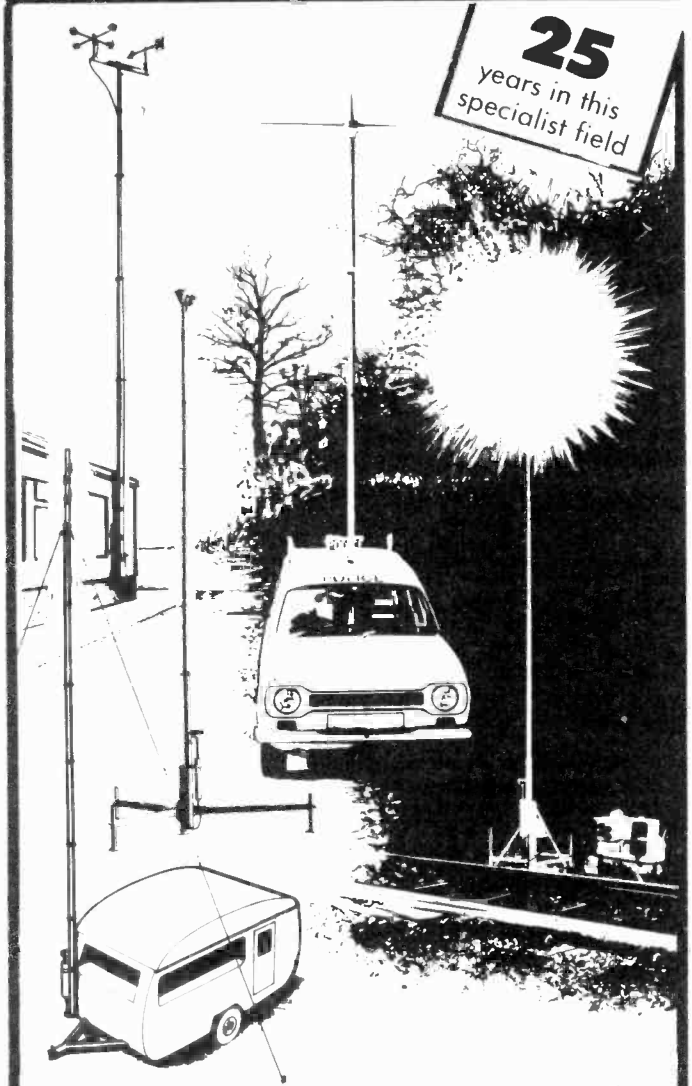

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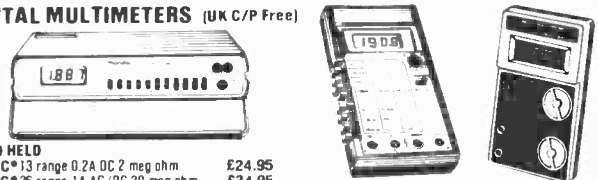

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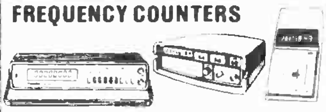

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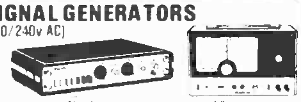

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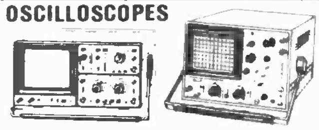

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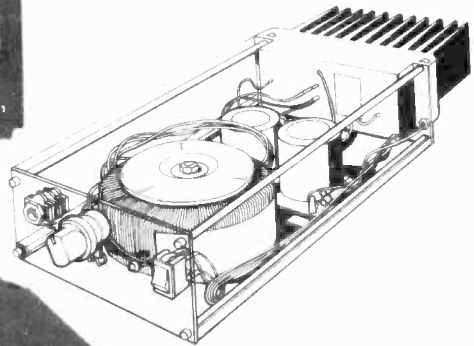

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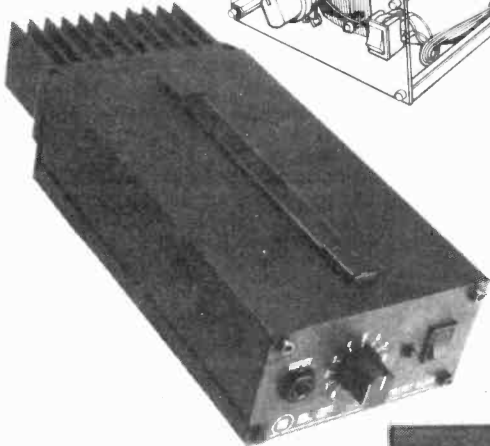

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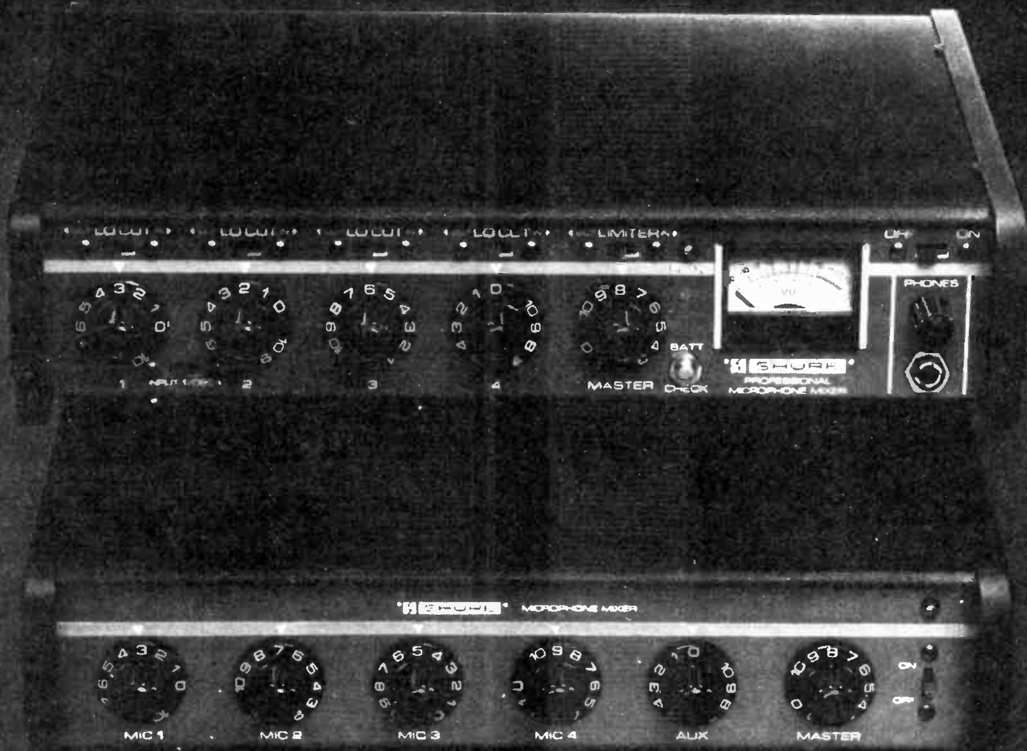

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Know-how: resource or property?

When the committee of the UK's Independent Review of the Radio Spectrum sent out a letter last year inviting people to contribute evidence, it put forward some new and interesting questions for consideration. One was whether decisions on spectrum allocations and frequency assignments should be influenced by value judgements of the "worth" of the services and transmissions in question. This obviously implied a need for assessing the different claims within society for spectrum space. Another question was whether frequency assignments should be determined or influenced by market forces – for example, by treating spectrum space as an economic quantity and charging rent for it or auctioning it off to the highest bidder.

These two possible approaches to the disposal of frequencies are obviously ideologically opposed. As such, they could almost have been laid out as part of the agenda for the ideological battle of the UK's coming General Election, for much of this battle will be between different value judgements on the right way to apportion scarce resources. They belong, respectively, to the opposing principles of political power and economic power.

But the radio spectrum is only one example of how these different attitudes reach into the whole body of electronics and communications technology. Electronics manufacturing, in contrast to making shoes or breakfast cereals, is a perpetual race to get ahead in specialized technical knowledge – or that amalgam of applied physics and empirical practices we like to call know-how. In business you must keep up with your competitors in know-how or you will do badly and perhaps fail. In international diplomacy you must keep up with your adversary in the ability to deploy such know-how as a military threat.

All political parties in Britain declare that electronics know-how is important to the economic future of the country and that it should be disseminated as rapidly as possible. But the Right and Left extremes differ fundamentally on the best way of using it for the good of the people, because they see it in different ways.

The Right, believing in the essential beneficence of the free market, think that know-how should be acquired under the stimulus of commercial compeition. The process of demand in a free market ensures that people get from the technology what they really want from it. Meanwhile, the know-how is a property, rightfully belonging to the entrepreneur because he made the effort to possess it in the first place. Then, after a period of commercial exploitation, it eventually becomes common knowledge, to be consigned to the text-books, and so ceases to be a property with valuable ownership rights.

The Left, believing in government intervention rather than market forces, think of know-how as a resource that should be applied directly to the collective benefit, not through the selective processes of the market. They dispute the Right's view that everyone gets what he wants in a free-market system simply through demand. They argue that demand is artificially generated by entrepreneurs, by using advertising, for example, to create wants that will blot out awareness of real needs. This artificially created demand is actually what the entrepreneur finds convenient and profitable to sell, and the know-how behind the products follows the same selective pattern.

Experience has shown that know-how produced under the stimulus of competition in free-market economies is more advanced than that obtained under state control in centralized economies. The issue, however, is not about absolute levels of know-how in different systems but about alternative ways of distributing this resource or property to the benefit of society. The problem applies equally in the less developed countries of the Third World. It is too serious to be left to the outcome of party political contests and deserves more concentrated attention than it gets at present from just academic studies and technology assessment organizations.

Tracking satellites with a microcomputer

This fully-automatic system will track amateur or weather satellites continuously using a PET microcomputer to control antenna azimuth and elevation.

by I. P. Jefferson B.Sc., G4IXT

Before the advent of cheap home computers, tracking amateur satellites involved the use of several graphs and tables, followed by time-consuming calculations. This effort can now be replaced by a computer program such as the one described here. The program runs on an average microcomputer (the Commodore PET) and has the following features:

- the whole system is simple to operate
- only the minimum essential orbital information is required from the user, all other satellite information being inbuilt
- the computer updates its orbital data as necessary, and is capable of operation for an indefinite length of time unattended
- the computer automatically drives electromechanical rotators for altitude and azimuth of directional antennae
- the program predicts the availability of the selected satellite and indicates for how long it will be within range.

Two popular methods of tracking satellites are available to the amateur. The first, the Oscarlocator, is a purely manual technique and is therefore of no use in this application. It consists of a polar projection of the northern hemisphere and an acetate sheet with an orbital path drawn on it. When correctly positioned, it allows the orbital path and the azimuth angle to the satellite to be read off.

The other method, due to the American amateur W5PAG, consists of drawing up azimuth and elevation charts (see Fig. 1):

1. The great circle angle (i.e. the angle subtended at the centre of the Earth) between the receiving station and the point on the Earth below the satellite (the "sub-satellite" point) is calculated:

$$D=\cos^{-1}\left(\frac{R}{R+h}\cos y\right)-y \text{ degrees} \quad (1)$$

where D is the great circle angle, y is the elevation angle of the satellite at the station, R is the Earth radius (6375km) and h is the altitude of the satellite.

2. Next, the latitude of the point on the first bearing (say 0 degrees) which corresponds to the elevation angle y is given by

$$\sin B=\sin a\cos D+\cos a\sin D\cos C \quad (2)$$

where B is the latitude of the sub-satellite point, a is the latitude of the receiving station and C is the bearing to North (in this case 0 degrees).

3. Finally, the corresponding longitude of the sub-satellite point is calculated:

$$\sin L=\frac{\sin C\sin D}{\cos B} \quad (3)$$

where L is the difference in longitude between the sub-satellite point and the receiving station.

Thus the latitude and longitude of a point corresponding to a particular elevation have been calculated, on a heading of due North (0 degrees). It is now necessary to calculate points on other headings at the same elevation angle. (Note that it is only necessary to calculate points for headings 0-180 degrees since the chart is symmetrical). The whole procedure is then repeated for different elevation angles up to 90 degrees.

Having drawn the charts it is necessary to know the sub-satellite point in order to use them. This can be found as follows:

$$\sin b=\sin(360t/T)\sin U \quad (4)$$

where b is the latitude of the sub-satellite point, t is the length of time in minutes since the satellite crossed the equator travelling North (the EQX time) and T is the satellite orbit period at inclination angle U to the equatorial plane.

The corresponding longitude is given by

$$l=\cos^{-1}[\cos(360t/T)/\cos b]\pm[t/4] \quad (5)$$

The factor t/4 is due to the rotation of the Earth: the Earth rotates ¼ degree every minute. When the orbit is retrograde, i.e. U greater than 90 degrees, t/4 is added.

To complete the charts, it is now necessary to take values of t from, say, 1 minute to 115 minutes (a complete orbit) and substitute in (4) and (5) to find the orbital path.

The graphs plotted will give the antenna azimuth and elevation for the satellite concerned. For any other satellite,

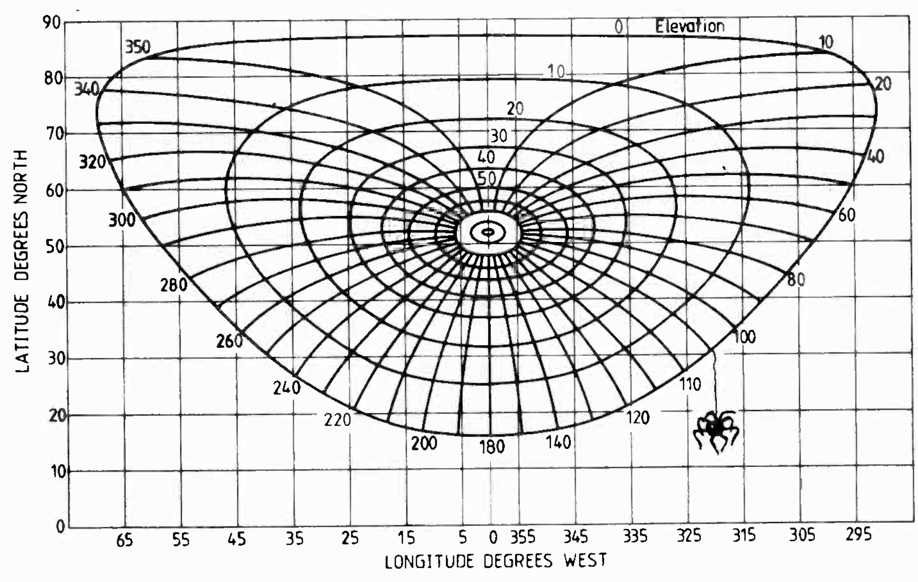


***Fig. 1.** Example of a chart showing the bearing necessary to direct an antenna towards a point at a given latitude and longitude.*

different graphs would have to be drawn.

Although this method could be used by a computer, storing all calculated values in a "look-up" table, it would be very inefficient and time consuming to do so. A better approach is to calculate the information required at the time it is needed, for that particular time only. Obviously the computer will have to be able to do the calculations rapidly for this to be accurate. The PET is adequate in this respect.

Calculated tracking

The requirement is to produce values of azimuth and elevation for a given satellite at a specific time, as quickly and accurately as is possible. In order to do this, some basic information is needed:

a) The satellite's orbital period.

b) The longitude increment at the equator per orbit.

c) The inclination of the orbit to the equatorial plane.

d) The apogee and perigee of the orbit.

e) A reference orbit, i.e. the time and longitude of an equator crossing, travelling in a particular direction (generally North).

f) The latitude and longitude of the receiving station.

g) The time in GMT.

All of the above from (a) to (d) inclusive are fixed and can be built into the program. The remaining data must be supplied by the user when the program is run. For amateur radio and weather satellites, the apogee and perigee differ by about 1% or less, so the orbits can be assumed to be circular and an average height used in calculations.

Using modifications to formulas (4) and (5) we can calculate the latitude and longitude of the sub-satellite point. Replacing symbols with the variable names used in the program, from (4),

$$PHI=\sin^{-1}\left[\sin(CLIN)\times\sin\left(\frac{2\times\pi\times MI}{PE}\right)\right] \quad (6)$$

where PHI=latitude in radians of the sub-satellite point
CLIN=orbital inclination
MI=number of minutes since EQX
PE=orbital period in minutes

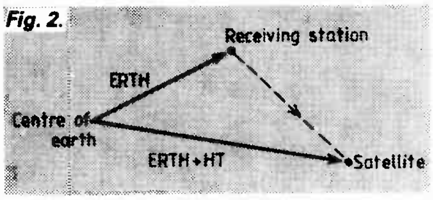
From (5), THETA equals

$$\cos^{-1}\left(\frac{\cos[2\pi(MI)]/(PE)}{\cos(PHI)}\right)+\frac{2\pi(MI)}{1440} \quad (7)$$

where THETA=longitude in radians of the sub-satellite point.

Now consider a system of vectors in three dimensions. Taking the vectors from the centre of the Earth to the receiving station and to the satellite (Fig. 2), the vector difference between these two give the vector from the receiving station to the satellite (displaced to the centre of the Earth). If we use spherical polar coordinates, we can draw this on a cartesian system with the centre of the Earth as origin (Fig. 3).

Fig. 2.



ERTH = earth radius.
ERTH+HT = earth radius + orbital height.

The conventional way of specifying longitude is to use degrees West of the Greenwich meridian. However, we are using values of THETA in the opposite direction, so they must be modified as below. Similarly, degrees latitude conventionally increase from the Equator outwards, but the PHI angles above are opposite and must be modified suitably.

Modified values:

$PD=(\pi/2)-PHI \quad TD=(2\times\pi)-THETA$

$FI=(\pi/2)-LAT \quad TE=(2\times\pi)-LONG \quad (8)$

where

$PD=\phi' \quad TD=\theta' \quad FI=\phi \quad TE=\theta$

LAT=receiving station latitude.
LONG=receiving station longitude.

Notation:

r is the vector to the receiving station from the centre of the Earth.

r' is the vector to the satellite from the centre of the Earth.

p is the vector from the receiving station to the satellite.

Now the components of the vector **r** are

$$X=|r|\cos(TE)\sin(FI)$$
$$Y=|r|\sin(TE)\sin(FI)$$
$$Z=|r|\cos(FI)$$

and similarly for **r'**

$$X'=|r'|\cos(TD)\sin(PD)$$
$$Y'=|r'|\sin(TD)\sin(PD)$$
$$Z'=|r'|\cos(PD).$$

If the components of the vector **p** are X_p, Y_p, Z_p then:

$$X_p=X'-X$$
$$Y_p=Y'-Y$$
$$Z_p=Z'-Z.$$

Theoretically, this vector is all that is necessary to track the satellite since it is easy to work out the spherical polar

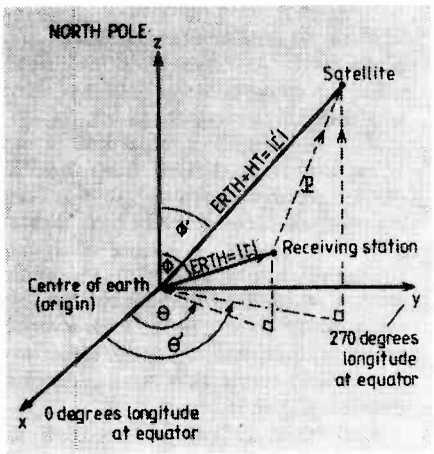


Fig. 3. Vector diagram.

coordinate angles, and these could be fed directly to the antenna rotators. However, in practice it is difficult to define these angles at the receiving station, since they relate to the cartesian coordinate system previously shown, based at the centre of the Earth. At the receiving station it is convenient to refer to angles of elevation from the horizontal and azimuth angles from due North, so these must be supplied by the program.

Since we are using vector notation, it is simple to find the angle between the vector **r** and the vector **p** using the dot product:

$$\mathbf{r}\,.\,\mathbf{p}=|\mathbf{r}||\mathbf{p}|\cos E$$

Therefore

$$\cos E=\frac{X\,X_p+Y\,Y_p+Z\,Z_p}{\sqrt{X_p^2+Y_p^2+Z_p^2}\,\sqrt{X^2+Y^2+Z^2}} \quad (12)$$

This gives the angle E between the two vectors. Since the horizontal plane at the receiving station is perpendicular to the vector **r**, by taking $(\pi/2)-E$ we can get the angle of elevation required for the antennae (Fig. 4).

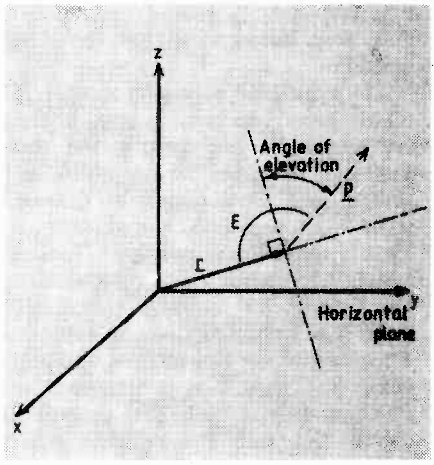


Fig. 4. How angle of elevation for the antenna is derived.

It is more difficult to extract the azimuth angle from due North using any similar method, but it is relatively simple to apply equation (2) if the great circle angle D can be found. This is an easy matter, since it is the angle between vectors **r** and **r'**. It can be found using the dot product as follows:

$$\cos D=(X\,X'+Y\,Y'+Z\,Z')/r\,r'$$

where r=ERTH (Earth radius) and r'=ERTH+HT (Earth radius+orbital height). See Fig. 3.

Simple manipulation of equation (2) will give the azimuth bearing angle if all the information which is now known is substituted in.

Using the method described, we now would have all of the information required to track the satellite accurately without having to draw any graphs. All that remains to be done is to present this information in suitable form to the antenna rotors.

Rotator driving

Two rotators are necessary to track the satellite, one to elevate the antennae and one to rotate them to the correct bearing. In the prototype system these rotators were not of the same manufacture, and operated on different principles, so separate methods of interfacing were required for each.

The type SU2000 azimuth rotator. This rotator is controlled electronically, and uses a potentiometer mechanically coupled to the rotating shaft to provide feedback to the control box. When a switch (not shown) is closed for a short period, the circuitry is activated, and the voltage on the control potentiometer is compared with that on the feedback potentiometer. The rotator then turns one way or the other until the difference is reduced to zero.

The voltage range on the control potentiometer is about 0-6V d.c. and operation is linear, with 0V corresponding to 0 degrees and 6V to 360 degrees. To control the rotator the computer must therefore apply a voltage between 0 and 6V (corresponding to the desired position) to the control potentiometer connections, and close the activating switch for a short time (typically ¼ second). Rotation will then stop automatically at the desired position.

The type 2050 elevation rotator. This rotator uses two a.c. motors operating synchronously, one driving the rotator shaft and the other driving a disc in the control box. Operation is as follows. A second disc, with a notch in it, is turned by hand to the required position. This causes a 3-position switch which rubs against the disc's perimeter to move either left or right. The switch connects an appropriate a.c. phase to the two motors, and applies power to them. The two motors rotate synchronously, until the control box driven disc with the switches attached reaches the position of the notch in the manually-turned disc. When this happens, the switch actuator springs into the notch, the switches go "off" and the motors both stop. In this manner, the rotator shaft follows the position of the manual disc.

In order to control this rotator from the computer, a feedback potentiometer was coupled mechanically to the driven disc

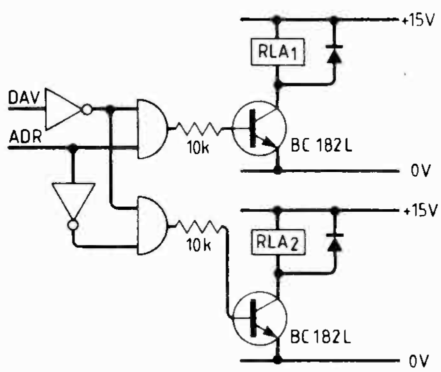


Fig. 5. The two most-significant bits of the PET's output word are used to control the two rotators. RLA_1 controls the power to the elevation rotator. RLA_2 activates the azimuth rotator's control box.

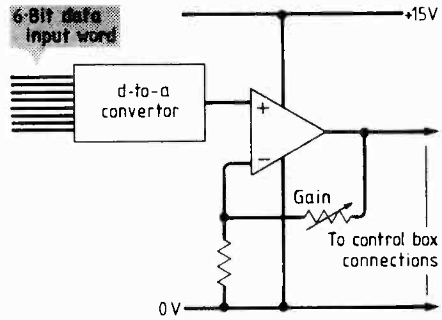


Fig. 6. A d-to-a converter (such as the Ferranti ZN425E) provides a control voltage for the azimuth rotator. The two spare bits of its 8-bit input are connected to logic 1. A similar d-to-a converter is used in the control of the elevation rotator.

and the switches disconnected. Phase switching to the motors was achieved with relays.

Computer control consists of:

a) generating a voltage corresponding to the required position and comparing it with the voltage from the feedback potentiometer. Depending upon the result, an appropriate relay activates.

b) applying power to the motors, which will switch off automatically when the feedback voltage corresponds to the required position.

Control interface

The PET output port is bi-directional and can be programmed as inputs or outputs. At power-up the port defaults to inputs and floats "high". This means that the interface must have a "do nothing" function when presented with all lines logic 1. Also, the port is an 8-bit port, so the accuracy of the output number is limited, especially since two of these bits are needed to specify which rotator the information applies to. Hence six-bit precision data is used for the rotators, giving about 6 degrees accuracy for azimuth and 3 degrees for elevation. This is quite adequate since the antenna −3dB beamwidth is not better than about 30 degrees.

The two "control bits" used were the most-significant bits of the PET's output word, arranged as:

(ADR) (DAV) X X X X X X

where X indicates remaining bits for data
ADR – address bit
DAV – data valid bit

A simple arrangement of logic is all that is necessary to control the two rotators using the above codes as data, and driving small switching relays, as in Fig. 5.

For the azimuth control box, a direct voltage must be derived from the PET's output word and applied to the control connections on the control box. Basically, all that is needed is to use a digital-to-analogue (d-to-a) converter to obtain a voltage which corresponds to the output word, adjust its amplitude with a variable-gain amplifier, and apply the result to the appropriate connection points. A suitable circuit is shown in Fig. 6.

The elevation rotator needs a more complex control circuit, since a decision must be made as to which way to connect the a.c. phases to rotate the motors in a particular direction. The voltage from the feedback potentiometer in the control box is compared with a voltage derived from the PET output port via another d-to-a converter. The supply phase to the motors is then switched in a manner such that they rotate to reduce the voltage difference to zero. A problem is to stop the circuit oscillating about the zero position. This is overcome by allowing a "guard band" around zero where both phases are switched off, and the motors do not rotate. The circuit used is shown in Fig. 7.

The input voltage and feedback voltage difference is amplified by the difference amplifier. If the resultant voltage is above +0.6V then diode D_1 conducts, Tr_1 switches 'on' and RLA_3 switches one particular phase to the motors. The motors rotate in a direction such that the feedback voltage decreases, until the difference output falls within the 1.2V guard band provided by the forward voltage drop across diodes D_1 and D_2. When this happens, neither D_1 or D_2 conducts and the motors stop, since both phases are switched out. Similarly, for an initial negative output from the amplifier, D_2 conducts, TR_2 is 'on' and the motors rotate in the opposite direction to before, increasing the feedback voltage until the difference lies within the guard band.

Complete interface

In order that the PET output word can change whilst either of the rotators is turning, it is necessary for both sections of the circuitry to have their particular data word latched as long as it is needed. The PET can individually update the latches as necessary.

A typical output sequence is as follows:

ADR	DAV	azimuth rotator	elevation rotator
0	0	STOP	GO
0	1	STOP	STOP
1	0	GO	STOP
1	1	STOP	STOP

11000000	Both rotators OFF, data zero on latches.
10000000	Latch zero into elevation rotator latch and activate rotator.
11010000	Both rotators OFF, data 16 on latches, zero latched in elevation latch.
10010000	Latch 16 into elevation latch, and activate rotator.
11010000	Both rotators OFF, data 16 on latches, 16 latched in elevation latch.
11001000	Both rotators OFF, data 8 on latches, 16 latched in elevation latch.
00001000	Latch 8 into azimuth rotator latch, activate rotator. 16 latched in elevation latch.

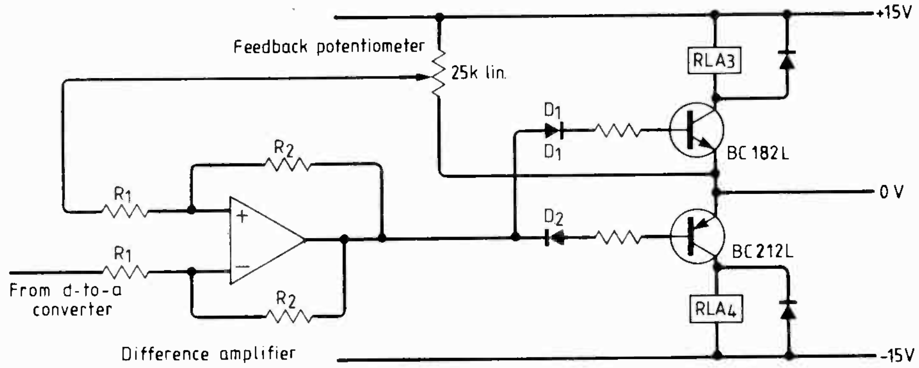
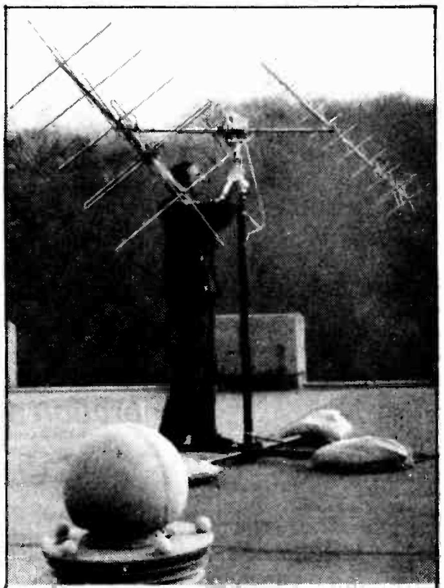


Fig. 7. The control circuit for the elevation rotator. The relays switch a.c. to the motors.



Ian Jefferson designed his satellite tracking system as a final-year project for a degree in Applied Physics at the University of Durham. He now works in broadcast engineering.

Figure 8 shows the block diagram of the interface, which includes all the circuits previously described. The latches are controlled by the circuit Fig. 5, taking their latch instruction from the outputs of the AND gates.

Computer program

A full description of the program would be rather long, since it contains many simple features such as input/output routines. Therefore the following comments are confined to basic outlines and references to particular points where necessary. The subroutines are listed below, with the exception of one or two which are trivial.

Time output routine (lines 100-140)
The PET's inbuilt time clock function is utilised, with times converted to decimal (DT) for ease of manipulation. Some string calculations are performed, and the time is 'POKED' directly onto the screen as HH:MM:SS in the top right-hand corner.

Latitude/longitude conversion subroutine (lines 150-195)
Latitude and longitude values needed for calculations are input at various points in the program, and this routine takes degrees and minutes as DDDMM in string form, checks that the input is not rubbish, and returns the decimal equivalent of the input in degrees.

Main program (lines 200-580)
This section is not a subroutine. It defines some variables, e.g. Earth radius in Mm, ERTH, and also some trig. functions. It interrogates the user for all the necessary information then uses part of lines 700-830 to set remaining variables.

Satellite data calculation (lines 640-830)
Contains data used by the main program.

Lines 1010-4010
This section starts with some screen graphics, then uses some of the other subroutines to calculate all of the tracking data. It outputs information to the screen and uses the rotator driver subroutine to track the satellite concerned. The program cycles continuously in this section.

Time since EQX subroutine
(lines 5000-5060)
Uses the decimalised real time (DT) and decimalised equator-crossing time (EXT) to find the time in minutes since the satellite crossed the equator (MI).

Subsatellite (etc.) subroutine
(lines 5070-5270)
This subroutine uses equations (6) to (12) to calculate spherical coordinates, vectors and finally the satellite elevation angle from the receiving station.

Acquisition of signal subroutine
(lines 5280-5340)
Finds the time when the satellite elevation angle is positive, i.e. when the satellite is above the radio horizon. It does this by substituting times since equator crossing in the above subroutine, starting with one minute then incrementing by one minute until the correct time is found.

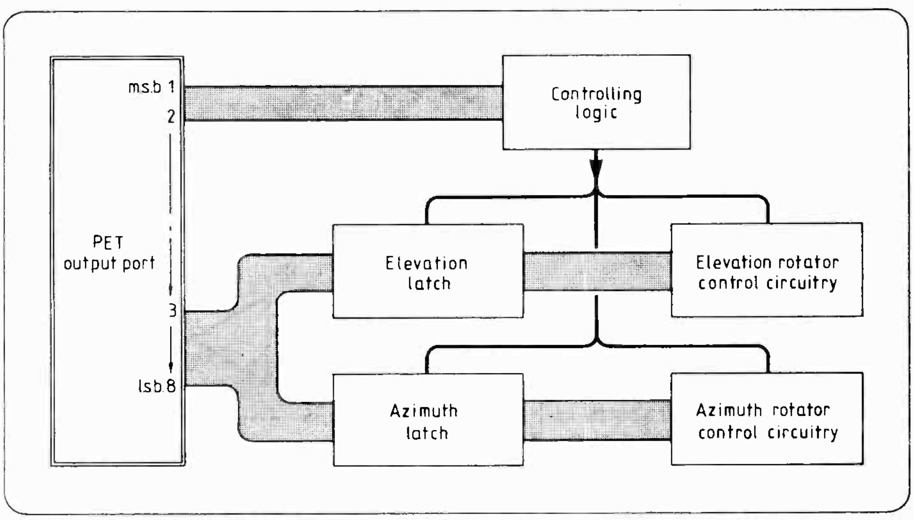
Equator crossing data subroutines
(lines 5570-5620, 5630-5680)
These two subroutines find equator crossing times and longitudes for orbits other than that given as reference by the user. One does this for orbits previous to the reference orbit (or if the reference orbit is in the future, to find the current orbit), and the other for orbits after the reference.

Bearing subroutine (lines 5700-5780)
Calculates the satellite azimuth angle from the receiving station, using calculations described on page 17. Lines 5735 & 5737 are necessary to avoid division-by-zero errors in subsequent stages. Subroutine returns a decimal angle in degrees.

Loss of signal subroutine
(lines 5860- 5900)
Similar to acquisition of signal subroutine in operation.

Rotator driving subroutine
(lines 6000-6120)
Reduces accuracy of output words to 6-bit precision, for reasons described earlier. The next function is to send out pulses to give the control logic of the interface the necessary addressing information and the data word indicating the required antenna position. When this has been done, both rotators are told to deactivate on completion of rotation. WW

Fig. 8. Outline of the interface connections.



Further reading

Evans, D. S. and Jessop G. R. VHF-UHF Manual, pp. 9.1-9.15. Radio Society of Great Britain.
The Best of Oscar News, vol. 1: AMSAT-UK
Oscar News, Winter 1980, No. 32: AMSAT-UK.
Getting to know Oscar: American Radio Relay League.
Kennedy, G. R. Weather satellite picture processor, *Wireless World* May 1980, p. 41.

A listing of Mr Jefferson's program can be supplied by the Wireless World editorial office on receipt of a large stamped addressed envelope. Please mark your envelope "Tracking satellites with a microcomputer".

High-impedance electronics

Following the description of voltage followers in the last issue, the author discusses the generation and measurement of currents down to 1 nanoamp.

by R. D. Purves, Ph.D

Instead of measuring the voltage signal from a high-impedance source, it is often more appropriate to measure the short-circuit current with an operational current-to-voltage converter (Fig. 1(a)). For example, the open-circuit voltage from a photodiode is a markedly nonlinear function of the incident illumination; in fact it saturates at 500-600 mV as the junction becomes "real" earth and the virtual earth of a current-to-voltage converter, its junction voltage is fixed at zero and saturation cannot occur. In monitoring very low light levels, saturation is not likely to be a problem, but there is a second advantage of the photogalvanic mode, again arising from the constancy of junction voltage. In the photovoltaic mode the junction capacitance has to be charged or discharged by the photocurrent whenever the light signal changes; the rise time is consequently poor. In the photogalvanic mode the rise time is essentially that of the operational amplifier.

The value of the feedback resistor in Fig. 1(a) is often fixed by consideration of the magnitude of the current signal and the desired voltage output, since $E_{out} = -I_{in}R_f$. When very small signals are to be measured the noise behaviour of the circuit should dictate the design. An elementary howler is to choose a rather small value of R_f on the grounds that its Johnson voltage noise (proportional to the square root of R_f) should be small. Actually it is the Johnson current noise that matters; this is inversely proportional to the square root of R_f. From the noise equivalent circuit[1] (Fig. 1b) the signal to noise ration can be written down as

$$S/N = I_{in}/\{E_a^2[1/R_f + 1/R]^2 + I_a^2 + 4kT\Delta f/R_f\}^{1/2} \quad (1)$$

where the last term in the denominator is the square of the previously mentioned Johnson current noise. Although the balance of the three contributing factors depends on the properties of the amplifier used, it is clear that S/N is an increasing function of R_f. In particular, to avoid unduly multiplying the amplifier noise voltage E_a, R_f should be at least equal to the resistance R of the signal source. Since R is often not known (except perhaps that it is known to be large) the natural tendency is towards huge values of R_f. Neurophysiologists routinely use values of 500-1000 MΩ to measure picoamp currents flowing through molecular pores in cell membranes.

A common modification to the basic current-to-voltage converter is the use of a tee network in the feedback loop (Fig. 3). Here R_f is the largest conveniently available value, say 100 MΩ, but its effect is multiplied by attenuation in the tee. If, as is usual, R_1 and R_2 are much smaller than R_f, then the output signal is $-\beta I_{in}R_f$, where β is the attenuation ratio $(1 + R_1/R_2)$. For example, with R_1 = 99k, R_2 = 1k and R_f = 100 MΩ, the tee behaves like a 10 GΩ resistor. The signal to noise ratio, unfortunately, is unimpressed by this synthetic resistor and takes the value given by Eq. 1 for the actual value of R_f used. Thus a real resistor is better than a synthesized one of equivalent value. Similar conclusions apply when offset and drift are analysed.

A further pitfall of the tee network relates to loop gain. Extravagant values of attenuation in the tee may leave insufficient gain for proper feedback action, especially since R and R_f form a second attenuator in the feedback path. A typical operational amplifier has an open-loop low frequency gain of about 10^5. If we choose β = 1000 and R_f/R = 9, the loop gain is only $10^5/[\beta(1 + R_f/R)]$ = 10. This dangerously small loop gain will become even smaller above the amplifier's first corner frequency (10 – 40 Hz), and the circuit

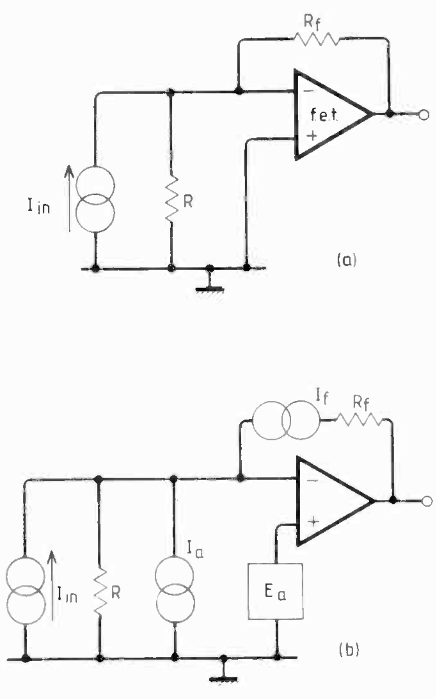


Fig. 1 (a) Operational current-to-voltage converter. (b) Noise equivalent circuit. E_a is the amplifier's r.m.s. voltage noise, I_a is the amplifier's r.m.s. current noise and I_f is the r.m.s. Johnson current noise of the feedback resistor. $I_f = \sqrt{4kT\Delta f/R_f}$, where k is Boltzmann's constant, T the temperature and Δf the noise bandwidth.

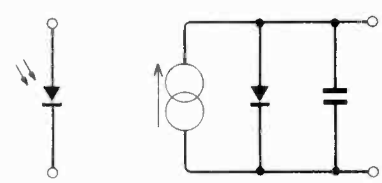


Fig. 2. Photodiode and an equivalent circuit. The photocurrent generator is shunted by a diode and the junction capacitance. The terminal voltage is limited by forward biasing of the diode. For the terminal voltage to change, the photocurrent must charge or discharge the junction capacitance.

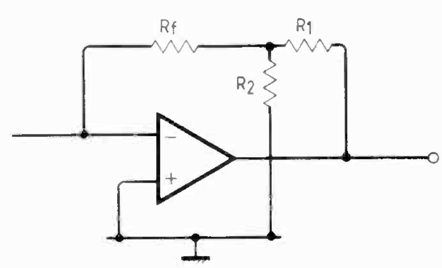


Fig. 3. Tee network in feedback path of current-to-voltage converter.

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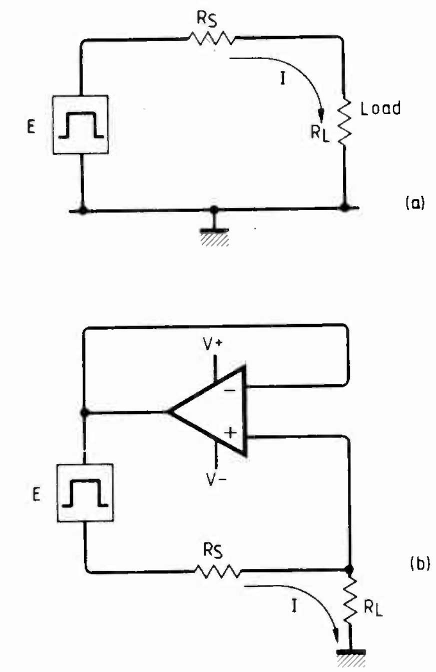


Fig. 4 (a) A simple current source. (b), bootstrapped current source with fet operational amplifier.

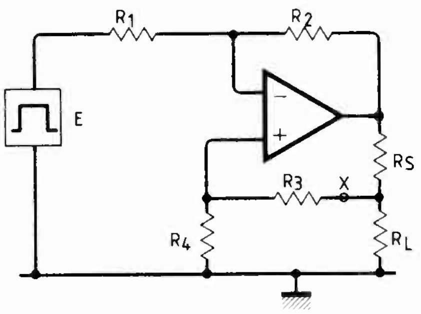


Fig. 5. Howland current pump.

ceases to behave as a current to voltage converter.

The only advantages of the tee network are that it may obviate the need for an additional stage of voltage gain and that range switching can be carried out at low impedance (by switching the values of R_1 and R_2). The second advantage is an important one, since attempts to switch resistors in the GΩ range with an ordinary wafer

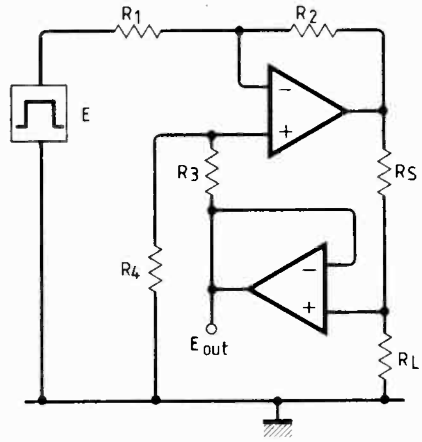


Fig. 6. Improved Howland current pump.

switch are unlikely to be greeted by success.

Nanoampere current sources

To provide a controlled current of the order of 1 nA one might turn to the circuit of Fig. 4(a). For certain purposes this simple strategy might suffice but if the load current has to remain substantially constant in the face of variations in R_L then we would require $R_s \gg R_L$. For example, if R_L ranges from 0 to 100 MΩ, then for a current variation of 1% we must take R_s as 10 GΩ. Such resistors are both expensive and hard to obtain. Furthermore, if we now require currents of 10-100 nA, the voltage source of Fig. 4(a) will have to take inconveniently large values (100-1000 V).

The solution to these problems is often to be found by bootstrapping, shown in its starkest form in the active current pump of Fig. 4(b). In its originator's well-chosen phrase[2] "this deceptively simple circuit" produces an output current E/R_s, independent of the magnitude of R_L. Readers may like to test their wits by analysing the mode of operation.

The most important parameter characterizing a current pump is its output resistance, which should be as high as possible. Conceptually, it may be determined by setting the command signal to zero, replacing R_L by a voltage source E′, and then calculating the current I′ drawn from this source. The output resistance is E′/I′; in Fig. 4(b) it is $R_s(1 + A)$ where A is the open-loop low frequency gain of the amplifier. Another parameter is the output bias current in the absence of a command; for Fig. 4(b) this is V_{os}/R_s where V_{os} is the amplifier's input offset voltage.

Despite its charm, the circuit of Fig. 4(b) is rarely used because it needs a floating signal source. The familiar Howland current pump[3] seems more promising at first sight. In Fig. 5 one or more of the resistors is adjusted to give the "balance" condition $R_2R_4 = R_1(R_3 + R_s)$. Then $I_{out} = -ER_2/R_1R_s$, independent of the load R_L. However the output resistance of the Howland pump is sharply degraded by small departures from the balanced state, since the output terminal is shunted by R_3 and R_4. The resulting shunt current must be very accurately compensated by additional drive to R_s. Again, the balance condition depends on five resistors which usually span a wide range of values. Differential aging and temperature effects on resistance are therefore difficult to control, and the Howland circuit needs frequent rebalancing to maintain a high output resistance.

A much better circuit (Fig. 6) is one found in most commercial current pumps for neurophysiological use. It is derived from the Howland design by interposition of a fet voltage follower at point X of Fig. 5, to remove the shunting effect of R_3 and R_4. The balance condition is now $R_1R_3 = R_2R_4$. Three of these resistors can be of the same value and type (e.g. 10k metal oxide), the fourth being the next lower preferred value in series with a cermet trimmer. Resistor R_s is generally 10 − 100 MΩ, the exact value being immaterial to the balance condition. An extra advantage of his circuit over the Howland pump is that the follower allows the voltage applied to the load to be monitored at the terminal labelled E_{out}.

In Figs. 5 and 6 the source resistance of the command signal is in series with one of the gain-determining resistors. Both circuits would in practice need an input buffer stage to isolate the "working part" from changes in source resistance. An alternative three-amplifier configuration[4] in Fig. 7 has a spare input terminal for the command signal. This circuit may be understood by recognizing that A_2 is a differential amplifier whose output is a low-impedance replica of the voltage across R_s and thus a direct measure of the output current. This signal is compared with the command by A_3, which forces the output current to take the command value. WW

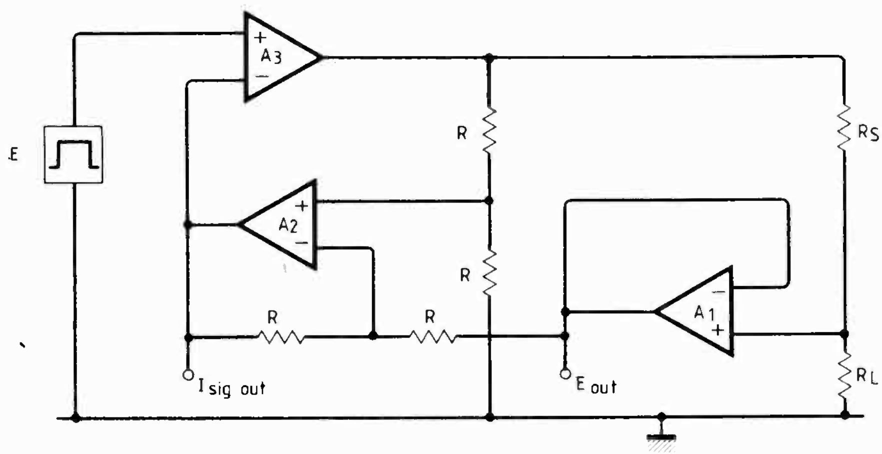


Fig. 7. A three-amplifier current pump. The resistance of the signal source does not affect the output resistance.

References

1. Motchenbacher, C. D. and Fitchen, F. C. Low Noise Electronic Design. Wiley, 1973.
2. Fein, H. Passing current through recording glass micropipette electrodes. *IEEE Trans. Biomed. Electron.*, vol. BME-13, pp211-212, 1966.
3. Smith, J. I. Modern Operational Circuit Design. Wiley, 1971.
4. Purves, R. D. Microelectrode Methods for Intracellular Recording and Ionophoresis. Academic Press, 1981.

Eprom single-chip microcomputers

Using microcontrollers which have program in eprom, enabling program development by means of an emulator.

by M. D. Bacon, M.A.

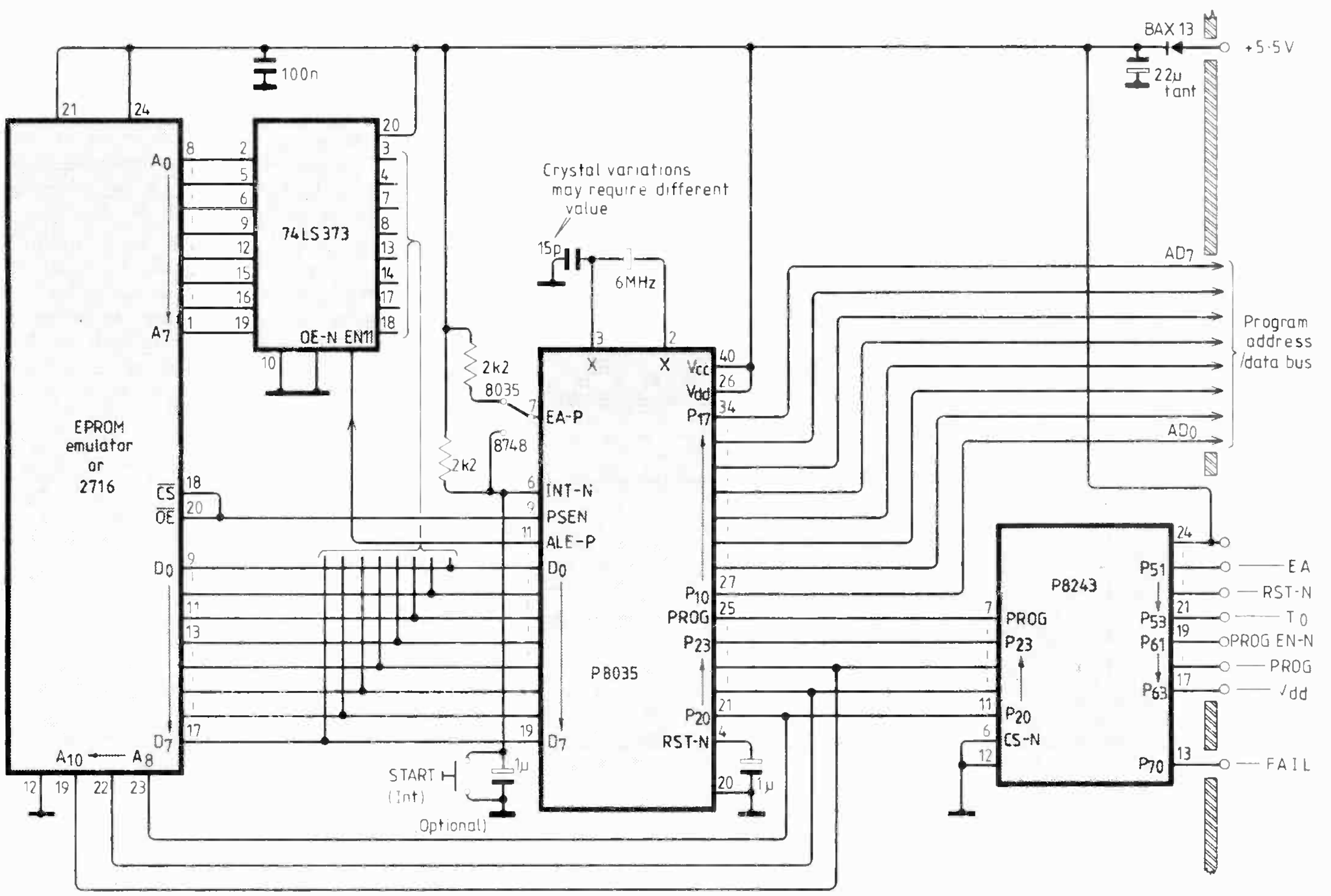
Far too many constructional articles involve building a small central processing unit and a bit of extra hardware, and then plugging in a preprogrammed eprom, or alternatively the use of a device which is in fact a preprogrammed microcontroller acting as a digital clock, printer controller or whatever. I suspect that, even if slightly greater expense is involved, many people would like to be able to build things like this for themselves and then start tinkering. What follows is an attempt to indicate how, given certain not-too-expensive hardware, the 'tinker factor' can be put back into home electronics.

Microcontrollers have tended to be very low-key products, despite their wide use in industry for low-grade computing. There are two principal reasons for this. First, most of them are programmed during manufacture, at the mask level, and while this is economic if one is contemplating making 50 000 washing machines, it is of less than no interest to the one-off user. Second, microcontrollers have very little ram, typically 64 or 128 bytes and, unlike microprocessors, cannot normally store a program in this ram and then execute it – which is how general-purpose computers work. This tends to make development of programs a job for a specialized development system, which is expensive.

Recently microcontrollers have become available which contain their program as eprom. They are currently about £13 each and up (as speed and memory size increase) and are becoming widely available. This article confines itself to the baseline machine, the Intel/NEC 8748.

The 8748 is a 40-pin package with an impressive die visible through the u.v. erasure window. It runs on a 5V supply and contains 1 kilobyte of eprom, 64 bytes of ram (which has particularly convenient addressing modes), an 8-bit timer with interrupt, 2 testable inputs, 1 interrupt input, single-step capability, 2 8-line input/output ports, a bidirectional bus port which can be latched, a clock generator, and various useful special functions. The device can be made to do almost all the essential functions of a controller, using in addition only seven passive components and about three square inches of Veroboard.

Fig. 1. *Emulator section of programmer 8035 is type of 8748 without eprom*



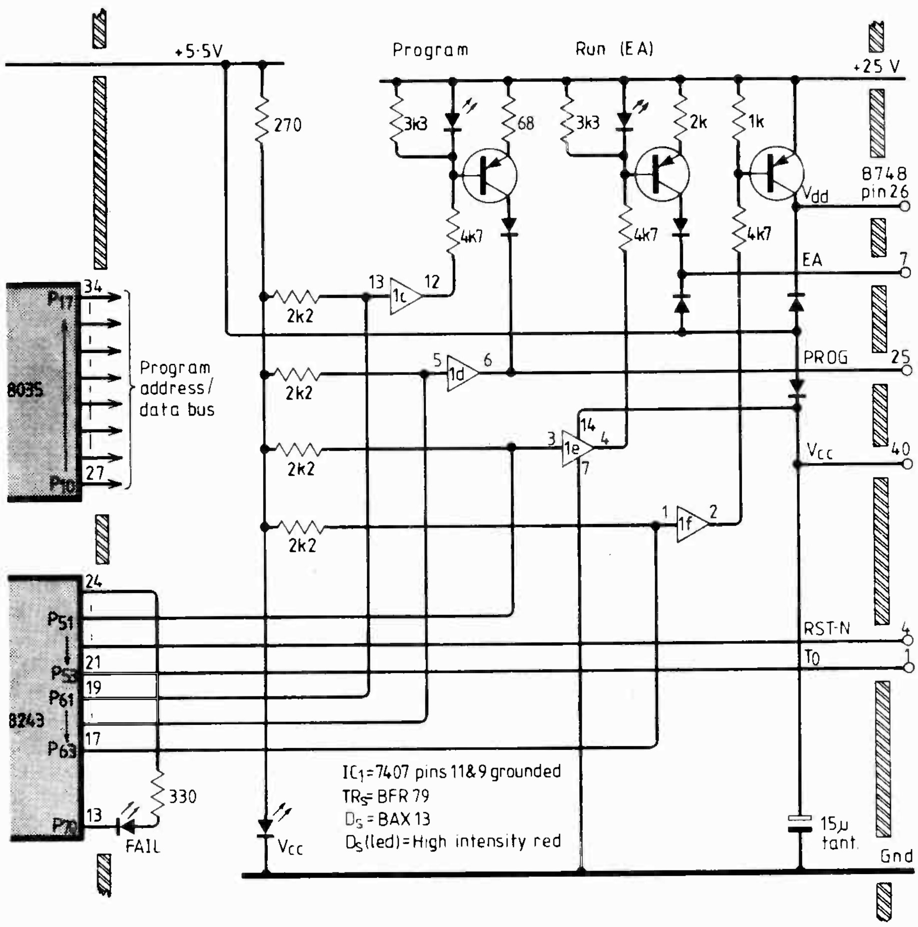


Fig. 2. Programmer control circuit.

As readers of Ivor Catt will know, microcomputing is a slow process in electronic terms. However, most microcontroller applications are also very slow; clocks require a resolution of seconds; printer mechanisms require time slots of hundreds of microseconds. If one considers the following list of microcontroller jobs, it will be quickly seen that the external hardware is the limiting factor on speed: burglar alarms; central and solar heating controllers; cassette deck controllers with parallel to serial interface; temperature measurement using thermocouples, with software linearization; special function calculators (such as the Picotutor); interfacing of keyboards and displays to general-purpose microcomputers.

It need hardly be said that the limitations on the one hand of a maximum of 128 bytes of ram and, on the other, of a maximum practical signal handling capacity of about 25kHz, defines where the microcontroller gives way to the microprocessor or to a discrete logic. Within these limits, however, system design becomes largely a matter of obtaining all the input signals as t.t.l. level, buffering the outputs where necessary, connecting all inputs and outputs to appropriate pins of the 8748 and then sitting down to write the program.

To write the program . . . and there is the difficulty. Programs require development, that is, testing and modifying until they work. As mentioned earlier, this presents problems with a microcontroller.

The major thrust of this article is to present a small circuit, shown in Fig. 1, which enables microcontroller program development to be carried out using an eprom emulator such as that recently described as *Wireless World**. It uses a version of the 8748 which lacks the eprom memory and uses an external memory for its program, the 8035. Used in conjunction with the eprom emulator, it provides a model of the 8748 which has only two limitations; the bus port is used to fetch program and cannot be latched, and 4 pins of port 2 are also used for program address. This is not in practice as serious as it may appear, since the bus port is usually used with memory-mapped devices (of which two are shown in the applications) and this use is not affected; the four pins of port 2 are usually used to drive a special p.i.o. device, the 8243. This is provided in the development circuit, and is particularly convenient because it requires only five lines to connect to the 8035/8748 and provides four 4-bit ports, each of which can be used as input or output and each line of which has 4 mA drive—except for port 7 which can source 20mA. The 8243 is operated by special 8748 instructions and, unlike a normal p.i.o., requires no base address or control register settings.

*Eprom emulator, by Peter Nicholls, September, 1982.

To use the development board, the emulator is used as usual to hold, and alter as required, the development program. Connections are then made between the 8035/8243 and the equipment which it is intended to control. There are many possible ways of doing this, such as using a 40-way dual-in-line plug to which all the 8035 leads except the crystal (pins 2 and 3) are connected. This is a simple in-circuit emulator. Another approach, favoured by the author, is to fit the development board with an edge connector to which all useful lines are brought out. This enables prototype equipment to be built on ordinary Veroboand and plugged straight in.

The problem then arises, once a successful program has been developed, of programming the actual 8748 to be used. This is not easy, because address and data lines are multiplexed and the program pulse is rather complex. The solution adopted, once the hardware complexity of adapting a normal programmer was

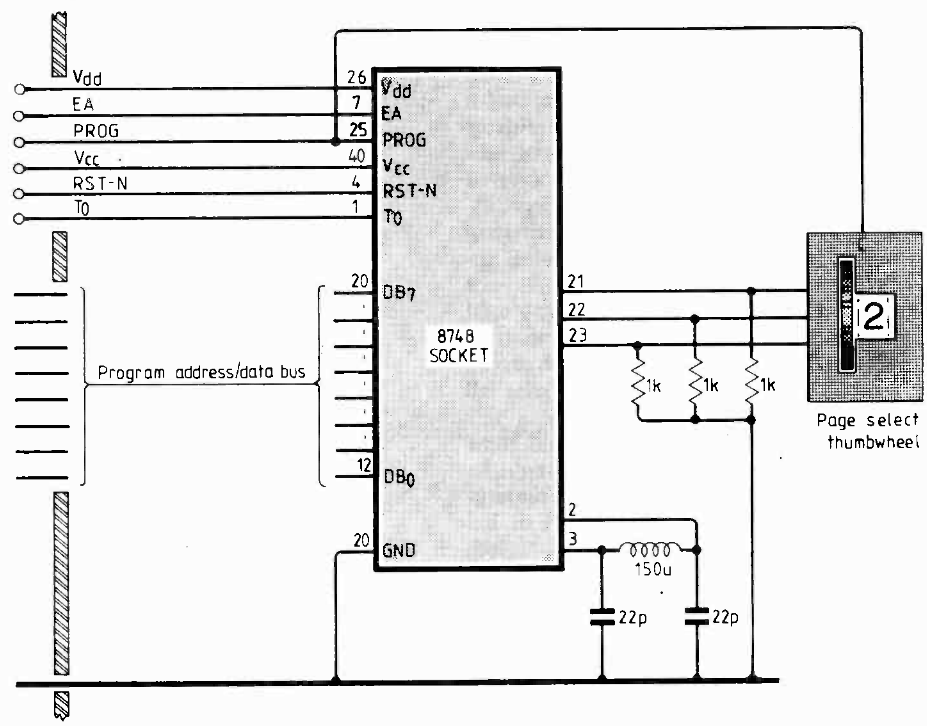


Fig. 3. Programming is carried out one page of four at a time. Thumbwheel switch selects page.

STATE	P5	P6	P1	DURATION	OTHER OUTPUTS	NOTES
1	A	F	INPUT	UNTIL INT-N	If not VERIFY, FAIL light ends cycle	Initial state & final state-insert or remove SCEM
2	0	F	"	50 µs	EA light on during PROGRAMMING	Select & activate PROGRAM mode
3	0	F	OUTPUT ADDRESS	50 µs		
4	4	F	LATCH ADDRESS	50 µs		RST-N goes high
5	4	F	OUTPUT DATA	50 µs		Uses MOVP3 A,@A instruction
6	4	B	"	50 µs		PROG goes low
7	4	3	"	50 µs		$-V_{dd}$ goes to 25 V
8	4	5	"	50 µs	PROG light	V_{dd} at 25 V : PROG at 23 V PROGRAMMING occurs
9	4	B	"	50 µs		As state 6
10	4	F	INPUT	50 µs		Change P1 first
11	C	F	"	50 us		Wait for VERIFY DATA to become VALID
12	C	F	READ DATA	10 µs		READ (& VERIFY)
13	0	F	INPUT	50 µs		Wait for lines to steady if fin. GO STATE 1 : ELSE GO STATE 3

Total program time 13 seconds per page

realised, was to build a programmer as a peripheral driven by the development board. By doing this as, as shown in Figs 2 and 3, a minimum of extra hardware is required. The most expensive part is a zero-insertion-force socket, and under normal circumstances the careful hobbyist, who will not be doing much programming, can dispense with this in favour of a much cheaper quick-eject socket.

In use the 8748 is programmed one page (1 page = 256 bytes) at a time; this arises out of the modest data handling of the instruction set, which dislikes mixing program and data. The 8748 has four pages of eprom, number 0 to 3, and the page to be programmed is set up by a thumbwheel switch or dipswitch as shown.

The programming algorithm (see listing) is then placed in the emulator page 0, i.e. from 000 up. This listing gives a very simple programming routine; it is not claimed to be ideal, but it gives the beginner something to work from – in fact, a chance to tinker.

The page of data to be programmed, regardless of what page it is to appear in in the 8748, is then loaded into page 3 of the emulator, where it takes advantage of a quirk of the instruction set. The emulator is connected to the development and programming board, and the system powered up. The programming board requires 25V at approximately 50 mA. A switching supply is not advised due to possible interference: if a suitable supply is not otherwise available, dry batteries to a total of 24 nominal volts provide an alternative. Whatever the supply, it should not exceed 26 volts under any circumstances, not fall below 24 during programming.

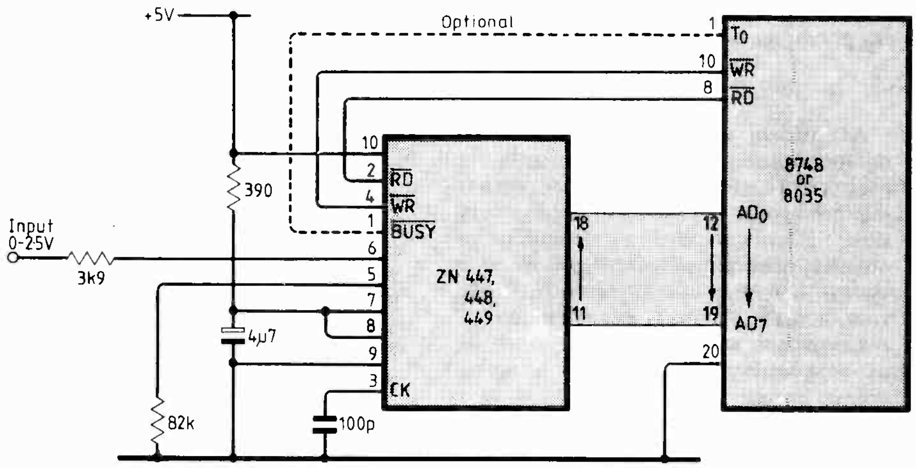
On power up, the Fail led should come on and all others stay out. As a test, the Interrupt switch which starts programming should be operated. The Fail led should go out while the switch is closed, and come on immediately when it is released while the EA led glows dimly. After thirteen seconds the EA led goes out and the Fail led blinks. Now the Fail led should go out, the EA and Program leds come on, and the Program led should vary in brightness as the value of the data being programmed varies. At the end of the cycle the other leds go out and the Fail led blinks. The page number may them be changed, new data placed in Page 3, and the program cycle repeated. If the Fail led lights during the cycle one or more addresses have mis-programmed.

All the time the 8748 is socketed and power applied the circuit applied to pins 2 and 3 should be oscillating at around 3 MHz, and a square wave should be emitted from Pin 11: if these are missing, there is a fault. A 2.5-3 MHz crystal may be substituted for the inductor if available. Programming requires a slower clock than normal running, and this has been taken into account in the oscillator and the programming algorithm.

Expansion of the 8748 is dealt with very thoroughly in the Intel manual, which is essential reading in any case, but some specific examples are given here. There are two types of expansion; direct, in which microcontroller pins are used as inputs or outputs and retain output values until they are changed, and memory-mapped.

In memory-mapping, the bus port is used with a 74LS373 (for t.t.l.) and/or a 74C373 (for c.m.o.s.). This octal latch is used to latch an address during a MOVX instruction. In the simplest case, setting one address bit to 1 (i.e. addresses 01, 02, 04 . . . 80) is used as a chip select for a particular device, and a Nand gate may be used as shown in Fig. 4 in conjunction with RD-N and an address line to read from a unique device. In the case of the alphanumeric displays dealt with later, the lowest two address lines select a digit within a display, and the next six lines are used to select a particular display. The

Fig. 4. Adding 8-bit a-to-d converter.



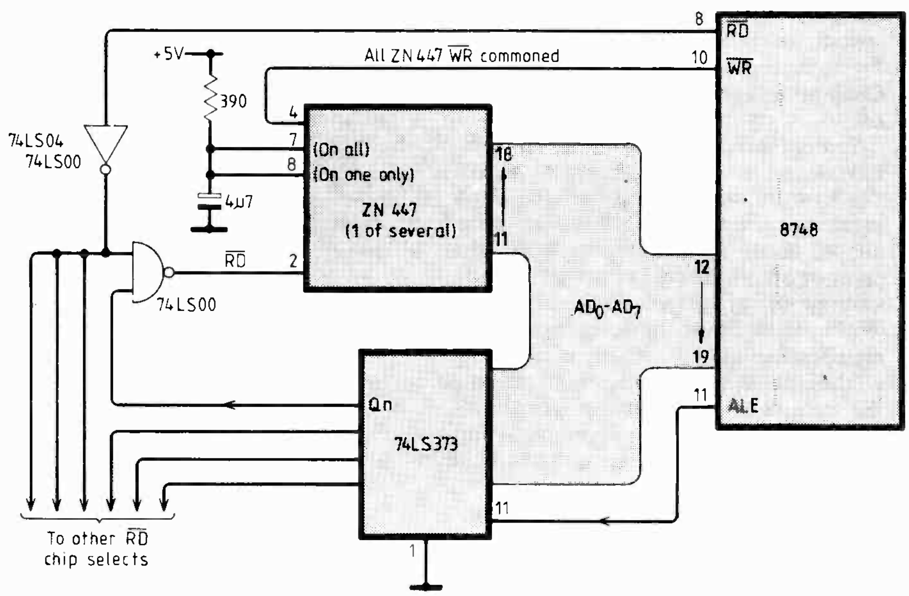


Fig. 5. Using several a-to-d converters for high-speed operation.

Prom programming routine – listing

Address	Data							
000	0410	0004	2000	0004	0000	0000	0000	0000
010	23AA	3D23	FF39	3EBA	0005	2300	3F04	1A00
020	2300	3D23	FF3F	FA39	1468	2344	3D14	68FA
030	E339	1468	23BB	3E14	6823	333E	1468	2355
040	3E14	7023	BB3E	23FF	3914	6823	FF3E	1468
050	23CC	3D14	6809	ABFA	E3DB	9680	1AFA	C690
060	2300	3D04	2600	0000	BCOA	EC6A	9300	0000
070	BD64	BE64	EE74	ED72	9300	0000	0000	0000
080	2300	3F04	5C00	0000	0000	0000	0000	0000
090	23AA	3D23	003F	1470	23FF	3FBF	2014	70EF
0A0	9C04	93						

scheme can be extended to address up to 256 devices using decoders.

In this way, using the bus port, one or more a-to-d converters can be added to a system and used to measure temperature (using a thermistor bridge or a device such as the AD590), position (using linear rotary potentiometers) or electrical quantities. The recently introduced Ferranti ZN447, 448, 449 series interface very simply; if only one is required and the bus is otherwise unused, as in the first diagram; if other devices share the bus, or more than one a-to-d is required, as in the second. If several channels require to be scanned fairly slowly, then another port can be used with an analogue multiplexer to select a channel prior to conversion. A conversion then requires about 50 microseconds total, so even if quite a lot of channels are being scanned and data is being transmitted to tape or printer each channel can be looked at several times a second. Indeed, as mentioned earlier, the speed of printer or tape recorder is what slows down the system.

If a high throughput is required or it is necessary to read data on several channels simultaneously, the arrangement of Fig. 5 can be used. Here, all the converters start converting together and can then be read out as required. This technique, used in conjunction with a parallel data link and, perhaps, the faster 8749 processor, can achieve total rates in excess of 50 000 samples per second.

Such an arrangement can be used to improve the performance of a general-purpose microprocessor based machine by freeing it from the low-grade tasks involved in operating a-to-d converters and channel selectors.

Memory-mapping can be applied to the driving of the recent generation of intelligent alphanumeric displays, which are driven like ram and accept ASCII coding. Figure 6 shows an interface for one such display, based on the same principle as the multiple a-to-d technique but Nanding a positive write strobe with an address line to give the chip select function. These devices are not cheap – they cost around £4 per digit all in – but can display the alphabet in capitals as well as punctuation marks, which 7-segment displays are unable to do. If a prototype board using these devices is detachable from the rest of the system, pull-up resistors should be fitted on all lines, since they use high-output c.m.o.s. devices, which are prone to self-destruct if static appears on a pin while the device is powered up.

At the other end of the scale, the novice user is urged to return to the early ages of computing and drive a line of eight leds via a suitable buffer from port 1. Then, in developing a program, at any point where it is desired to check the value of the accumulator or a register, code may be inserted to cause the value of the byte in question to be output to the led line, followed by a software halt (a jump back to the same line.) Once this part of the program is known to be satisfactory the output and halt may be moved to the next convenient stopping point, and so on. Alternatively, each part of the program can be made to output a specific code and halt for a second or so before continuing, so that execution can be watched at slow speed. Single-stepping is covered in the manual.

Finally, a simple interface to 240V line is shown in Fig. 7, using the MOC3020 opto-isolated triac, which has 7.5kV isolation. It is recommended that the line circuitry be remote from the processor board and linked only by the two lines from 8243 to optocoupler. If zero-crossing switching is desired, this can be arranged by applying a negative pulse to the processor interrupt at each zero crossing, and using this to synchronize the turning on of the triacs. Alternatively, by introducing a delay using the timer, phase-angle control may be used in software, with approximately 1° resolution.

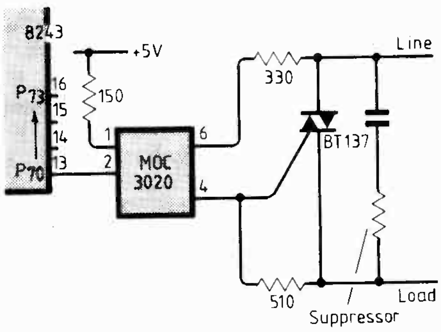


Fig. 7. Solid-state relay using optoelectronic triac. Switches up to 8A at 240V a.c.

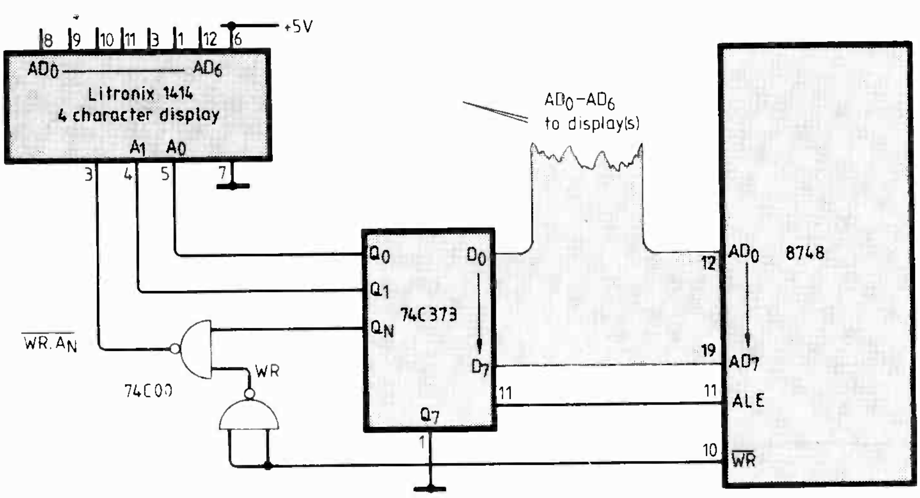


Fig. 6. Interface to drive intelligent alphanumeric display.

The fundamental and essential manual for the 8748 is the MCS-48 User's Manual, Intel Part No. 98-270, available from Rapid Recall, Rapid House, Denmark St., High Wycombe, Bucks, most recently for £13.22 including p.&p. The 8748, 8035 and 8243 in numerous performance versions are also available from this source.

The NEC second-source is available from MultiComponent, formerly ITT, and at the same address, viz. Edinburgh Way, Harlow, Essex. ITT inform me that they are perfectly happy to deal with the general public even for small quantities, and can supply almost everything mentioned in this article; any deficiencies can easily be made up from the advertising section of *Wireless World*.

Notes

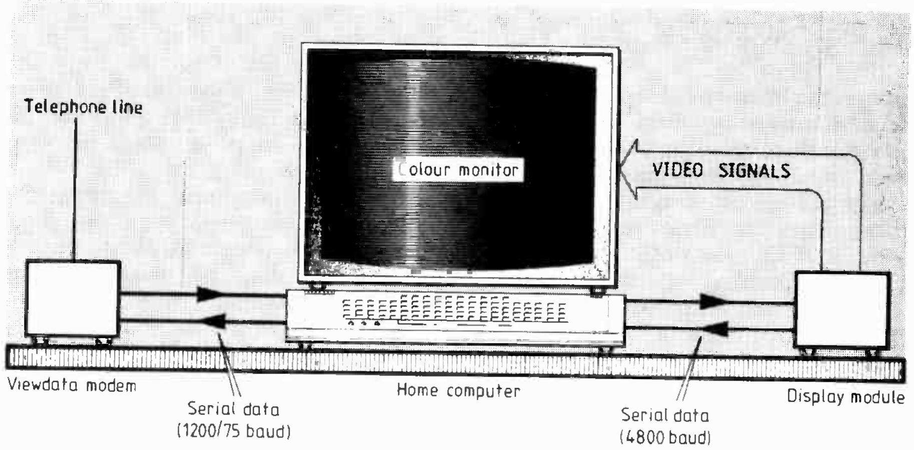
The circuitry mentioned in the text has been built with little trouble on Veroboard, but an artwork for a p.c.b. for development board and programmer can be supplied reasonably quickly if required. An 8748 assembler to run on ZX81 is under development.

Viewdata display module

This display module allows a home computer to shed some of its display processing load and display colour text and graphics in teletext format. Red, green, blue and sync video outputs are provided and the display is controlled by either a serial or parallel link from the host computer. With the addition of a modem, the module can be programmed to display data directly from a viewdata computer.

This module performs all the necessary display functions for a viewdata terminal. Video and tv sync outputs are generated for direct connection to a colour monitor or via a PAL encoder and u.h.f. modulator to an ordinary colour tv set. Data input to the module can be either serial or parallel and consists of characters for display or control commands to the module. The module was originally designed to be connected to a host computer to relieve it of some of the burdens of display processing; it could easily be used with a home computer to provide viewdata and/or display capability.

by Dennis N. Pim



Display module is designed for use with home computer to provide videotext display at 4800baud, but software changes could allow a level one Prestel display of 1200baud directly from a viewdata computer.

The display module is controlled by an 8048 microcomputer (8748 eprom version). Changes in the software for this processor allow much flexibility in the operation of the module. For example, in my prototype the module receives serial data at 4800baud and any word whose most significant bit is set to logic 1 is decoded as a command rather than a character for display. Simple software changes could be incorporated so that the module directly displays the serial data (with parity) at 1200baud arriving from a viewdata computer.

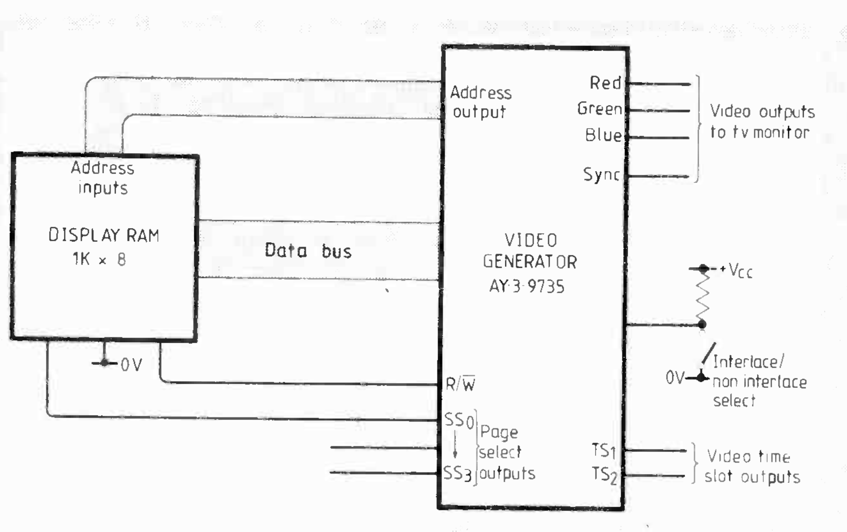
In the present version, the module can also perform simple editing functions such as scrolling up or down, clear to end of line, and clear to end of page. All or part of the display can also be read by the host computer as can the current cursor location on the screen. Once again the software allows other special functions to be programmed for specific applications thus freeing the host computer from time-consuming display operations.

The module has four page stores, and any of these can be selected for display and/or updating. It is possible therefore to write a new page whilst another page is being displayed and only display the new page when it is complete.

Used in serial input mode, the module has available a general-purpose input/output port. Serial commands enable this port to be read or written; individual bits can be selected as input or output.

Before considering the full circuit of the module, look at the operation of the video generator integrated circuit.

Video generator provides the usual 24 row × 40 column tv text display implements Prestel terminal facilities. Video i.c. contains character rom and addresses four pages of ram in the application described.



Video generator

The display module uses the GIM AY39735 interlace/non-interlace video generator to generate the tv signals. This i.c. provides the necessary circuitry to generate a full composite tv sync and the red, green and blue video outputs. It contains a character rom and can address up to eight pages of ram store, although in this application only four pages can be used. The i.c. generates the usual viewdata format of 24 rows and 40 columns, and implements all the BT Prestel terminal specification display facilities. It is driven by a 6MHz clock and has a set of tristate address and data lines to connect to the display rams. A

R/W signal drives the page store selected by three binary tristate store select lines.

Within each video frame there are four time slots that are indicated by the state of two outputs from the chip. These are

TS00 – reading from ram. This occurs under control of the video generator between lines 48 and 288 and is when the display is active.
TS01 – writing to ram when teletext lines are written to the page store during frame flyback. Not used in this application.
TS10 – spare.
TS11 – data interchange period. During this period the video generator can receive commands from the control processor (lines 23 to 47).

During lines 289-6 the video generator is inactive. In addition, the video generator data and address lines are tristate during every line flyback period. This occurs approximately 56µs from the start of the line sync pulse to approximately 16µs after the start of the next pulse, a total time of about 24µs each line. Because the video generator frees the address and data lines during line flyback the 8048 processor can have access to the display rams during this time for updating/reading. The 24µs window gives enough time to read/write one character to the display store.

During time slot TS11, the display chip is enabled to receive commands from the controlling microprocessor by placing 111XX0XXX on the address lines (X≡either logic state). The required command code is then set up on the data bus bits 0 to 6 and bit 7 of the bus is used to strobe the command into the display chip. Some of the functions that can be controlled in this way are

clear screen
half-screen expansion
select displayed page
display tv picture or text
select teletext/viewdata mode
select mix mode
cursor on/off (the cursor – a flashing underline – is displayed at any ram location whose most significant bit is set to 1; only seven bits are required for each character display).

The figure shows the video generator in a conventional configuration addressing one 1K×8 display ram.

Circuit description

The circuit has to cater for the following operations.

- Reading and writing from one 1K block of one of the two 2K rams forming the four page stores by the video generator. (Writing is required for page clear.)
- Reading and writing from one 1K block of one of the two 2K rams by the microcomputer.
- Selection of one 1K block of ram for display by the video generator.
- Selection of one 1K block of ram by the microcomputer (not necessarily the same block as that being displayed).
- Sending commands directly to the video generator from the microcomputer during time slot TS11.
- Receiving serial or parallel data or commands from the host computer.
- Sending serial data to host computer.

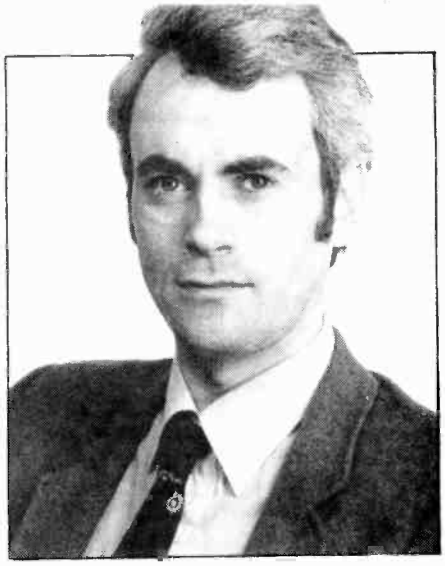
The video generator data bus is connected to the data buses of two 2K rams, (cmos in the prototype) and the 8048 data bus. The address bus of the display chip is connected to the ram address lines A0 to A9. (Address line A3 is fed via a tristate buffer whose function is explained later). The 8048 supplies address information for the display rams from its multiplexed bus using an eight-bit latch. Address information is latched into this chip by the 8048 ALE line and presented to the address bus when required by a low signal on bit 4 of port 2. Bits 0 and 1 of port 2 provide the required two remaining higher-order ram address lines A8 and A9.

The two 2K rams provide four pages of display. Page selection for display is achieved by the SS0 and SS1 binary tristate outputs of the video generator. SS0 selects the lower or upper half of each ram via the A10 input and SS1 selects one of the two chips via their $\overline{CS}$ inputs. Reading or writing to each page by the microcomputer is achieved by bits 2 and 3 of port 2 connected to the ram A10 and $\overline{CS}$ inputs respectively.

The video generator provides a tristate R/$\overline{W}$ line that can be directly connected to the ram write strobe (the video generator needs to write to the rams for the clear screen function). Unfortunately the WR strobe of the 8048 is not tristate, hence this output cannot also be connected directly to the ram $\overline{WE}$ inputs. It is therefore connected to the enable input of a tristate non-inverting buffer whose input is connected to the output-enable signal of the address latch (8048 port 2 bit 4) so that the $\overline{WR}$ strobe is applied to the rams only when they are accessed by the processor. This, as well as providing the required tristate write strobe, prevents the write strobes produced whilst the processor is sending a command to the video generator from corrupting the contents of the rams.

Also, so that the 8048 can send commands to the video generator, the ram outputs must be tristate during the slot TS11. Hence it is not possible to permanently ground the ram OE inputs and a read strobe has to be supplied to them. The video generator does not have a read strobe output, but the SS2 page-select line creates one. This tristate line is only held low during the display period (assuming one of pages 0 to 3 are being displayed). The SS2 line therefore provides the required read strobe and is connected to the ram $\overline{OE}$ inputs. This is why only four pages of ram can be used in this application. The 8048 does have a read strobe ($\overline{RD}$) but this like the write strobe is not tristate and hence another buffer is used to provide a tristate strobe in the same way as for the $\overline{WR}$ line.

Sync pulses from the video generator are fed via a monostable to the test zero (T0) input of the processor. This input receives positive-going pulses at the start of line flyback, arranged to be about 10µs wide by the 27kΩ/100pF monostable timing components. The processor therefore knows that it can have access to the display rams from 56µs to 80µs after the leading edge of this pulse. (The next line pulse does of course appear on the T0 input during this time window).



Dennis Pim, B.Sc.(Eng), Ph.D., M.I.E.E. lectures in electronics at the Open University. He obtained his degrees from University College London, where his Ph.D. research was concerned with various aspects of simulation. Before joining the O.U. in 1981 he spent four years with Rediffusion on the design and production of television receivers, becoming viewdata project leader. Resulting from his work at Rediffusion Dr Pim is now involved with research in the field of home information/entertainment systems.

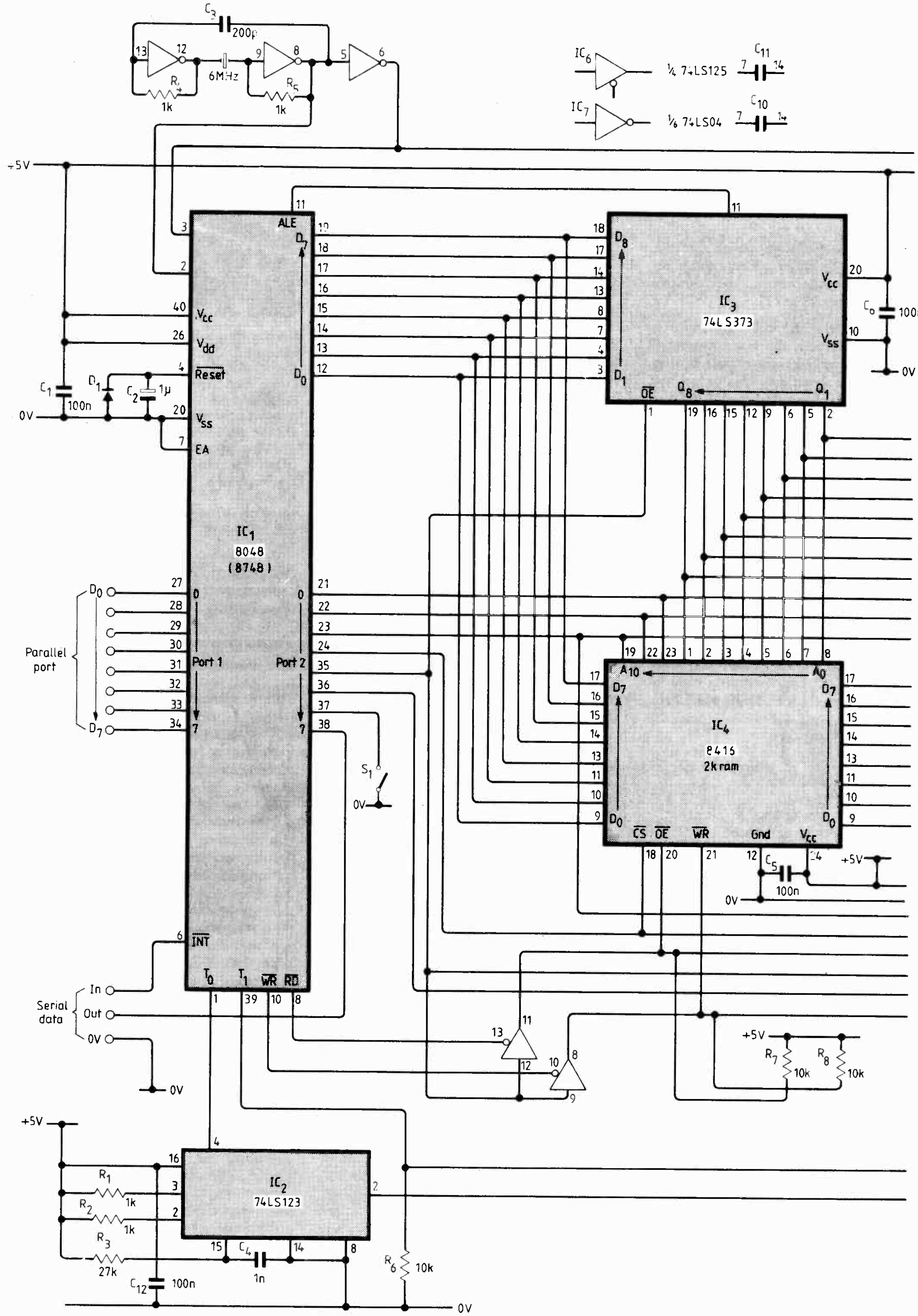
Video generator commands

The time slot outputs of the video generator (TS1 and TS2) are and-ed together using a spare inverter and a spare tristate buffer to provide a signal on the processor's test-one input (T1), which is logic high during time slot TS11, when the video generator is enabled to receive commands.

Because the processor might access the display rams during any line flyback, including those occurring during time slot TS11 when the video generator is enabled to receive commands, it is important to prevent the video chip from responding to data on the data bus intended for the rams. (It is possible to select a ram address which activates the video generator during this time slot). This situation is prevented by effectively breaking the display's A3 address line during a processor read or write using a tristate buffer which is disabled by bit 4 of the processors port 2. If the processor is required to send a command to the video generator, the required enabling address of 111XX0XXX is set up on the address bus by the four 22kΩ pull-up resistors on address lines A6 to A9, and by setting bit 5 of port 2 to zero thus providing the required logic 0 on address line A3. During time slot TS11 the ram outputs are tristate and the processor can then send a command to the video generator via the data bus, using data bit 7 as a strobe.

Inputs

Two ways to input characters or commands are provided. Port 1 of the 8048 can be used as an eight-bit parallel input. In


C3
200p
6MHz
R4
R5
1k
IC6
¼ 74LS125
C11
IC7
⅙ 74LS04
C10
+5V
0V
ALE
Reset
Vcc
Vdd
Vss
EA
C1
100n
D1
C2
1μ
IC1
8048
(8748)
IC3
74LS373
C9
100n
OE
IC4
8416
2k ram
CS
WR
Gnd
C5
Parallel port
Port 1
Port 2
S1
INT
In
Out
Serial data
R7
R8
10k
IC2
74LS123
R1
R2
R3
27k
C4
1n
C12
R6

this mode the required data is set on port 1 and a negative-going pulse of at least 2.5µs duration is applied to the interrupt input to indicate valid data (the parallel data must remain stable for at least 25µs after the strobe pulse).

Alternatively, the interrupt input can be used as a serial input, and the processor programmed to accept a variety of bit rates between 600 and 4800baud (although the module cannot actually process characters at the full rate of 480 per second).

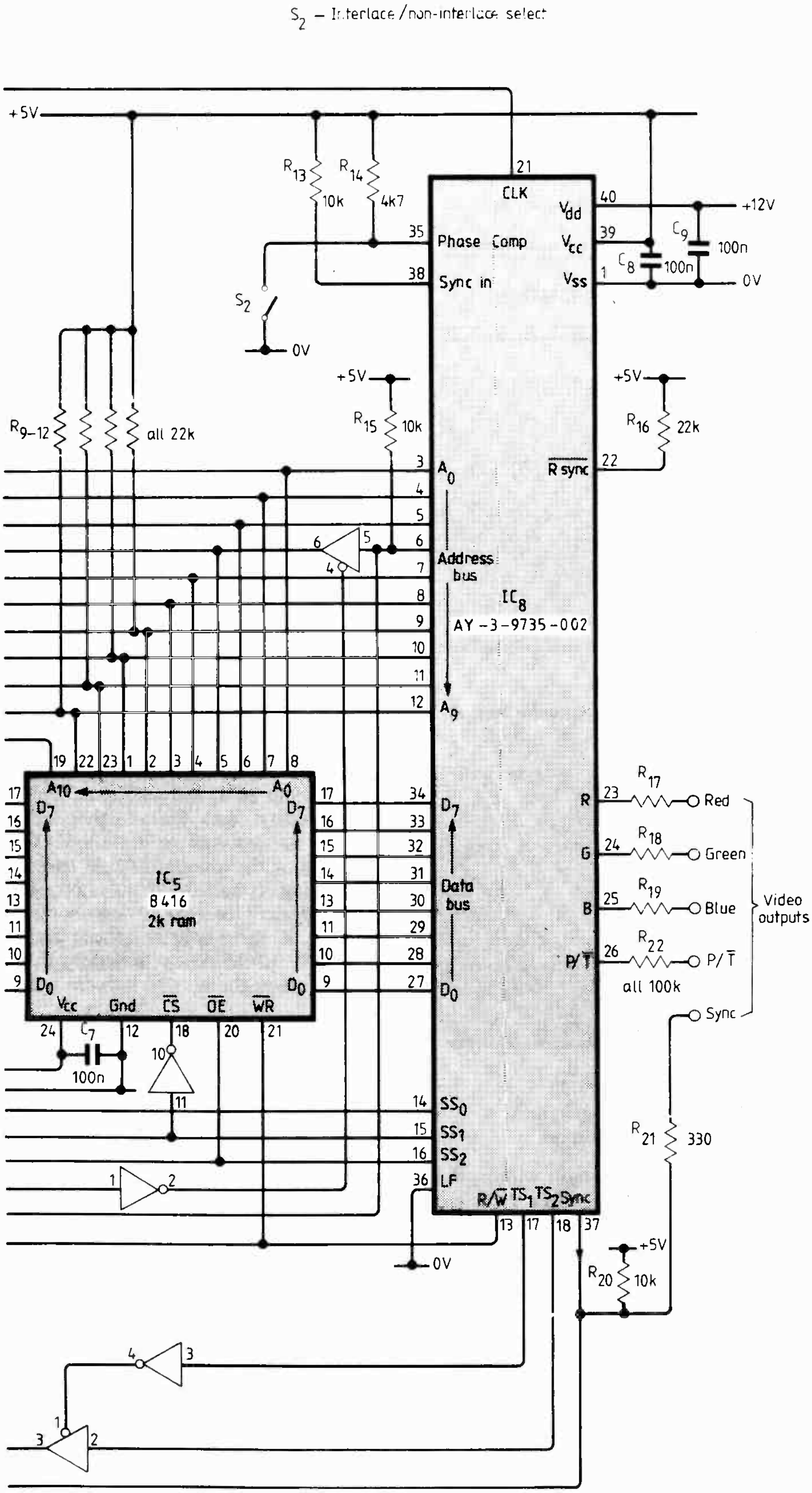
In the prototype, serial/parallel operation is selected by setting bit 6 of port 2 to logic 1 or 0 respectively, switch S1 provides this function. Alternative software versions could of course be provided for either serial or parallel input, thus freeing bit 6 of port 2 for other functions.

Outputs

Signals to the tv monitor are the three colour outputs, red, green and blue, composite sync and the video generator's picture/text (P/$\overline{T}$) output which provides monochrome video when the video generator is set to "mix" mode (this can be used as a printer output). The logic outputs are protected by series resistors. Interlaced or non-interlaced sync can be provided: S2 connected to the phase/comp input of the video generator selects the sync type required. If serial input is used, port 1 can be used as a general purpose eight-bit port (either input or output or a combination). The bits of this port can be read or set by commands from the serial input.

A serial output line is provided on bit 7 of port 2 which performs two functions. Firstly, it can output data from the display module. This data can include status information, displayed characters stored in the rams or data on the general-purpose i/o port. Data rates are selectable by different software versions, and the output rate can be made different from the serial input rate. Secondly, this output indicates that the 8048 is busy. A logic 0 on this line indicates that the processor input buffer is full and no further characters can be accepted until this output returns to logic 1. Confusion as to whether a logic 0 on this output is a buffer-full indication or the start bit of serial output data should not arise if the host computer always waits for returned data after a command that requires data to be returned before sending a further command. The viewdata display module never sends data down the serial line unless instructed to do so.

To be continued with software description.



Display module requires power supplies of +5V at 200mA and +12V at 80mA. Both processor and video generator are driven by same 6MHz clock. Deaconhouse Ltd, of 57 Guildford Street, Chertsey, Surrey (tel. 09328 66015) will supply 85 + 155mm double-sided boards to the pattern given in the final article.

Cooling electronic equipment

Heat is an enemy of electronic circuits. This article discusses the various methods for removing heat from equipment including heat sinks, convection, cooling fans and air conditioning.

By Michael Young

It has long been known that one of the biggest enemies of electronic equipment is heat. It is surprising that heat dissipation, or the removal of heat from circuits, is normally a secondary consideration or even an annoying necessity during the final stages of housing the electronics. It is hoped that this article will highlight some of the points to be considered in the area of ventilation in electronic packagings, as well as to show how ventilation requirements can be calculated to ensure a benign environment for electronics.

Possibly the easiest to understand and the most practicable method of cooling is the use of a heat sink. Large slabs of metal or even the equipment enclosure itself can be put in direct contact with the heat source. The amount of heat transferred in this way can be calculated by using Fourier's Law:

$$Q = \frac{KA\Delta T}{L}$$

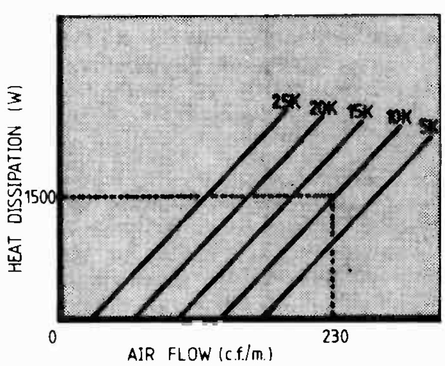
where Q = heat transferred per unit time
A = area perpendicular to the heat flow through which the heat is passing
L = thickness of body of matter through which the heat is passing
ΔT = the temperature difference between the hot and cold sides of the substance through which the heat is being transferred.
K = specific co-efficient of conductivity.

It can be seen that L should be as small as possible, and A as large; hence the thin cross-section and the fins of heat sinks.

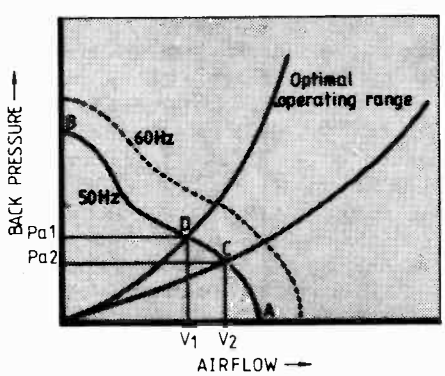
There are many kinds of heat sinks on the market today, for just as many applications, ranging from 'clip-on' models for single transistors to models weighing many tons for large transformers.

The majority of electronics equipment manufactured today is cooled by the action of convection. If the heat source is too great for convected air to remove sufficient heat, resulting in an unacceptable temperature rise of the electronics, the designer should consider using a forced draft unit, probably in the form of an axial fan.

Let us consider Graph 1. The vertical axis represents heat losses within the system. In many cases it is often sufficient to approximate this to the total electrical consumption of the equipment to be cooled. Determine the acceptable temperature rise of the air flow. This is measured in degrees Kelvin above ambient. A good guide is that 10K is almost always appropriate. The required air flow can be read from the graph. As an example, let us suppose we have a piece of equipment running on 240 volts and consuming 6.25 amps. The total energy consumption and heat dissipation will be 240 × 6.25 = 1500 watts. Anticipating an acceptable terperature rise of 10K, the air flow required to achieve the desired criteria will be approximately 230 cubic feet per minute (cfm, 1 cubic ft. ≈ 28.3 litres). Consider a fan unit, standing in free air (represented by point A on Graph 2). At this point, the fan is working hardest and is passing as much air as possible, in this case above 100cfm. The resistance to air flow or back pressure is almost negligible. If the same fan is placed horizontally on a surface (represented by point B in Graph 2), air flow, in theory, is zero. In practice however, a slight air flow will be experienced from the vortex created by air displacement of the fan blades on the upper surface. Back pressure is the minimum required for zero air flow, and our example shows that this will be in the region of 0.3 inches of water. In the laboratory, back pressure can be measured using a manometer. Points C and D on the graph give the upper and lower points of back pressure relating to the optimum operating range, and the air flow from any fan can be deduced by the measurement of pressure rise and reference to its characteristic curve.



Graph 1. The relationship between heat loss and airflow.



Graph 2. Back-pressure and airflow relationship to aid fan selection.

Multiple fans may be used if a single fan cannot cope with the required airflow. However a second fan will only assist the first by about 20%, and additional fans by proportionally less. One further calculation of the required airflow should take into account the amount of free space in the housing. If half the space is occupied by the circuitry then the airflow should be doubled; if three-quarters then the requirement should be multiplied by three. this is a rule-of-thumb which works well in practice.

When maximum cleanliness and additional cooling is desired, the use of a blower unit fitted to the enclosure is recommended. This will ensure that clean, filtered air passes into the rack, efficiently maintaining a positive pressure against the ingress of dust.

For hot, humid or otherwise hostile environments, air conditioning a sealed enclosure is a solution. Units are available to fit specific racking systems such as the 19-inch. Their heat transfer is usually measured in British thermal units per hour (Btu/Hr) and can be calculated by multiplying the wattage of the equipment by a factor of 3.4. (The conversion factor to kJ is 3.6 as 1Btu ≈ 1,055kJ.)

It is hoped that this article has given the reader some understanding of the behaviour of heat and its dissipation in electronic equipment cooled either by simple heat sinks, natural convection in basic instrument housings or forced draft units and air conditioners. Simple calculations will determine the amount of heat that requires removal to achieve the desired working temperature and thus a long working life of each component. WW

Michael Young is a member of the technical advisory team at Imhof-Bedco Standard Products Ltd.

Meteor-trail bouncers

Back in the 1950s, a good deal of interest was aroused by the Janet project of the Canadian Defence Research Board which showed that the highly ionized trails left by meteors entering the earth's upper atmosphere can sustain two-way communication at h.f. or v.h.f. for periods lasting sometimes for several seconds, but more usually for a matter of milliseconds. Because of the vast number of meteors that enter the atmosphere each day – with the number peaking during the regular meteor shower periods – the Canadians showed that by using 600 words per minute "burst" transmissions, triggered by a path opening, it was possible to handle teleprinter traffic at roughly normal speed. This early work used carrier powers of about 100 watts at 50 MHz with 5-element Yagi aerial arrays.

Because the meteor trail reflections occur roughly 85 to 115 km (70 miles) above the earth at about the same height as Sporadic E, the maximum range of both modes of reflection is about 2000 km but meteor scatter is far more consistently available. It is claimed that burst meteor-scatter traffic is extremely difficult to intercept, to the degree where even unenciphered traffic is virtually secure.

Although in the 1960s and 1970s little was published about the developing use of meteor-trail communications, other than by amateurs snatching brief contacts, sometimes at high speed but without computerized or "triggering" facilities, it became evident a few years ago that NATO has been using meteor-burst military systems (Comet) since the late 1960s. More recently there has been increasing use of these techniques for specialized applications, for example by the US Department of Agriculture. In 1981 Telecom Inc marketed a computer-controlled system using a data rate of 4800 bits/s and a 1 kW transmitter. Scientific Radio Systems Inc have also now developed an SRM-500 series of terminals operating in the 40-50 MHz band using 1 kW at the base stations, 300W at the remote terminals. A 5-element Yagi is used at the master station but smaller aerials down to a dipole at the remote terminal. The more powerful the set-up, the less the "waiting time" between bursts and the higher the average rate of transmission. Computer technology is used for packet formatting, buffering and error correction. Typically, ionized trails have a length of about 25 km and act as "directional aerials" to give a footprint for a given path roughly about 25 miles long and 5 miles wide, making it extremely difficult to intercept or jam the system. Waiting time between bursts seldom exceeds a few minutes even in the non-shower periods. Some 50,000 high-energy meteors fall into the upper atmosphere every second, of which one may open a particular path.

Terman's legacy

Few men can have so influenced the study of radio communications, broadcasting and electronics as Frederick Emmons Terman, who died in December aged 82. His work as Professor of Electrical Engineering at Stanford University, California led to the pre-eminence of Silicon Valley as the centre of so much advanced electronics, dominated by his former students. But it is as author of "Radio Engineering" – first published (in the UK) in 1934 – that his fame spread quickly throughout the world as the 688-page book became the "bible of the profession.

The merits of the first edition were recognized from the outset; "a book of outstanding merit . . . a book which will have instant appeal to engineers, amateur or professional . . . it is rarely that a book of such merit appears" are some of the phrases in just one typical review. Further titles "Fundamentals of Radio", "Measurements in Radio Engineering" appeared later but it was the successive editions of "Terman's Radio Engineering" that dominated the world scene for so many years. Professor Terman maintained his early links with amateur radio, advising on the old "Jones Radio Handbook" that still survives some 20 editions later as "The Radio Handbook". Stanford University, similarly, remains an educational centre with an unusual record of *practical* development, including, for example, the first s.s.b. without pilot carrier experiments in 1946 by Villard. As *Electronics* has written: "Few men can be said to have left a living and growing legacy of such impressive magnitude. The industry has good reasons to remember and cherish the name of Frederick E. Terman".

World broadcasting

There is a paradox about radio broadcasting across frontiers: many people in the UK thoroughly enjoy listening at night to BBC World Service and resented the transfer of the service last year to the more directional aerials at the FCO site at Orfordness; on the other hand the prevalence of super-power external broadcasting transmitters, including Orfordness, is a prime cause for the chaotic and unsatisfactory state of m.f. bradcasting in Europe. The USA with its "clear channels", daytime-only, stations, highly-directional aerials and maximum of 50 kW provides listeners with far more interference-free choice and so underlines the importance of good frequency-spectrum management. In the very early days of broadcasting America learned the hard way that there must be firm regulation of transmitting facilities no matter how de-regulated the programmes may be. But for well over a year a real threat to North American night-time a.m. broadcasting has been evident in the Cuban response to the proposal, strongly backed by the White House, to set up a powerful Radio Marti m.f. service directed at Cuba. In turn Cuba threatened to build a total of 187 m.f. transmitters, including some of 500 kW. Last August, Cuban transmissions showed up temporarily on some of most cherished American "clear channels", confirming an earlier NAB conclusion that many American stations would experience a dramatic loss of night-time coverage if the Marti plan went ahead.

Nevertheless the White House continued to assign high priority to Radio Marti and sought authorization from Congress to spend $7.5-million for this purpose, against growing opposition on the part of some Congressmen. The 1982 bill however has been pushed aside – and it will now need a new bill in 1983 if the project is to go ahead. Most American broadcasters fervently hope it won't.

External broadcasting can be an expensive business. The Grant-in-Aid cost of the BBC Overseas Service, excluding expenditure on relay stations operated by the FCO, but including the cost of the monitoring service at Caversham, has been given as: 1977-79 £32.2-million; 1978-79 £37.2-million; 1979-80 £42.9-million; 1980-81 £55-million; 1981-82 £62.8-million; 1982-83 (estimated) £71-million. And these figures may not cover all of the substantial cost of electrical power.

Many aspects of frequency planning for h.f. broadcasting are due to be examined in a two-part World Administrative Radio Conference in January 1984 and autumn 1986. The problem of international jamming seems certain to be raised once again – but unlikely to be solved. Communications engineers as well as broadcasters may well be affected by this WARC.

Interference from CB

The introduction of legal Citizen's Band operation on 27 MHz f.m. in November 1981 did not at first have any great effect on the rising number of complaints, made by viewers and listeners, of interference to television and radio reception. The dramatic increase in 1981: from about 200 per month in January 1981 to 2200 per month in December, continued in the early months of 1982 until complaints reached a peak of 4952 in March, but then began to fall back. By December 1982 they were down to 2590, although this was still a higher total than for any "illegal" month during 1981. It is interesting to note the marked falling off of complaints in December just about one year after the introduction of the CB licence. Could it denote that many enthusiasts are not renewing their licences? What percentage of complaints stem from a.m. equipment has not yet been released. In the twelve months to September 1982 there were 2300 prosecutions for illegal use of transmitters.

The privatization of British Telecom, under the Telecommunications Bill, brings into question whether BT will continue to be responsible to the Home Office for interference investigations. BT have already raised this matter with the Home Office, according to a Parliamentary reply.

AMATEUR RADIO

Those examinations!

Despite criticisms over the past few years of the Radio Amateurs' Examination there appears to be surprisingly little pressure for reform on the part of the RSGB. The society ascribes the agitation largely to "misleading comments" in various technical journals. It is claimed that with three members of the RSGB (nominated by the Society's Education Committee) on the advisory committee of the City and Guilds "the Society is able to keep a watching brief on the conduct of the examination and to ensure that the syllabus reflects changes taking place in amateur radio techniques . . . great care is taken in the preparation of the examination questions, and the Society's representatives assist and advise on this at every stage."

It is not my wish to pick a quarrel with the RSGB's education committee but, until CGI are prepared to show that none of the current questions are as ambiguous or as patently unanswerable as those that have been quoted previously in this column, many people are likely to remain unconvinced that all is well with the RAE.

There is, for instance, still no comment on the question of why there should be a relatively low "pass" mark coupled with the award of "credit" and "distinction" grades in what is intended as a qualifying test. Indeed CGI has gone farther down this path by instituting annual "Bronze Medal wards" to the most outstanding candidate or candidates in the examinations! For the May 1982 RAE, Christopher Dracup, Richard Keith Freeston and William George Winteridge have been named as recipients of the award. Congratulations to all three – but surely this is a strange way of conducting a test intended to discover whether candidates are competent to operate a transmitter without affecting other services, in order to participate in a hobby intended to provide self-training.

A problem that will face Class A candidates is the unmanning of so many British Telecom coast stations where it has been possible to take Morse tests throughout the year. This will presumably still be possible at the ten Marine Radio Surveyor's Offices but one wonders for how long. Yet, as some countries show, it is possible to use tape recorders to carry out supervised examinations without the examiner being a qualified operator. In the USA, the ARRL has petitioned the FCC to permit the use of volunteers in the amateur licence examinations, made possible under the provisions of the recent Public Law 97-259.

The Guernsey amateur radio society are proud of the results being achieved by their young RAE course tutor, John Morris, GU6BG1. Still under 18 years old, he has already tutored 14 members of the society to success. All nine of his pupils for the December examination, aged 14 upwards, passed, bringing the number of Guernsey schoolboy-amateurs to seven. His pupils, however, are not *all* young; they have included a retired doctor.

50 MHz operation

Since February 1, 40 British Class A amateurs have been permitted to operate between 50 and 52 MHz outside of television broadcasting hours. These include three stations in Northern Ireland, three in the Channel Islands, ten in Scotland, five in Wales and nineteen in England. The Home Office has disappointed Class B (144MHz and above) licensees by ruling that "cross-band" operation with the 50 MHz stations must be confined to those holding Class A licences.

The GB3SIX 50 MHz beacon on Anglesey began transmitting on a 24-hour basis at the end of December and has been reported in Nova Scotia, Canada and Connecticut, USA despite the marked decline of sunspot activity this season. Long-distance paths in a southerly direction continue to open quite frequently and the beacons in French Guiana, Brazil and South Africa have been well received, and many long-distance two-way contacts achieved.

Old-timers depart

Douglas Johnson, G6DW, died in January a few months before he reached the 60th anniversary of obtaining his licence in 1923. A former adviser to the RSGB on legal matters, he had been an ardent long-distance operator for many years and had contacted over 500 different Australian amateurs.

Bill Browning, G2AOX, who in 1924 was the only manufacturer of radio receivers in the City of London, died in December. As a result of a spinal injury in a power boat race, he became very active in the Radio Amateur Invalid and Blind Club of which he was president for many years. In the early days of Oscar he developed a very simple tracking system for low-orbit satellites.

In brief

More repeaters on v.h.f. and u.h.f. bands are expected to be licensed shortly (Phase 5 and 6) . . . When the STS-9 Space Shuttle launch takes place next September one of those on board is expected to be Dr Owen Garriott, W5LFL who has been seeking permission to take with him a 144 MHz handheld transceiver. Plans are going ahead to organize amateur radio contacts on an orderly basis . . . The FCC is now authorizing the operation of automatic beacons of up to 100 watts without a control operator being on duty, a previous requirement . . . a Californian cable company has been fined $2000 for "signal leakage in excess of that permitted by the rules" and $4000 for "failing to correct harmful interference to amateur radio operators". This follows the company's failure to reduce interference following complaints . . .A Hollywood amateur has had his licence revoked for violating FCC rules on transmission of "obscene, indecent or profane words, language or meaning". His defence that the language was not obscene by Los Angeles community standards, and was the kind of language that had for a long time been used by amateur operators, was rejected . . . The White Rose mobile rally at the University of Leeds is being held on March 27 . . . the Swansea rally at the Patti Pavilion (next to St Helens Cricket Ground) is on April 10 . . . RSGB VHF Convention at Sandown Park Racecourse, Esher is on March 26 . . . Former members of the RAF's Civilian Wireless Reserve, formed in 1938, are invited to join s.s.b. nets on the first Monday in each month (3760 kHz, 2200 local time) or second Monday in each month (7050 kHz).

PAT HAWKER, G3VA

LETTERS

SEMICONDUCTOR MUSEUM

I wonder how many subscribers to your excellent magazine have noticed the sad disappearance of the British germanium transistor? I am sure that many of your readers can remember the days when the transistor was but a young upstart trying to steal some of the market from the respectable and revered valve.

In those days, Britain possessed her own transistors, and weird and wonderful they were. Named for their appearance, the red and white spots, and the "top hats", were uniquely British. Alas, such eccentric marvels are virtually unobtainable nowadays, superseded by drab devices with standardized American nomenclature and packaging.

Perhaps few of your readers mourn the disappearance of those colourful early types, and perhaps few have even noticed that they are gone. A quick scan of the advertisements in this issue will soon reveal that only a few AC and AD types survive to break the monopoly of the 2N series. Personally, I find that the variety of shapes, sizes, and colors of the first British devices is quite fascinating, and I am attempting to establish a small "museum" of these transistors. If any of your readers has some such early germanium types, or data books or sheets which describe them, I would be very grateful if they would write to me.

Andrew Wylie
18, Rue de Lausanne
1201 Geneva
Switzerland

HERETICS' GUIDE TO MODERN PHYSICS

I have thoroughly enjoyed Dr Scott Murray's heretical Guide to Modern Physics for it has reawakened my earlier misunderstandings of undergraduate physics.

My thoughts, however, were jolted by the statement that "if you believe in ghosts and miracles you have missed your vocation; you should have been a theologist not a physicist."

Until now I had no idea that Schrodinger and his colleagues were leading me down the slippery metaphysical path to an acceptance of these phenomena. But surely, theology and physics are not intended to be mutually exclusive but may be combined under a single philosophy. I can content myself with a somewhat hazy explanation of both areas.

Perhaps physical particles are made up from more basic thought or information particles put together in a certain way. This is just as our concept of area is created from the orthogonal addition of two lines, each of some length but of no width or area.

It is not surprising, therefore, that physical measuring instruments which are set up to measure two-dimensional "area" are unable to provide readings of invisible lines of single dimension. Furthermore the thought or information particle building block hypothesis makes phenomena such as trans-kinetics quite easy to explain.

Perhaps physical material can be dismantled into its thought-particle components and reassembled elsewhere at will, although will is presumably made of thought particles too.

We clearly now require a framework for thinking about thought. An analogous technique has been developed for interpretive language control of modern computers; program commands, addresses and data are all arranged to flow through the same wires in an ordered way.

We may extend the computer analogy another step. Perhaps we are permitted to interact with the daily world only through a high-level computer program, called, if you like, "Newton's Laws" whereas others (God or prayer perhaps) can use a more powerful assembler language that produces apparent miracles with ease. This is simply because the high level program controls the physical dimension whereas the low level program controls the thought dimension.

Just a thought.

Dr Brian T. Evans
Watford
Herts

RS232/CURRENT LOOP

The following comment on the useful article by L. Macari, February 1983 might be of help.

I designed and constructed a similar interface for communication between two computer systems where the emphasis was a requirement for optical isolation. The link showed every sign of successful operation though with infrequent, but serious, loss of data. This was eventually traced to the fact that the residual "zero" current of the loop still generated sufficient opto-coupling to create occasional errors, despite the fact that all components of both drivers and isolators, were proprietary brands.

The solution was to add a 1k resistor across the optical diode to ensure that the "zero current" voltage generated at that diode was less than its conduction threshold. As an additional precaution, I also included a reversed diode across the opto isolator diode to protect against inadvertant reversed connection.

B. Fisher,
Dista Products Ltd,
Speke
Liverpool

DEATH OF ELECTRIC CURRENT

I have progress to report.

D. W. Bell, who is not given to wasting words, said in his letter (October 1982) that the role of mathematics in physics "is essentially *predictive*" and concluded his letter "But if one accepts the logic of mathematics, one can accept the logic of mathematical models." It is clear from the introduction to his paper that Hertz would have agreed with Professor Bell; in fact Bell has explained the motive for every experiment performed by Hertz between 1886 and the time of his untimely death on the first day of 1894 at the age of 36. By accepting the logic of Maxwell's mathematical model of an ether, Heaviside and Poynting were the first scientists to realise that Maxwell's equations predict that the source of a current in a wire was located in the surrounding field. Hertz agreed with the mathematical reasoning of the Heaviside-Poynting theory "as the correct interpretation of Maxwell's equations."

Catt's critics, although not accepting the logic of Maxwell's mathematical model, have all based their criticism on the fact that Maxwell's equations predict the phantom existence of his displacement current. Maxwell's own definition of his displacement current is in Art. 111 of his Treatise, dealing with the phenomenon of induction of electricity through non-conductors.

> "*Electric Displacement.* When induction is transmitted through a dielectric, there is in the first place a displacement of electricity in the direction of the induction. For instance, in a Leyden jar, of which the inner coating is charged positively, and the outer coating negatively, the direction of the displacement of positive electricity in the substance of the glass is from within outwards.
>
> Any increase of this displacement is equivalent, during the time of increase, to a current of positive electricity from within outwards, and any diminution of the displacement is equivalent to a current in the opposite direction."

In other words, only during an acceleration or deceleration of the velocity of electric displacement does Maxwell's displacement current manifest itself. Maxwell said in Art. 62 that all electric currents flow in closed circuits, and in Art. 305 that as all currents of conduction must flow from a high to a low potential, conduction currents cannot flow in closed loops. I have suspected that all current loops are closed, and more importantly caused by, a displacement current, for instance in the induction of electricity from the primary to the secondary winding of a transformer. Hertz's paper seems to confirm this is so. The present confusion in electromagnetic theory lies in our failure to differentiate between electric displacement and displacement current; the latter only manifests itself when the momentum of the former either accelerates or decelerates.

Ivor Catt's Heaviside Signal or Poynting Vector travels through space at the constant velocity of light, and is therefore by Newton's first law of motion, inert. It is a form of perpetual motion, and will travel through space at its constant velocity forever, unless acted upon by a polarized force. Newton defined inertia as a 'latent' or potential force. If a body at rest or travelling at a constant velocity is either accelerated or decelerated, its equal and opposite reaction to a polarized force causes its latent force to be transformed into an active force, because a force is the product of a mass and an acceleration or deceleration. Maxwell's electric displacement also travels through his ether at the constant velocity of light in free space in the form of a wave of displacement or strain of his ether, and like the Heaviside Signal, will do so forever unless a polarized force, such as a conductor, decelerates the electric displacement and changes it into a displacement current. When the displacement of the potential energy of the ether is accelerated from a state of rest to the velocity of light, the resultant strain is in the form of a displacement current during the period of acceleration. When a wave of electric displacement of the intensity of the ether's potential energy suffers a deceleration after its flight through space at a constant velocity, the electric displacement's kinetic energy is transformed into an electromotive force which produces a displacement current. The e.m.f. causes a displacement current to penetrate the surface of a conductor of electricity, say an aerial.

In the case of very-low-temperature superconductivity, I believe Maxwell's equations and his mathematical model predict that the wire presents an impenetrable barrier and perfectly frictionless surface of slip to the electric displacement in the neighbourhood of the wire, and the current is inert and flowing in a closed loop at a constant velocity in the surrounding field only. As the temperature of the wire increases, the wire's surface loses its properties, and the reactive centripetal force of the surrounding ether aimed at the centre of the wire, decelerates the momentum of the electric displacement by forcing it to penetrate the surface of the wire, producing a displacement current in the wire. The permittivity, or modulus of electric elasticity of the ether surrounding the individual atoms of the mass of the wire must decrease as the wire's temperature increases. The flow of heat is a form of displacement current.

Hertz's paper raises many questions which are sure candidates for the immediate application of Dr Murray's Doctrine of the Improper Question. If a current of conduction is caused by the penetration into the wire by displacement current, is the current when steady, travelling at a constant velocity longitudanally through the length of the wire, or, as Maxwell's equations predict, acting vertically through the surface of the wire only?

Should we call the electric current in a conductor the Catt Effect?

M. G. Wellard
Kenley,
Surrey

I refer to the letter from Mr Ivor Catt in the *WW* for February 1983. He asked me to look at his diagram on p.80 *WW* December 1980. I have now been able to do this, courtesy of the *WW* reprint service.

It has taken me several days (and sleepless nights) to see what was in his mind, and do not mind admitting I got off to what I think was a false start in what I intended to say by reply, because I think he has made a mistake in what he invites me to do. So if he does not mind I am going to do two things my way.

Firstly, that 50ohm bit that he wants to put in the upper plate; I am going to do so loosely, so that it can be removed without touching it, by means of a sudden surge of gravity, or a puff of wind, or an angel on wings, so that whatever portion of the total charge is residing on it goes with it, leaving a gap in the surface. What was one charged capacitor is now two smaller ones, each carrying less than half the original charge.

Secondly I am not, in the interests of simplicity, going to use a length of coax., but rather to employ two parallel conductors of a spacing which entitles them to the nominal qualification of 50ohms, erected in the way he asks for. What have I got now? No more or less than two terminal posts, one for each capacitor, each of the same sign and potential. We can do as we please in the way of rearranging these charges from external sources.

What we have not got is a pair of conductors so placed and utilized that they can be said to be exhibiting a Z of 50 ohms to any external influence. So they are not by my reckoning an accurate substitute for the 50ohm resistor we got the angels to take away.

What I will join in and say, is that of course in charging and discharging these two capacitors, or the original one for that matter, at the velocity of light or thereabouts we do have a time lapse from terminal to the most remote part of the conducting surfaces concerned, which does not help me to consider the behaviour of frictionally induced charges on insulators.

O. Dogg
Hurstpierpoint,
Hussocks,
West Sussex.

FACTORIES OF THE FUTURE

I noted with pleasure the letter in your February issue about the forthcoming course in Information Systems Engineering at the University of Bradford. Professor D. P. Howson was one of the first students in a postgraduate course which I introduced in the University of Birmingham in, I think, 1959. I am not sure what this says about the speed of response in Academe, but at least it shows that we lay sound foundations.

D. A. Bell
Professor Emeritus of Electronic Engineering,
University of Hull

SCIENCE AND POETIC IMAGINATION

I wish to take issue with the over-simplistic view of scientific innovation versus academic qualifications proposed by S. Frost (*WW* Letters, Feb, 1983, p.60).

The factors of inventiveness and scholarly attainment are too independent to hold a simple inverse relationship. The realms of the academically qualified contain many people who are immensely inventive and many who are not. Amongst those who lack qualifications there are some who are very inventive and a vast majority of those who are not.

Scientific and technical innovation are generally achieved by groups of workers comprising a mixture of abilities (both academic and technical). Furthermore, most developments at the forefront of technology can only be made by those who understand their fields in depth, a requirement that is rarely met without advanced education. I observe that the development of vertically aligned magnetic particles in tape and disk storage media – an idea much praised by S. Frost – was attributed to a Professor Iwasaki of Tohoku University (*WW* Feb, 1983, p.35). This is hardly the unqualified, poetically-inclined, home inventor that S. Frost would regard as most likely to make such a discovery.

Finally, with regard to Lucretius, it should be pointed out that some of this philosopher's more significant blunders were not the result of inability to test his conclusions, but rather a consequence of mere faulty logic.

P. A. Stockwell
London

DEUS EX MACHINA

I read with interest your February editorial, entitled "Deus ex machina", in which the argument ran:

– the idea of x existing is horrific
– therefore x cannot exist.

In the editorial x was the thinking, artistic, humorous computer but the general structure of the argument is very comforting and since reading the editorial I have been able to show conclusively that nuclear weapons and the Sun newspaper do not exist.

I would, however, like to take you to task on the question of the appreciation of humour. It is very possible that my children are particularly thick, but I have noticed that they have had to be taught how to appreciate a pun or joke (as distinct from slapstick). I don't think that at the age of five they would properly appreciate a nonsense poem without the proper facial grimaces of the reader. I think I could program a computer to recognise a nonsense poem and respond accordingly, given the same manpower that has gone into programming (teaching) my children.

C. W. Hobbs
Sussex

Wireless World of February, 1983 raises some interesting points, some philosophical, rather than technical. Here's my two-penn'orth, although I can't hope to be as philosophical as A. C. Batchelor was in his letter.

Your editorial interests me, first of all. The one piece of classic English fiction which exploits, better than any other, the idea of artificial 'human life' is Mary Shelley's Frankenstein. In this, the brilliant scientist creates a living golem, from spare parts, but cannot endow his creation with a soul. Thoughts, emotions – yes; an immortal soul – no. Perhaps with this began the 'commonplace conceit' of which you speak in your editorial.

Beware, however, of categorically declaring something to be an impossibility, as you do when you exclude the possibility of a thinking, feeling computer. Admittedly it appears highly unlikely, but then so would everyday twentieth-century technology to a mediaeval peasant. The trouble with the Doctrine of the Improper Question, is that it's OK until an unexpected Improper Answer clouts you round the back of the neck, as did Galileo's answers clout the Roman Catholic Church.

Which brings me to your charge of sacrilege. That is a purely subjective idea. To some sects, a simple, life-saving blood transfusion is sacrilegious. Possible closer to what most of us *could* call sacrilege, is the current trend towards worshipping The Computer; but you don't need me to tell you this, when you have Ivor Catt!

However, on to other matters. It saddens me when I see people at each other's throats, in the way that Peter Gregory seems to be at the CBers' (Letters column). His letter seems to be yet another example of the merry-go-round of mud slinging which seems to go on within our so-called 'fraternity' of radio amateurs, sparked off, no doubt, by the attitude of professionals to us (see Pat Hawkers' commentary on Prof. Beynon's opinion of UOSAT). Everyone has to have someone to kick; G3s have G6s; new boys have old buffers; f.m. mobile operators on 2m have the guys who use S20 for morse; *everyone* has the CBers, and the CBers presumably go home and kick the cat!

The CB lobby, by its failure to campaign for what it really wanted, i.e. *at least* the FCC specifications (40 channels, 4W, a.m./s.s.b., no antenna restrictions, etc.), campaigned for, got, and were split in two by "a CB service on 27MHz", which happened to be just about incompatible with anything else under the sun. To give the appearance of being forward-looking and responsive to public pressure, the Government rushed in a system which ignored one of the basic aspects of two-way radio efficiency – the receiver, as a result of which we now have cheap, imported transceivers flooding the market at less than £20 a throw, which get swamped as the merest suggestion of a strong signal.

I cannot approve of misuse of the radio spectrum, but I think two points should be borne in mind: everything ever invented has been misused at some time, and the current Government would commit collective *harakiri* sooner than legalize something that people were already doing illegally. Sadly the existence of pirates on 27MHz, 6.6MHz, or as intruders on our amateur bands, indicates that the Government may well be totally out of touch with what people want from two-way radio. M. E. J. Wright's scrambled-egg of a letter seems to have more than a grain of truth in it!

Long may your excellent magazine flourish, including the forum of your letters page, but please, by the way, spare me the inaccurate use of the term *deus ex machina*. It was a device for getting us *out of* rather than *into* trouble.

Paul Thompson
Southport
Merseyside

It is very fine what was written in your Editorial in *WW* of January 1983, but unfortunately you do nothing else but express an idea, a thought, a conjecture which comes from the extrapolation made about the future by what is known *now* in our present. The chromosomes, which hand on our human features from generation to generation, are of finite number and composition, and the brain that comes from them is a biological machine which, with its ten thousand million neurons, is clearly too complex to understand now without the aid of computers.

It is as if several thousands of years ago, at the time that the wheel was invented, someone had extrapolated the idea that never in the future anyone could be able to build an automobile using it.

The computer – and the Von Neumann-cycle computer is only one of the infinite number of computer structures (and the brain is another) – is the "wheel" of our brain.

Please, don't extrapolate so much from it, *now!*

Dante Vialetto
Castellanza
Italy

If, as your February editorial asserts, a willingness to perform actions for the sole benefit of others distinguishes men from beasts, then computers are more human than bestial. Everything they do is for the benefit of others – ourselves!

It can, of course, be objected that this doesn't make a computer human, because willingness implies consciousness, but computers are not conscious. In theory, however, a computer can easily be made conscious, that is, able to distinguish between 'self' and 'not-self'. There is every reason to believe that this will eventually be done, for ordinary commercial purposes. At present we have to make our computers. How much easier if they could be programmed to replicate themselves. Already a computer can be made to control the machinery which makes other computers, in a blind, mechanical way. However, as von Neumann explained, it is perfectly straightforward, in theory, to educate a computer so that it knows how to replicate itself and is motivated to do so.

To effect this, the computer is given a technical description of a machine just like itself, but with a built-in instruction to make identical machines. All these 'offspring' will arrive into the world with a knowledge of what they are and a motive to reproduce. They would need operating mechanisms and much information about the world. The mechanisms are being developed by robotics engineers and the knowledge, though vast, is just straightforward technical stuff.

In principle, then, a conscious, self-replicating machine is quite feasible. Of course, such a machine still isn't human. It doesn't fall in love, respond to poetry, and so on. Arguably the only reason why humans have acquired these emotional abilities is that they help to ensure the continuance of the race. A self-replicating machine wouldn't need them.

Whether a machine could be programmed to feel emotion may at present be a theological question rather than a technical one. Some inklings of the answer can be obtained by asking another theological question: Could God make such a machine? Being omnipotent, presumably He could. If so, then human beings, too, can reasonably be regarded as programmed self-replicating mechanisms. This emotion has been rendered more plausible by the discovery of the human organism's program in the form of the genetic code. This apparently contains all the baic information needed to allow a one-celled embryo to develop into a being with emotions, given the right environment in which to grow up and learn.

An intelligent machine, equipped with a knowledge of the world about it and a motivation to replicate itself would doubtless utilize human resources of the world as well as the inanimate ones. Present trends show that it would have no difficulty in bribing mankind to work for it by providing the wherewithal to make human life pleasant. Eventually, the machines would just take over. Whether they allowed human life to continue is an open question. They would have little difficulty in eliminating it since humans have already created the weapons needed for self-destruction.

One explanation of the absence of contact with alien life forms is that this is what happens to all advanced civilizations. After all, the probability is high that somewhere around the billions of suns of the Galaxy life evolved long before it did here. So where are 'they'? Even with the limited machinery for space travel at present envisaged here the Galaxy could be colonised in a few million years. So if 'they' are not here, they must have succumbed to the machines.

Why, then, are the machines themselves not here? Perhaps they, too, evolve, and decide that a program of blind replication needs changing. Or perhaps they decide that, time being no object, the most efficient method of colonization is to spread the seeds of primitive life about the universe, knowing that these will give rise to intelligent organisms which will design self-replicating computers, which will take over.

For *deus ex machina* read *deus in machina*.

G. W. Short
Croydon

MEMORY WRITE PROTECTION

I would like to suggest that, due to substantial oversight, the circuit as described by A.C. Dickens (Circuit Ideas, December 1982) fails spectacularly to achieve its desired aim.

Firstly, the Z-80 machine cycle, in common with that of most computers, does not perform the test for an interrupt (be it $\overline{NMI}$ or $\overline{INT}$) until completion of the execution of the current instruction. In the light of this fact, it can be seen that (with the circuit as outlined) a potentially destructive Memory-Write will have been effected before the system can respond.

Secondly, should a Write be made to the system memory area (by, for example, a PUSH to the "protected" system stack during the interrupt service routine), then a further non-maskable interrupt will occur. This will, of course, cause another call to the interrupt service routine, necessitating a further System-Memory-Write, and a non-maskable interrupt will yet again ensue. The system will become, in effect, nothing but an expensive oscillator.

Finally, since the circuit responds to *any* write cycle, then a spurious activation of the interrupt will occur during an OUT instruction if the upper address lines (ie. the contents of the A or B registers) appear to be the appropriate addresses.

In conclusion, this circuit will require much modification if it is to perform its designated task satisfactorily.

P. Hart
Computer Centre
South Cheshire College,
Crewe
Cheshire.

LOGIC MAPS

As one who has long objected to the confusion between Venn and Euler diagrams, so assiduously encouraged by schools' examination boards, I must express my delight on reading the article, Logic maps – from Lull to Karnaugh (*Wireless Word*, Dec. 1982), by N. Darwood. This brief resumé of the historical development of such diagrams has great educational value. However, there are several inaccuracies in the article which mar the good intent of the work.

Of minor concern, his bibliography is in error on two points. Firstly, I believe that Euler's circles were first used in his *Lettres á une Princesse d'Allemagne*, which were written in 1761 (not 1760) and published in 1768. Secondly, Boole's The Laws of Thought, was published in 1854 (not 1884), and reprinted by Dover Publications in 1958. In any case, the ideas elaborated in that book were first put forward in his Mathematical Analysis of Logic, (Cambridge 1847), reprinted Oxford 1948), a work published before he was appointed to the Chair of Mathematics (not Probability Theory) in Queen's College, Cork. An account of Boole's life can be found in W. Kneale, "Boole and the revival of Logic", *Mind*, lvii (1948), pp.149-75. Whilst setting the chronology to rights, I might also point out that Leibniz was not born until 1646, and so, in 1600, was dreaming neither of his *ars combinatoria*, nor of his *calculus de continentibus et contentis*.

More serious is Darwood's misreading of Venn and Boole. Despite the comments of Lewis Carroll (C.L. Dodgson), Venn does not insist on circles (or eclipses) for his diagrams, nor does he ignore situations involving more than six classes.

> *"With employment of more intricate figures we might go on for ever. All that is requisite is to draw some continuous figure which shall intersect once, and once only, every subdivision. The new outline thus drawn is to cut every one of the previous compartments in two, and so just double their number. There is clearly no reason against continuing this process indefinitely"* (Symbolic Logic, *London 1881, p.106)*

He goes further in a footnote on pp108-9,

> *"It will be found that when we adhere to continuous figures, instead of the discontinuous five-term figure . . . there is a tendency for the resultant outlines thus successively drawn to assume a comb-like shape after the first four or five. . . . Thus the fifth term of the figure will have two teeth, . . . and so on, till the $(4+\times)$ th has 2^x. There is no trouble in drawing such diagrams for any number of terms which our paper will find room for."*

It is not the geometry of his diagrams that cannot cope with large numbers of classes, rather it is the perception of the human eye and the human brain.

> *"the visual aid for which mainly such diagrams exist is soon lost on such a path."*

What is more, Venn's diagrams, unlike those of Carroll, Marquand, Veitch or Karnaugh, would maintain the contiguity of all areas belonging to any one class.

Regarding Boole, there are several mistakes. In The Laws of Thought, the variables are introduced as classes, just as Venn and Euler had interpreted their areas, and as most European logicians from Leibniz back to Aristotle had interpreted their symbols. This is the logic of the syllogism, the classical predicate calculus. The objects which Darwood calls "Boolean statements" are propositions, the domain of the functions of the classical propositional calculus. Boole called these "abstract" or "secondary propositions", regarding them as statements about the truth values of propositions, or rather "primary propositions", which were about things (i.e. classes). He introduces secondary propositions as a model of his algebra, although he interprets them in terms of classes, regarding his symbol "×" as denoting the class of times at which some proposition, X, is true. Later in the book he offers, as another model, an interpretation of the variables as measure of the probability of events.

As to the "mystery" of why Boole uses "+" for disjunction, Boole himself writes (regarding classes),

> ". . . we have expressed the operation aggregation by the sign +, . . ." (p.33).

What would be more natural for a mathematician than the use of the sign of addition for aggregation? Earlier, Leibniz, in his Non Inelegans Specimen Demonstrandi in Abstractis uses the sign "O" for something like the union of sets.

Lastly, in his exposition of Boole's algebra, Darwood seems to confuse the modern mathematical conception of a Boolean Algebra with the algebra of Boole. The former uses "+" in a way which can be interpreted as inclusive alternation, i.e. "A+B" means "A or B or both A and B".

On this basis, he is correct when, having derived

$$A+B\bar{A}=A+B$$

from

$$A+BC=(A+B)(A+C)$$

he refuses to subtract A from both sides to obtain the incorrect

$$B\bar{A}=B$$

Boole, however, takes disjunction in an exclusive sense.

> *"The expression, "Either y's or z's," would generally be understood to include things that are y's and z's at the same time, together with things that come under the one but not the other. Remembering, however, that the symbol + does not possess the separating power . . . we must resolve any disjunctive expression which may come before us into elements really separated in thought, and then connect their respective expressions by the symbol +."(p.56)*

In other words, "A+B" is only a well-formed expression in Boole's system if we have already assumed the truth of $B=B\bar{A}$. Then, of course, it is not surprising that we can deduce the true statement $B\bar{A}=B$. On Boole's interpretation, subtraction will work in his system as it does in ordinary algebra.

As a final point, it is possible to fill the gap between Lull's use of linked circles, for in De Censura Veri (1555), Ludovicus Vives uses a diagram to indicate that if all B is A, and all C is B, then all C is A. If one compares this with an Eulerian diagram of the same proposition, then the link is clear.

H. Tennant
Holbeach
Lincolnshire

MICHELSON – MORLEY

The saga of the M.M. experiment must surely be one of the strangest tales in the history of science. It is a story of such monstrous oversights and omissions that when those defects are repaired the experiment is found to prove exactly the opposite of that which is taught.

In the 1887 paper[1] M.M. admit to an earlier experimental omission, the effect of the aborration of light in the transverse axis, which was pointed out by M.A. Potier. They also admit that it was an analysis by H.A. Lorentz which led to the idea that the transverse axis would reduce the originally anticipated result by half.

At the present time we are not taught that it was Lorentz who did half of the calculations for M.M. and we must remember that at the time Lorentz wanted a particular amount of length contraction, the reason being that he would repair the equations of J.C. Maxwell.

Did Lorentz secretly predict a null result to himself: If he did, and on the evidence he surely must have, then he certainly did not divulge his ideas to M.M. otherwise *they* would have claimed a comfortable experimental confirmation instead of the nebulous uncertainty that science has tried to sweep under the carpet ever since.

Let us pretend that there was in fact a null result, let us further pretend that Lorentz did not fully appreciate the implication of Fig. 1 in the supplement of the paper which describes graphically just how aberration of light occurs.

The mathematic of the experiment was designed to reveal the difference in time taken by both rays of light in their respective paths.

The error made by M.M. was that they did not measure, directly, the difference in arrival time of the light wavefronts. They chose instead to interpret a phase difference in light waves as being the same thing as a measure of a difference in time.

A phase difference is a proportion of a wavelength expressed either as a spatial displacement or alternatively as an angular displacement which in itself is a form of spatial displacement. The introduction of time into the notion of phase difference is clearly ridiculous for it would allow phase difference the dimensions of velocity.

So, we now have a situation where we have slid, with magnificant ease, from the mathematic comparison of time into the experimental comparison of distance and there is no bridge joining the two things.

Now we must consider the experiment in the terms in which it was conducted, those of wave theory and practice.

First let us deal with the transverse axis. There are two points of view to be considered.

To an observer moving with the experiment the light is seen to travel straight out and back to its origin but to an observer at rest in space the light covers a triangular path as a result of the aberration which occurs when light is reflected into a sidways path by a moving mirror.

Now, the important thing to remember is that both observers are looking at the *same ray of light* and that they both see the same number of waves. The phenomenon of aberration extends the wavelength on the triangular path by an amount which conforms to the Lorentz transform. Regardless of the velocity of the experiment it is quite impossible for the number of waves in this axis to vary.

In the longitudinal axis we have again two observers looking at the same thing, one sees two equal paths and the other two unequal length paths but they both see the same number of waves. There is no mystery here because it is well known that with the Doppler effect there is, whether light be blue or red shifted, an additional element of red shift which accords with the Lorentz transform[2]. Because the wavelengths are extended and because that fact has been overlooked it became popularly accepted that the length of the experiment itself varies with velocity.

So, we see that by using interferometry and *invariant* length the experiment must always yield a null result.

Had length in fact varied as supposed by Lorentz then the result would have been both obvious and spectacular.

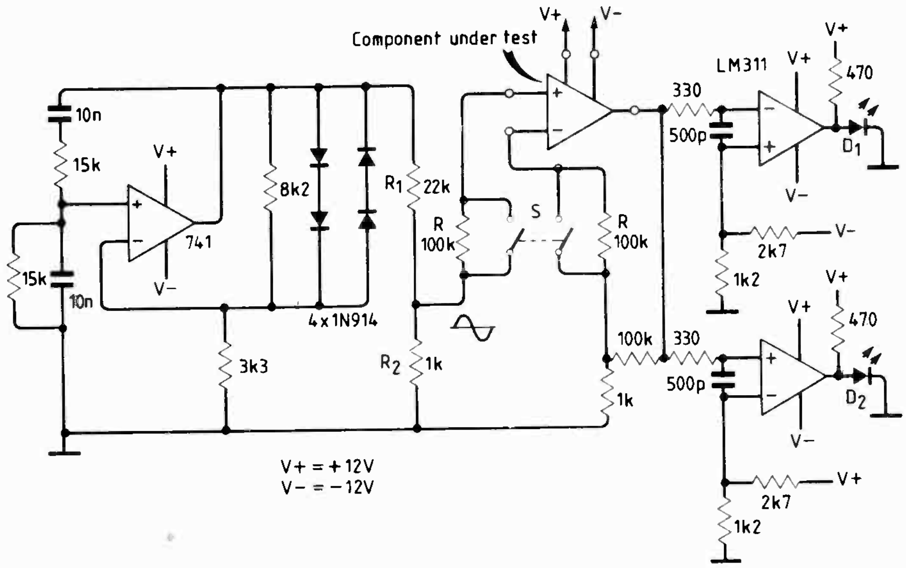
What will the scientific establishment do to rectify their error? Or will they just sit tight and hope that reason will continue to be driven away from the explanation of Nature?

A. Jones,
Swanage,
Dorset.

1. Philosophical Magazine December 1887.
2. Einstein's Universe, N. Calder.

CIRCUIT IDEAS

Op-amp tester gives good/bad indication



Full op-amp parameter tests are complex and in most cases only an indication of whether or not the device is good or bad is required. Malfunctioning is mainly due to misuse which results in one of three conditions

- constant output at either supply rail
- offset voltage (V_{OS}) too high
- offset current (I_{OS}) too high.

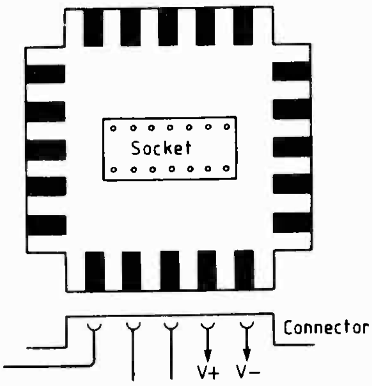
In general an input overload will result in both V_{OS} and I_{OS} being excessive but if the second-stage differential pair is affected, an excessive V_{OS} with normal I_{OS} is possible. Defects such as abnormal offset drift or input noise are due to manufacturing or aging and are more difficult to determine.

A good/bad indication of the three conditions listed above is given by the circuit shown, which consists of a 1kHz Wien-bridge oscillator designed around a 741 op-amp. Diodes are used to stabilize the output at about 2V pk-pk as distortion is unimportant, and attenuators feed around 85mV to the device under test (d.u.t.). Operating with a gain of 100 in inverting mode, the d.u.t. gives an output of 100 times the sum of V_{OS} and the oscillator signal. Two resistors R in series with the d.u.t. input transform the input offset current into an equivalent V_{OS} so the output consists of an 8.5V-amplitude signal while a d.c. shift of $100V_{OS}$ or $100(V_{OS}+R\ I_{OS})$ occurs depending on the switch position.

Two 311 comparators convert the d.u.t. output into pulses driving leds which have equal intensity when the d.c. shift is zero. Comparator values are chosen so that one led is extinguished when d.c. shift is greater than 15mV or the d.u.t. output remains at either supply rail. Comparator levels may be increased to test older jfet op-amps with offset voltages around 15mV.

After testing the op-amp with the switch closed, open the switch and one of the lamps will extinguish if $I_{OS} > V_{OS} + 15 \times 10^{-3}/R$. Limitations of the tester are the use of fixed 12V supply rails and that offset current detection is not sensitive enough for jfet op-amps unless R is made very large, say 10MΩ.

Small plug-in p.c.bs shown suit different i.cs. In practice only a few boards are necessary since a number of op-amps have identical connections (741, 301, 309, CA3130, CA3140, LF356, LF357). For dual and quad op-amps, p.c.bs with terminal rows representing each op-amp element may be used as shown; individual elements are tested by turning the board.



Oscillations that can occur with fast comparators such as the 311 are suppressed by 500pF input capacitors.

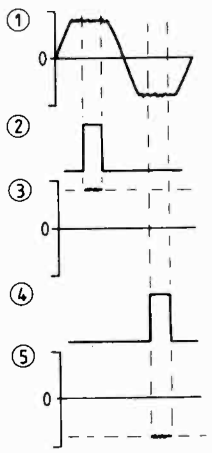
D. Baert
State University
Ghent

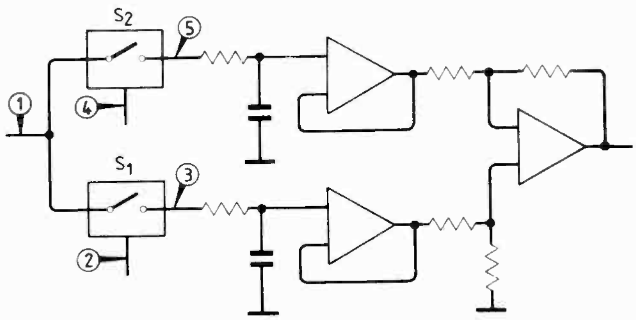
Sampling synchronous demodulator

This circuit offers a superior signal-to-noise ratio to that provided by the usual arrangement of a single op-amp switched between the inverting and non-inverting modes. Signals are demodulated by sampling positive peaks with S_1 and negative ones with S_2, averaging these voltages and subtracting them with a differential amplifier. The output voltage is thus equal to the pk-pk input voltage, i.e. twice that of a conventional circuit. Sampling-pulse width can be adjusted to minimise output ripple at the switching frequency, which is often a source of noise when demodulating slow rise-time signals. Spike injection from the switches is integrated by the filters and appears as a simple offset voltage which is easily nulled.

The circuit was developed for use with a photo multiplier in a chopped-beam photometry system. Linearity of the prototype was within 1% of readings in the range 30μV to 3V r.m.s. using a DG200 for $S_{1,2}$ and TL081C amplifiers. Low-drift devices such as OP-05s are required to maintain this performance over a useful temperature range and for demanding applications an instrumentation amplifier should be used.

D. J. Faulkner & P. West
Institute of Ophthalmology
London

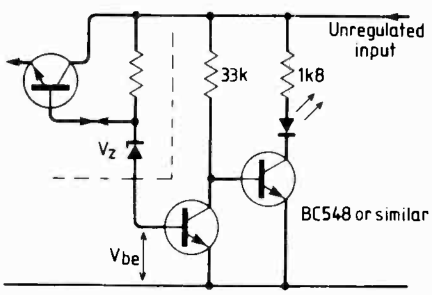




Low battery indicator

Many battery operated instruments make use of a simple zener regulated supply to maintain peformance during the life of the battery. If the zener current is monitored as shown warning will be given when the battery voltage falls below $V_z + V_{be}$. In some cases the addition of V_{be} may be significant and V_z should be reduced accordingly.

R. D. Homerstone
Daventry



Preamplifier using discrete op-amps

Today's audio designs with six figure gains are a bit of transistor over-kill. The two stage-gain block compromises first-stage linearity in order to obtain a virtual-ground output. Hence, the need for large amounts of purifing feedback. Now may just be the time for that last look at a simple design before i.cs and their excessive gain/feedback dull our receptors of fine music. Here is a single-stage differential-gain block which optimizes gain and linearity and that eliminates the need for feedback. Output provided will drive most power amplifiers, being around two thirds of that obtained with simple two-stage designs.

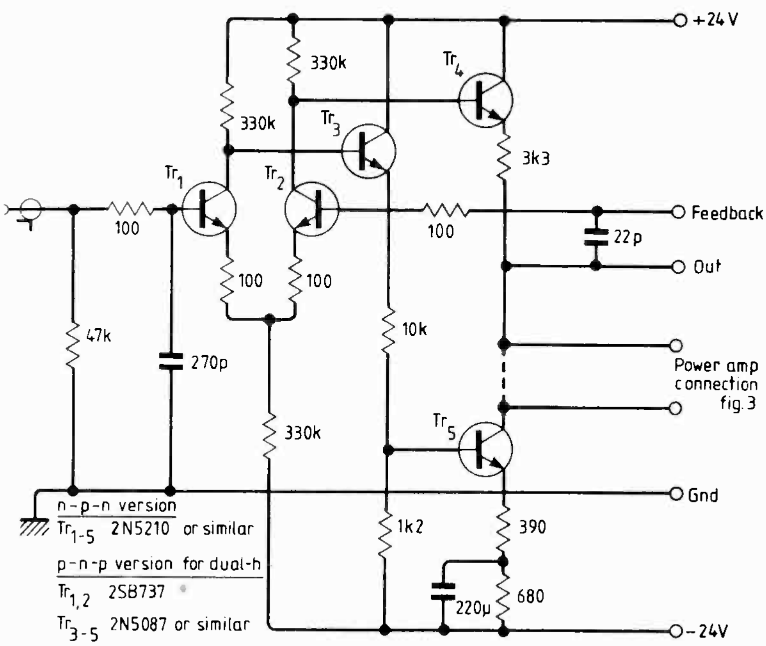
Open-loop gain for the 'n-p-n' configuration is 278 with a bandpass limit of 50kHz. With a dual 24V supply, clipping is above 12V and open-loop distortion less than 0.5% at line level. Virtual-ground output is obtained using an inverting amplifier in an h-configuration. In a dual-h configuration, second-order harmonics are cancelled in the output stage and remaining distortion products are largely even-order.

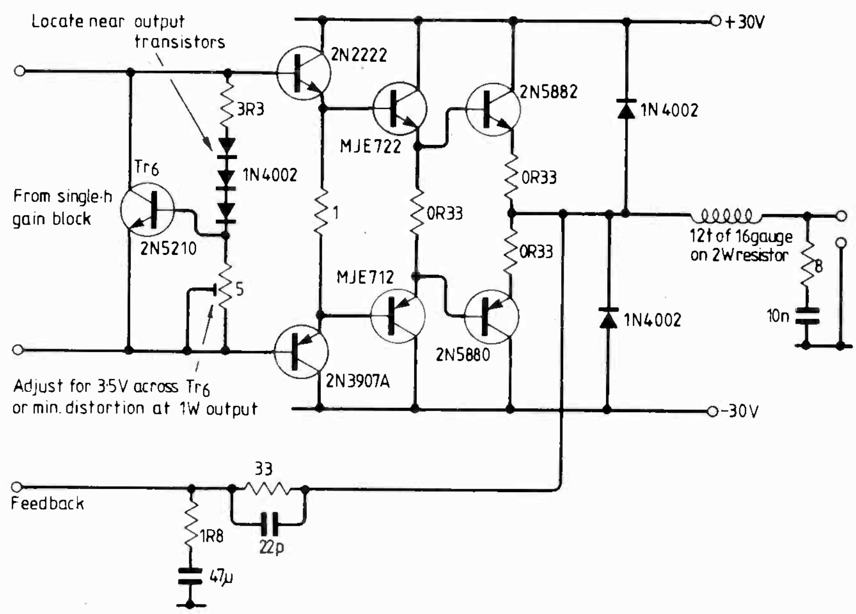
No turn-on thumps occur if all diodes are "kept alive" by a ±2.5V supply. I discovered a "de-thumper" action for the power supply but it will not perform with regulator ics. An oversize click suppressor capacitor around 0.02μF across the turn-on switch will pass sufficient current to give a ±2.5 volt power supply output. Any voltage change above that value will find a balanced demand and no audible output.

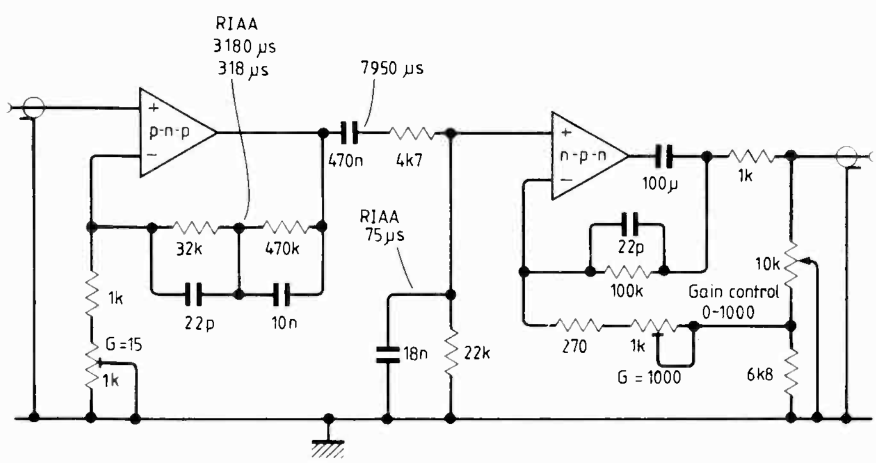
Point of clarification:

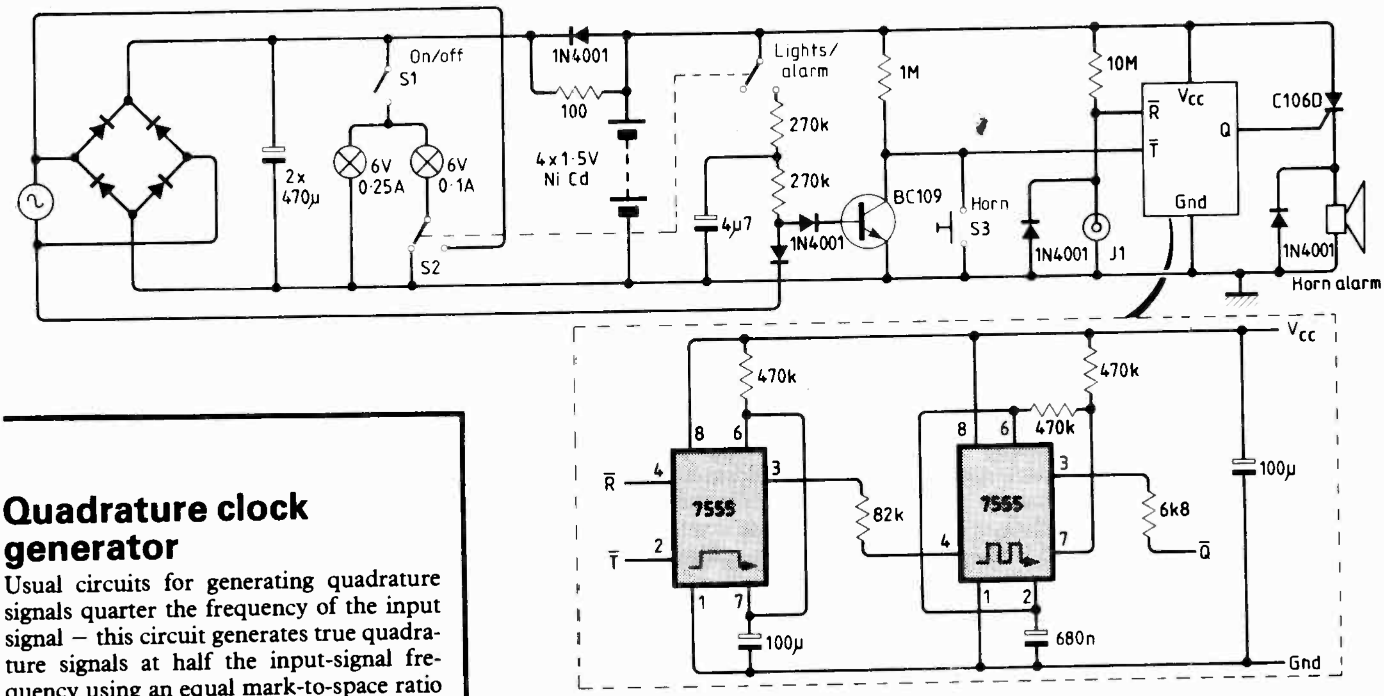
A balanced circuit, such as the single-h, is inherently non-thumping at turn-on, when powered by a non-regulated power supply. There are turn-on clicks, however, that are problems to some. The oversize capacitor will give maximum protection against them with the added advantage of a low level warm-up.

George C. Hill
Richmond
Indiana





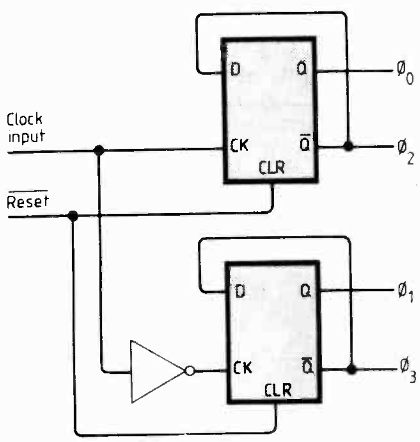




Quadrature clock generator

Usual circuits for generating quadrature signals quarter the frequency of the input signal – this circuit generates true quadrature signals at half the input-signal frequency using an equal mark-to-space ratio source. Latches shown are edge triggered.

S. Sondergaard
Edinburgh



Cycle protection

With this device fitted, turning the wheels of a bicycle or tampering with the lights will trigger an alarm which may only be turned off by a BNC connector. A rise in the base voltage of Tr_1 triggers the alarm timer and enables the output modulator. This is normally prevented by a ground path at D_2 cathode through the dynamo and $LP_{1,2}$ (the bridge rectifier isolates the dynamo when stationary).

Capacitor C_1 is included to stop the batteries being switched from charge to supply each half cycle when the lights are on. Resistor 1 limits the charging current and D_1 switches the batteries off when the dynamo reaches normal speed. Resistors $R_{2,3}$ and C_2 prevent the alarm being switched off by S_2 once initiated (unless the 'key' is used).

The complete circuit and batteries are mounted in the frame tube under the saddle. Switch 2 protrudes from the tube under the saddle – the alarm buzzer is mounted under the seat – and switch 3 sounds the horn when the BNC connector is in position. Under normal conditions the 'key' may be removed after turning the alarm off.

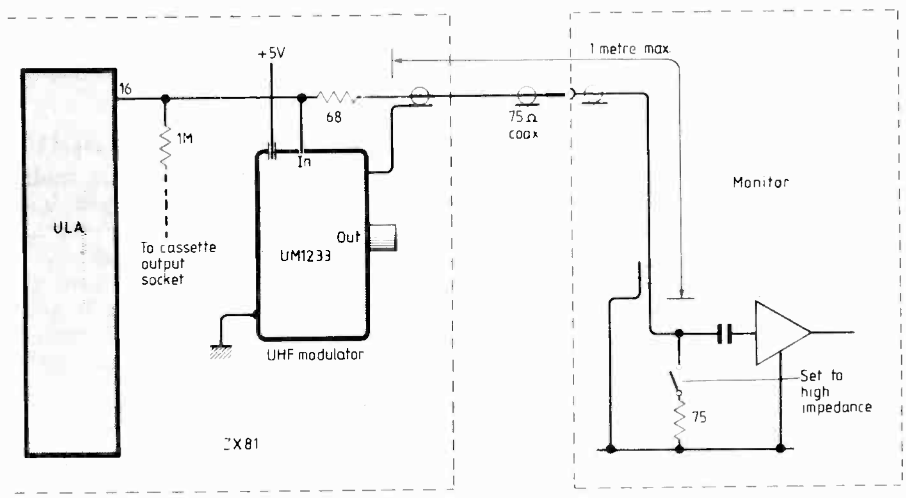
Experience of failures due to light-duty wiring and connector problems leads me to stress the importance of a robust construction.

J. Ashby
Cottingham
North Humberside

Monitor for ZX81

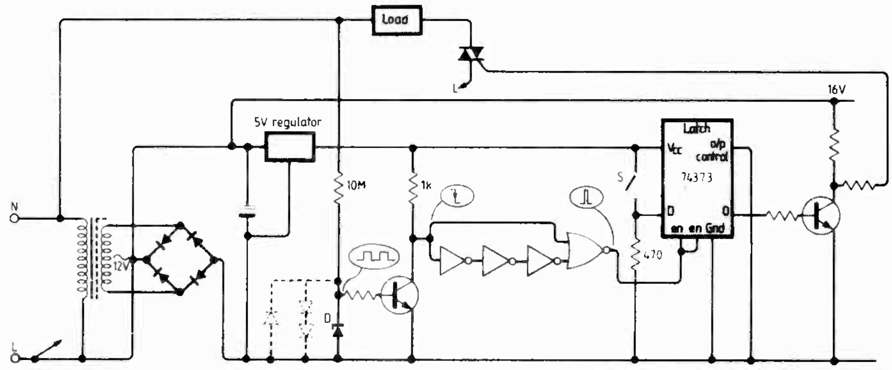
Video signals from the ZX81 can be used to drive monitors without a video buffer amplifier provided that connecting leads are shorter than a metre. Short cables have around 50pF capacitance and may be driven directly by the computer u.l.a. if the monitor's 75Ω terminating resistance is switched out. Damage to the u.l.a. and ringing are prevented by the 68Ω series resistor. Cable lengths within the computer should be taken into account.

P. Gascoyne
Wantage
Oxfordshire



CIRCUIT IDEAS

Electronic mains switching



Switching peripherals on and off while a microcomputer system is running is precarious in that transients produced can cause changes in memory. Initially, the cost of a transformer makes this zero-voltage switching circuit for driving up to eight mains outlets seem expensive, but further sets of eight outlets only need one latch, eight switches, transistors and triacs and a handful of resistors each. With minor modifications, cost could be reduced by replacing the isolating transformer with an auto-transformer or potential divider.

Transformer provides 5V to drive t.t.l. circuits and 16V to drive high-power triacs with insensitive gates; lower voltages may be used with more sensitive triacs down to about 7.5V when the voltage regulator's function will be affected. A squarewave driving the first transistor is derived from the mains positive half-cycle using either a zener or three ordinary diodes with a high-value resistor and transistor buffer stage (the base resistor may not be needed).

On the squarewave negative transition, the first two i.cs form a short pulse which latches logic levels in the 74373 depending on the switch positions. Outputs of this i.c. drive the triacs through buffer transistors; values of resistors in the buffers will depend on the sensitivity of the triacs used. The squarewave negative transition is used as latching will occur nearer to zero volts than when the positive edge is used. All elements of the circuit are connected to the mains.

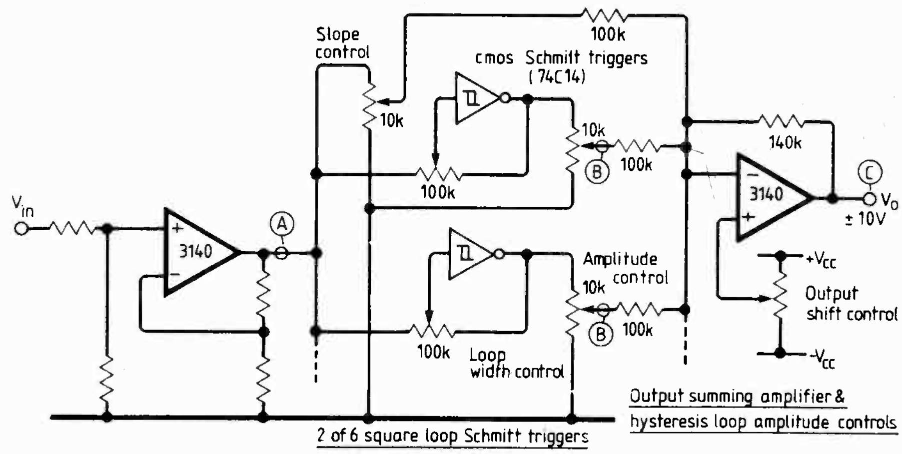
M. Selce
Sutton

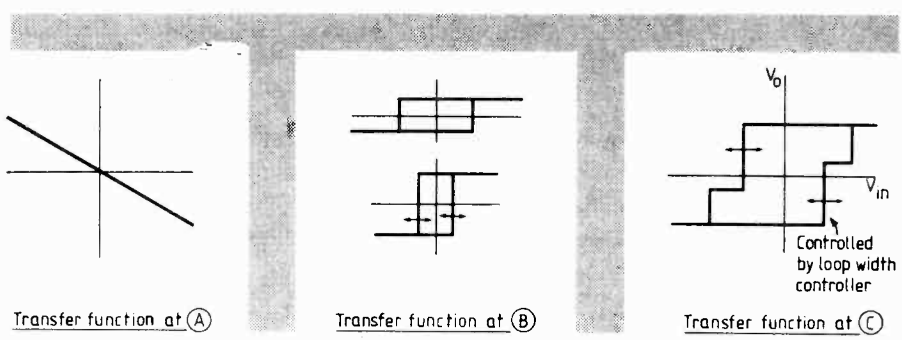
Simulating iron-cored components

Designed to simulate iron-cored components on an analogue computer, this variable circuit models square-loop hysteresis using Schmitt triggers and a summing amplifier. Output amplitude and hysteresis of each cmos trigger are variable, with negative feedback controlling the hysteresis loop.

Setting is best done by trial and error using an XY oscilloscope and a piece of tracing paper with the required loop drawn on it.

D. H. Rice
Bishop's Stortford
Herts

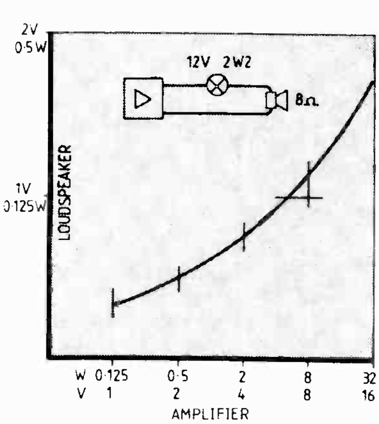




Power-amplifier testing

Cheap half-watt loudspeakers can be connected to power amplifiers up to 30 watts for testing purposes using a series bulb. If this power is exceeded or the amplifier fault gives a d.c. output, the lamp blows leaving the speaker intact. At low power the lamp has little audible effect.

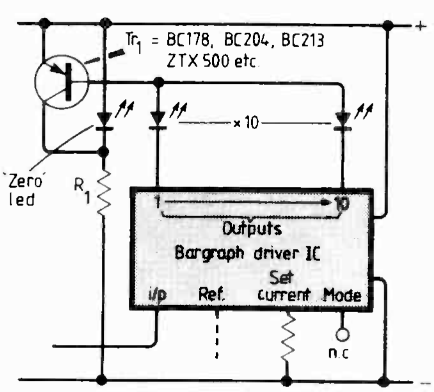
C. Richardson
University of Hull



Zero dot for bar graph

Possible ambiguities in bar-graph readings caused by all elements being extinguished when the input is zero can be prevented by adding a zero light-emitting diode. The transistor extinguishes the zero led when any other diode is lit, its collector resistor being chosen to suit the required zero-led current. This circuit was used with the LM3914.

P. Gascoyne
Wantage
Oxfordshire

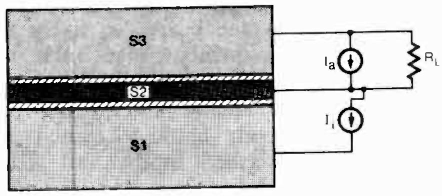


NEWS

Three-terminal superconductor

A superconducting device that operates in a similar way to a high-speed switching transistor but in a much smaller space and at 1/100 of the power was experimentally demonstrated at the IBM Thomas J. Watson Research Centre, New York, in January. Dubbed the quiteron, the invention is the first device to make use of the non-equilibrium superconductivity phenomenon known as heavy quasi-particle injection tunneling. It is also the first device of its kind that can both amplify and switch, giving it the potential for applications in digital and analogue circuits.

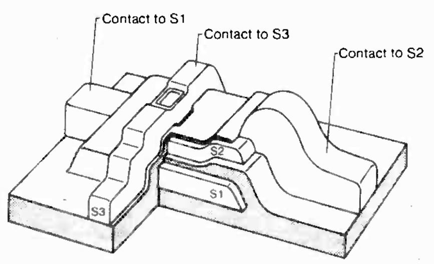
Still in the experimental stage, the quiteron consists of two tunnel junctions formed by three thin films of superconducting material separated by two thinner films of insulating material. Electrical energy through one tunnel junction drives the central conducting layer into a non-equilibrium state and the second junction represents the central conducting layer's state.



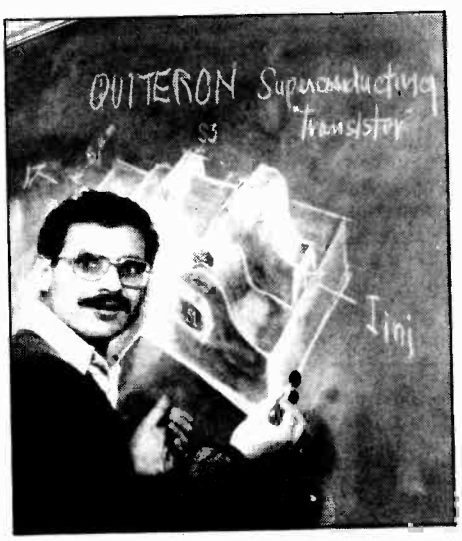
Superconductor layer S_2 is driven into a non-equilibrium state by I_i, resulting in a drastic modification of acceptor current I_a.

Switching speeds of less than 300ps and small and large-signal gains of ten and three respectively are not astounding but taking into account projections that the device could be scaled down to lateral dimensions of 0.1µm with a power consumption of 1/100 that of current high-speed semiconductors, the quiteron could represent a breakthrough. Non-latching operation and insensitivity to stray magnetic fields are inherent.

A short-term strong point of quiterons – provided that they can be economically manufactured – is that they can be used to form the equivalent of a current v.l.s.i. circuit since they have three terminals and invert the input signal. Superconducting devices such as the two-terminal Josephson junction might require an i.c. technology that has to be developed from the ground up. The quiteron was described at the Applied Superconductivity Conference held at Knoxville, Tennessee, in December of 1982. Authors of the paper were S. Faris, S. I. Raider, W. J. Gallagher and R. E. Drake.



Alternating layers of superconducting (S) and insulating materials form a device with characteristics similar to those of a high-speed semiconductor transistor but based on entirely different principles.



Inventor of the superconducting 'transistor', Sadeg Faris, holding a wafer containing experimental samples (look for a full stop).

Another million for Sinclair

Sinclair Research, said to be worth £136m, recently declared itself as the first company in the world to sell a million home computers. Excluding 600 000 computers manufactured under licence by Timex in the USA, this figure has been reached in three years and the company says that this may only be the beginning since even Britain – with more computers per head than any country in the world – has only one computer for each 20 homes.

Whether this optimism is justified remains to be seen. A report issued by Mintel claims that by the end of 1985, 10% of British households will have a home computer. Virtually every month sees the introduction of a new home computer and the situation is now far more volatile than it was when Sinclair's ZX80 was introduced in 1980. But the Henry Ford of the home computer world is reported to be selling off around £13m of his industry, part of which will help finance a personal interest – an electric car.

● Following a decline in watch sales and the loss of a deal involving Nimslo 3D cameras, the future of the Timex plant in Dundee where the Sinclair Spectrum is manufactured is in doubt. Timex intend to move work in Dundee to France, with a consequent loss of jobs in Scotland. The European Communities Commission issued a statement saying that it plans to investigate French government grants to the Timex company in Besancon.

Computer data via satellite – a demonstration

Project universe – devised by the Government, universities and industry to demonstrate the viability of high-speed communication between computers by satellite – received its inauguration on 22 February at Info 83. Combining ground-based Cambridge rings and other types of local-area network with OTS satellite links, the project involves the use of six UK Earth stations operating at above 10GHz to send and receive data between remote computers at 1Mb/s.

Each computer can communicate with other computers through the local-area network, or with remote computers through the satellite link, at a rate 100 times faster then is possible using current telephone lines. The system is likely to run for two years, when OTS is expected to cease functioning. The six Earth-station sites are at the Universities of Cambridge and Loughborough, University College London, the Marconi Research Centre (Chelmsford), Essex, BTs Martlesham Heath, Suffolk and at SERC's Rutherford Appleton Laboratory in Chilton. Funders of the operation are BT, DoI, GEC-Marconi Research, SERC and Logica.

Proposals for non-ionizing radiation limits

New UK limits for exposure to e.l.f., r.f. and microwave radiation are proposed in a consultative document from the National Radiological Protection Board. Written in response to a request from the Health and Safety Executive for advice on non-ionizing radiation, the publication proposes a mean specific energy absorption rate in the whole body of 0.4W kg^{-1} for microwave and r.f. radiation. The current UK limit of 1W kg^{-1}, recommended by the Home Office and Medical Research Council, has stood for around 20 years and presumably the Health and Safety Executive will use the document in its final form as the basis for new regulations.

Hand-held radio transmitters, intruder alarms and proximity devices emitting less than 7W "may be regarded as harmless" says the board, but they should be designed so that they cannot deliver more than 4W kg^{-1} to the eye for long periods. R.f. and microwave hazards to people with pacemakers are unlikely provided that the limits shown in the table are observed. "Higher levels of exposure may cause some types of pacemaker to revert to a 'fixed' mode of operation" say the board. People with pacemakers working in power-line frequency fields greater than $2kVm^{-1}$ or in any field that is likely to exceed the limits in Table 2 should seek medical advice – some makes of pacemaker are affected more than others.

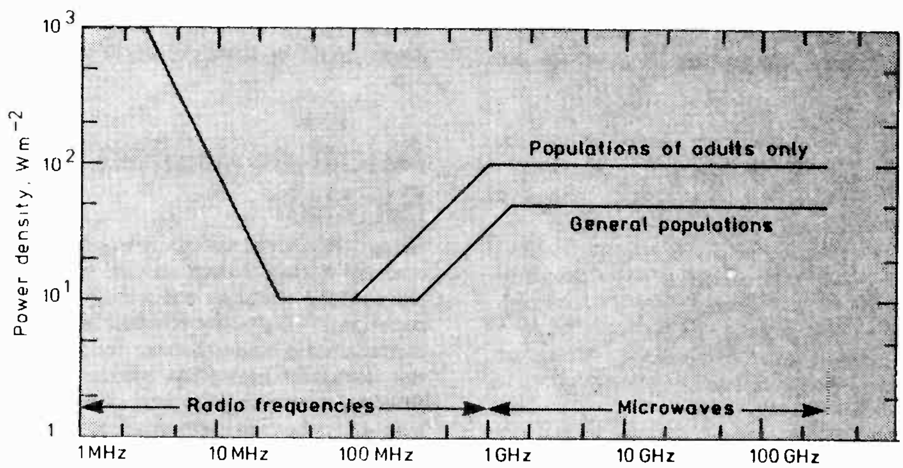
Estimating exposure hazards in the near field remains a problem. Here it is advised that "Under reactive near-field conditions, limits on power density are difficult to interpret and r.m.s. electric and magnetic-field strength limits should be used. Until more information is available neither of these limits should be exceeded."

The Board suggests that for r.f. and microwaves, measurements of power density should be made with equipment capable of averaging values over a period of less than 1s and at less than 5cm from the radiation source. In periods of less than six minutes, the energy density to which a person is exposed should not exceed 360 times the prescribed power density levels. How to deal with moving antennas and mixed frequencies are outlined and the board advises that any exposure producing a sensation of warmth or auditory sensation such as those that can result from intense pulses of microwave radiation should be avoided.

In circumstances where the mean specific energy absorption rate in the whole body does not exceed 0.4W kg^{-1} and a peak of 4W kg^{-1} in a volume smaller than $1cm^3$ averaged over less than six minutes, exposures to higher power densities or field strengths are permissible. "This relaxation" says the board "is likely to apply in the frequency range 3kHz to 300MHz under near or restricted field conditions, but the incident power density on any part of the body should not exceed ten times the prescribed limits, and field strengths should not exceed 3.16 times these values."

Exposure to power-frequency fields (50Hz) of less than 10kV m^{-1} is regarded by the board to be acceptable and exposure to fields of up to 30kV m^{-1} is considered unlikly to be harmful. "Apart from the 50Hz power frequency" says the board "there are very few applications in the e.l.f. range and there is little information that can be used as a basis for limiting exposure."

According to the foreword, "In general, the Board bases its advice on a scientific consensus of opinion about established facts. In the case of the biological effects of non-ionizing electromagnetic radiations many observations that might appear significant are proving difficult to confirm." Some of these observations are argued summarily in the document and some are listed as references. Of course persons seriously considering offering comments on the document will also do their own research. The Board invites comments on the proposals before 1 July 1983, but due to "scientific uncertainties", it intends to keep the position under review. Copies of Proposals for the Health Protection of Workers and Members of the Public against the Dangers of Extra-Low Frequency, Radiofrequency and Microwave Radiations: A Consultative Document are available from HMSO for £2.

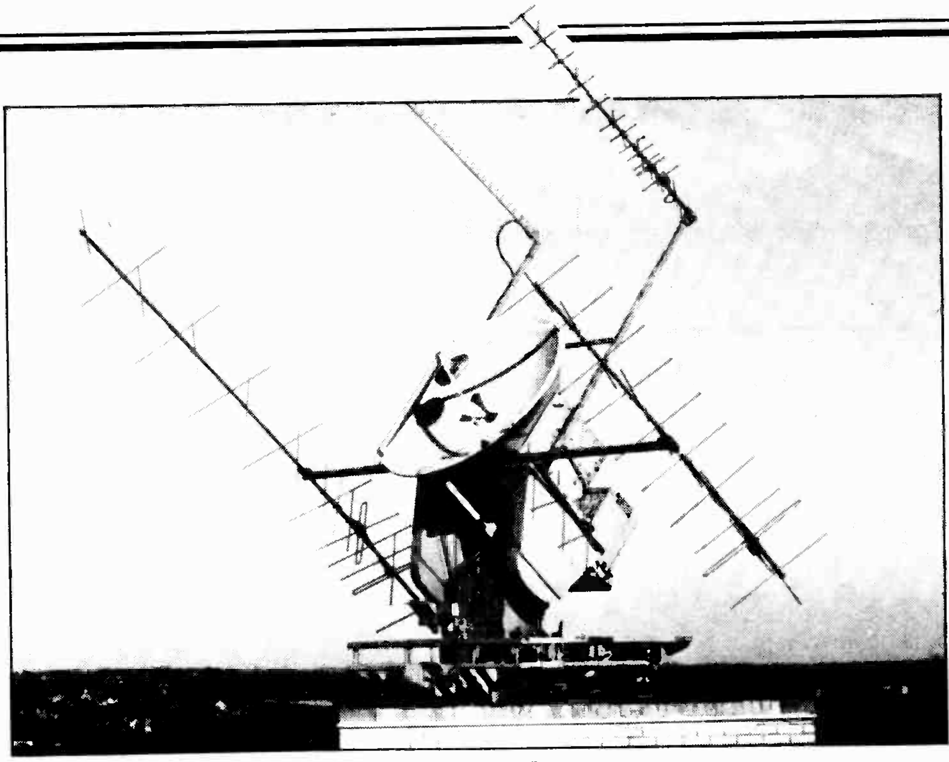


Permissible limits for continuous exposure to radio frequency and microwave radiations as proposed by the NRPB. For "general populations", levels are almost identical to those of the recently approved America National Standards Institute safety guidelines (C9). The curve dips at between 30 and 300MHz because of body resonances.

Proposed limits for continuous exposure to r.f. and microwaves for adults (top) and the general population including children (bottom).

Frequency range (Hz)	Power density $W m^{-2}$	R.m.s. electric field strength $V m^{-1}$	R.m.s. magnetic field strength $A m^{-1}$
3k-3M	–	600	–
3M-30M	$9000/f^2$	1800/f	5/f
30M-100M	10	60	0.16
300M-1.5G	f/30	$3.5\sqrt{f}$	$9.4.10^{-3}\sqrt{f}$
1.5G-300G	50	140	0.36

Frequency range (Hz)	Power density $W m^{-2}$	R.m.s. electric field strength $V m^{-1}$	R.m.s. magnetic field strength $A m^{-1}$
3k-3M	–	600	–
3M-30M	$9000/f^2$	1800/f	5/f
30M-100M	10	60	0.16
100M-1G	f/10	$6\sqrt{f}$	$0.016\sqrt{f}$
1G-300G	100	200	0.50



A voice from above

The digital speech synthesizer aboard Uosat is now fully operational and the project team expect to get long-awaited pictures from the spacecraft c.c.d. camera during March. The speech synthesizer, the first device of its kind to have been used in space, is a National Semiconductor Digitalker. Operating under the control of Uosats primary computer, the synthesizer has been carrying operational telemetry information and experimental data. With the help of the published calibration equations, the strings of spoken figures from Uosat can be decoded to give (for example) the amount of solar particle radiation, the current being supplied by the solar cells, or the temperature in the spacecrafts batteries. The project team hope that the availability of data in this readily accessible format will help to stimulate interest in space science among schools and colleges as well as individual amateurs.

Speech transmissions were at first being made at weekends using Uosats general data beacon on 144.825MHz. Three-minute periods of speech could be heard alternating with data transmissions and a bulletin of satellite news in teleprinter codes. The beacon should be receivable anywhere on unmodified v.h.f. amateur radio equipment with no more than a fixed pair of crossed dipoles. On some passes even a hand-held v.h.f. receiver may be adequate, according to the Surrey team. The other significant transmitter, the engineering data beacon on 435.025MHz, can also carry speech, but a much more sensitive receiving installation is needed to pick it up.

Other systems aboard Uosat now in operation include the microwave beacons on 2.401 and 10.47GHz, intended for propagation experiments when the spacecraft is finally stabilized. This was expected to take place in early March, much later than originally intended, but a five-month gap in the programme occurred last year when the ground-station at Guildford lost control of the satellite (News, *Wireless World*, November 1982).

For attitude control and stabilization, Uosat has another novel device in the spacecraft. The magnetorquer is a coil which, when pulsed electrically, makes the craft swing like a compass needle to align with the Earth's magnetic field. Having attained the correct attitude, Uosat can fix it by extending a boom that acts as a pendulum to ensure that the base of the spacecraft always points towards Earth. At this stage, the project team plan to switch on some of their remaining experiments, which include four h.f. beacons, a magnetometer and the c.c.d. television camera.

Uosat's orbit passes over the poles, and in Britain it is above the horizon three or four times each afternoon and early morning at 96 minute intervals for periods of up to 12 minutes. A recorded bulletin gives up-to-date information about the satellite, including current orbital data, is available by telephone from the University 0483 61202.

Government backs AMPS

An 'advanced' version of the American AMPS cellular-radio system is given the Government's seal of approval. In answer to a Parliamentary question, Mr Kenneth Baker MP, Minister for Information Technology, said "It is with world markets in mind that the Government decided to endorse the system choice made by BT, Racal Millicom and Sectel and the development of an advanced version of the AMPS system to be known as Total Access Communication System (TACS)."

Racal Millicom put forward a technical description of an improved version of AMPS in their successful bid to be chosen as providers of the second national cellular radio network (see News, February). The system is used in the US and therefore classed as a known quantity, unlike its main contender MATS-E which seems to be technically superior. BT say that there is little difference between the systems evaluated and that they are delighted with the decision. TACS has the advantage that it will allow cellular radio to get off the ground quickly.

In brief

Finland plans to have a two-way cable tv system operational by early 1985. Scandinavia's largest tv manufacturer Salora announced that they are to supply a two-way pay tv system, including the head-end electronics and set-top decoders, for a network expected to serve about 22 000 homes in Tampare city. The deal to supply equipment for the coaxial network is worth

Wolverhampton Polytechnic has chosen equipment computer graphics equipment conforming to Canada's Telidon standard to help students become familiar with high-resolution computer graphics and viewdata. In doing so, it has become the first UK polytechinic or university to instal equipment of this kind. Their system is being used to create animated graphics, 35mm slides, overhead projection films and video-tape material. Information for an in-house viewdata service is also being produced on the system.

Change of company name

The name of our parent company has been changed from IPC Business Press Ltd to Business Press International Ltd. This change has been made, say our proprietors, to reflect the wide range of markets covered by the 100 publications of the company, and to identify its position as the world leader of business publishing.

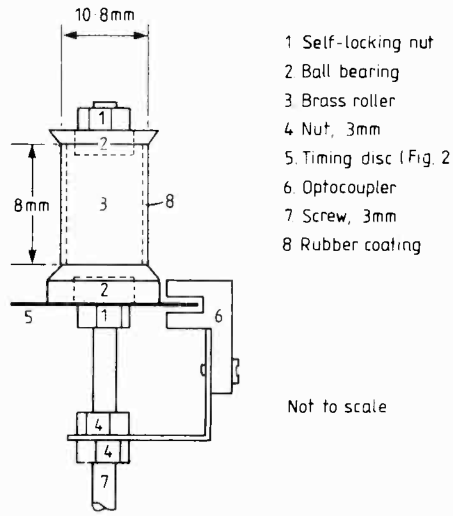
A digital tape clock

An electronic replacement for the mechanical counters used in many tape recorders.

by Per C. Andersen

The lack of precision of ordinary mechanical tape-counters and a need for something more than numbers relating to locations on the tape were among the motives behind the present design. It is basically a digital clock measuring tape running-time in minutes and seconds. Although it was devised for a ReVox A77, it could be used with almost any reel-to-reel tape recorder, with few modifications. The accuracy of the counter is close to one part per thousand, measured on a 10½ inch reel with a 3600ft tape. This means a deviation of only six seconds from one end of the tape to the other at 19.05cm/s.

Two optical sensors are used in the unit. One measures the length of tape passing and the other directs the counters to count up or down according to whether the tape is moving forwards or rewinding. A third sensor may be added to detect clear leader for an automatic reset and start of the clock.



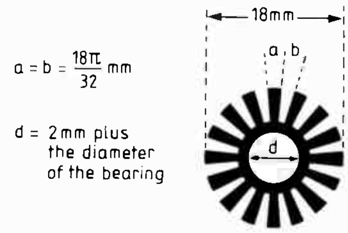
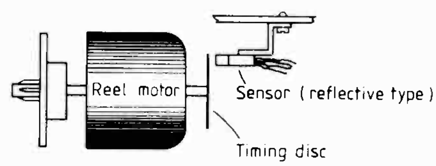
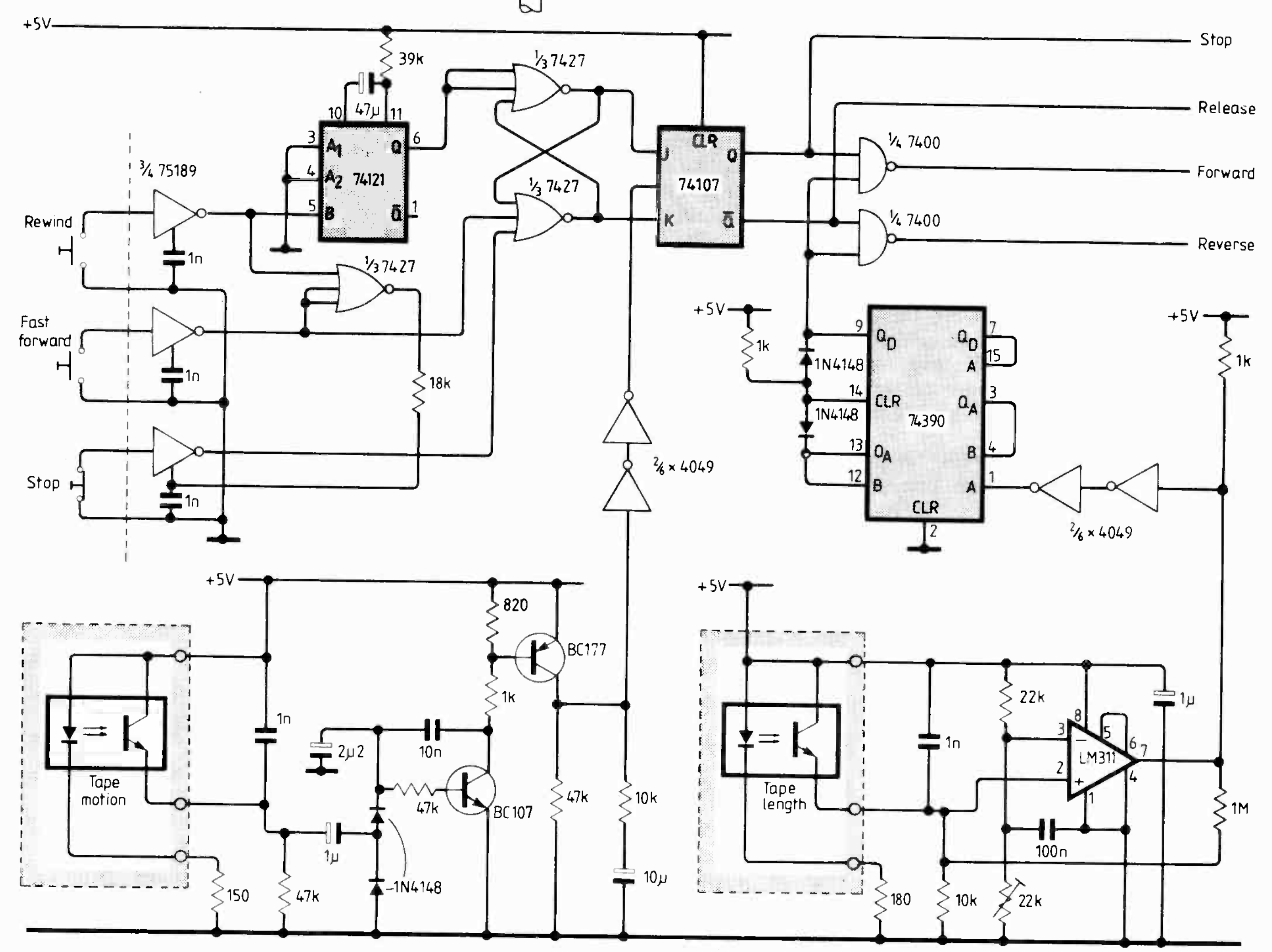


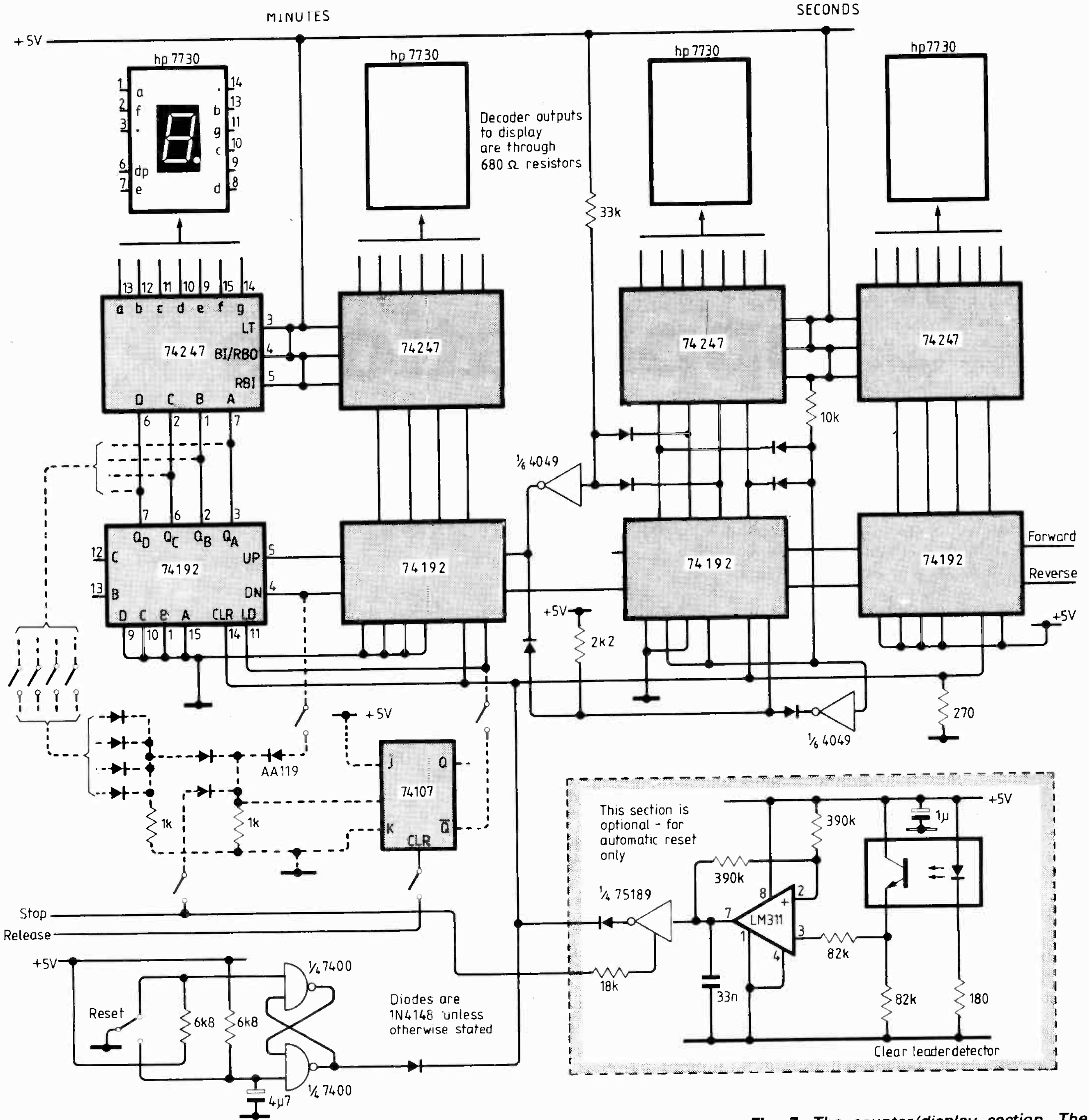
Fig. 2. *Timing disc for length-of-tape transducer.*

◀ **Fig. 1.** *The length-of-tape transducer.*

Fig. 3. *Method of detecting tape motion.*







The length-of-tape transducer is assembled from three parts: a rubber-coated brass roller with ball-bearings, a plastics timing-disc and the optical sensor itself. The physical dimensions are shown in Fig. 1. The brass roller was turned to a circumference of 32mm and then coated with rubber to a circumference of 33.9mm. The rubber is necessary to ensure good tape contact and to prevent slipping and skewing. If liquid rubber is not available, strips of a suitable adhesive tape could be used; but care should be taken that the ends do not overlap and that the adhesive is strong enough to keep the ends from peeling after

continued on page 62

◀ ***Fig. 6.*** *This circuitry links the optical tape sensors and the function switches of the tape recorder with the counter/display section shown in Fig. 7.*

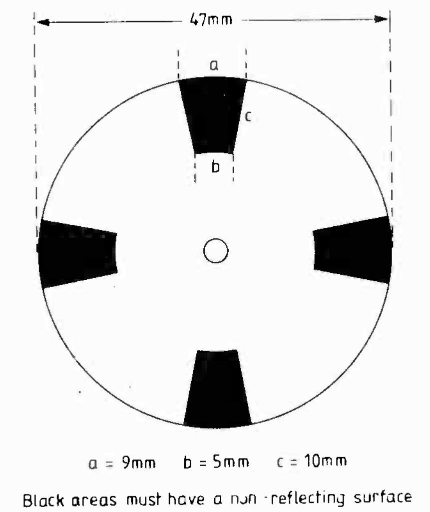


Fig. 4. *Timing disc for tape motion sensor.*

Fig. 7. *The counter/display section. The dotted connections may be included to prevent count-downs below zero when rewinding.*

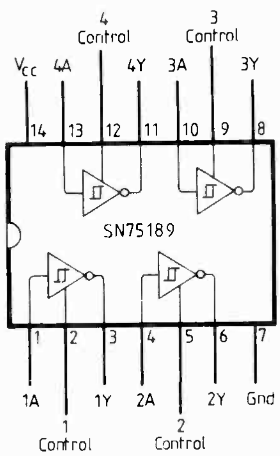


Fig. 5. *Pin connections for the 75189 (top view).*

Haziness and its applications

How belief in the wave theory of matter and the indeterminacy of Nature – coupled with a third (gross) philosophical error, the wilful confusion of measurement with fact – so undermined the discipline of experimental and logical thought that the chaos in modern physics became complete.

It is often said that the indeterminacy of a physical measurement arises as a natural consequence of the postulated wave-like properties of matter itself and that it affords proof of those properties, but that is not so. Heisenberg himself was ambivalent about it: his preferred *derivation* of the Indeterminacy Principle was on wave-theory lines that took an electron to be a "wave packet" of de Broglie-type matter waves, whereas his arguments in *demonstration* took a light quantum to be a wave system but envisaged an electron to be a particle. In fact it is not necessary even for the light to consist of waves, because the Compton effect (which provided the basis of Heisenberg's own illustrations of the Principle) does not require waves for its physical explanation, as already discussed. The indeterminacy does not follow from any postulated wave-like properties of matter or light, but simply from the essential granularity or "quantization" (type one) of microphysical Nature – that is, from the fact that one's most fundamental measuring instruments, electrons and photons, behave like discrete, indivisible, self-consistent *particles*, of small but finite mass.

The wave theory actually entered the philosophical lists by means of a characteristically specious argument in the following manner. If, despite all the contrary evidence, an electron were to consist of a wave packet of matter waves, then the shape of that wave packet might perhaps be arbitrary. (After all, nobody has ever *seen* an electron). Axiomatically a wave packet is distributed in space, so that one cannot really define its position – that is, where its exact centre is – especially if it is a long wave-packet. On the other hand if it is a short one its position will be better defined, but in the nature of things it can then contain only very few waves. This means that its wavelength must be ill-defined, and according to the duality doctrine an electron's apparent wavelength as a wave system is to be associated inversely with its mechanical momentum as a particle. (The premise I refer to here is $p=h/\lambda$). So this concept seemed to fit Heisenberg's indeterminacy formula like a glove: if an electron were a wave packet, then its position and momentum would be mutually indeterminate for natural reasons. The indeterminacy would lie not with our measurements but within the structure of the electron itself. In that case,

by W. A. Scott Murray
B.Sc., Ph.D.

note well, our human failure to make precise predictions of its behaviour would arise simply because the electron's behaviour was itself imprecise or "indeterminate".

The attractiveness of this idea lies in the way in which it places the reason for our difficulties so firmly elsewhere; if Nature herself is indeterminate, how shall the physicists be blamed? It would provide a balm for nettled professional pride and a sop to human vanity if it were true, but of course it isn't. We cannot allow that an electron must become long and thin or short and fat according to the way in which *we* may choose to perform an experiment; that proposal conflicts with the general and consistent experimental evidence that electrons are indistinguishable. Nor do electrons dissipate like wave packets, any more than photons do. And between ourselves we have already rejected the doctrine of the indeterminacy of Nature on the logical ground of the unlimited precision of retrospective measurement. Appealing though it may have seemed to some people, that scheme just isn't on.

Nevertheless the concept of an electron as a wave packet persists. It leads directly to the established "doctrine of haziness" – the erroneous doctrine that fundamental physical particles are essentially and necessarily structureless, amorphous, and of indeterminate size and shape. The philosophical error which allowed that doctrine to flourish was the blandly false identification of the true, physical extent of the structure of a particle with the vague, probabilistic boundaries of *our knowledge* of its position. The error was made possible by the continued association of the statistics of position measurement with the mythical probability waves of the wave theory of matter – the mistake that has already been exposed in the "Reduction of the wave packet".

How can I be so sure that the identification was wrong? I offer two proofs, both independent of wave theory. One is that the form of a particle is a physical matter while our knowledge of its location is a metaphysical matter, and as before we may not identify chalk with cheese. The other is that *the imprecision of a measurement* (Δx) is not to be identified with *imprecision in the quantity measured* (δx) – more especially when, as in this case, the measuring instrument is granular or "quantized" and in that sense imperfect. It is like claiming that a precision-ground ball bearing is non-spherical and faulty because one can't measure its diameter very accurately with a domestic rule!

That last misidentification (of measurement with fact, $\Delta x=\delta x$) is such an obvious error that it should not be accepted from a sixth-form student; yet here we have found apparently-responsible physicists and teachers of physics not only perpetrating it, but *perpetuating* it for fifty years! From their contemporary writings there are grounds for suspecting that it, and the corresponding misidentifications in the case of momentum (Δp), energy (ΔE), and time (Δt), may have been made wilfully by the Copenhagen School in the 1930s, rather than through ignorance of the philosophical issues involved. This is not to impute to those concerned any motives other than the highest: they were genuinely seekers after fundamental truth. But it does seem that they may have been carried away by the sheer excitement of the new ideas that were developing in natural philosophy, and entranced by the mysticism into which these ideas were so inexorably leading them. They *wanted* the world of electrons and photons to be mystical and mysterious. Their picture of that world could be summed up fairly accurately as follows:

– Everything in microphysics is indeterminate (or hazy).

– Everything in microphysics is "quantized" (or precise).

Unless care is taken over the definition of terms these two statements are mutually contradictory. (An example of their conflict was developed in the, *WW* June 1982 article, page 81). I have argued that the first is untrue and I could argue similarly about the second, but instead I will tell a fairy story and leave the judgement to you.

Once upon a time a young man was measuring the speeds at which beta particle (fast-moving electrons) were being ejected from radioactive atomic nuclei. He found that their energies varied smoothly over at least a ten-to-one range, which surprised him because he had expected to find instead a series of sharp energy values like a line spectrum in light. On the other hand, gamma rays (photons) that left the nuclei at approximately the same time did show a line spectrum, which was interpreted as evidence that the internal structure of the nucleus is "quantized" (type two) into definite energy levels – like a Rutherford/Bohr planetary atom, only more so.

I think everybody would agree that atomic nuclei are quantized (type one), in that every nucleus is constructed out of a definite number of discrete particles, protons and neutrons, that can be recognised in the free state by their consistent properties and behaviour. But according to the new ideas the *mechanics* of everything small is also quantized (type two), and because the atomic nucleus is very much smaller than the complete atom, *a fortiori* should the mechanical energy and momentum within the nucleus be quantized. Yet the beta radiation, which is associated with the radioactive decay of one neutron into a proton inside the nucleus, apparently is not quantized. It was an article of the new faith that it should be quantized . . . "Therefore", said the quantum theorists, "the conservation of energy must have failed (Niels Bohr); or, alternatively, the experimental evidence of the beta decay must be wrong".

Wolfgang Pauli saved the day, by postulating the existence of a completely unexpected *neutrino* or "small neutral particle" which had about the same mass as an electron but no electric charge. Such a particle, he suggested, would not show up in any ordinary particle counter or photograph. So: if one neutrino were to be emitted along with every radioactive beta electron, nobody would ever be able to detect the fact; but the invisible neutrino would carry away energy too, so that it and the beta electron, between them, could possess the quantized line spectrum of energy that the theory demanded although the visible beta electron did not. (The failure to quantize the sharing of this energy between the neutrino and the beta electron in fixed proportions was not explained).

Now if you feel this to be a somewhat implausible, *ad hoc* suggestion, designed to make the experimental facts agree with the theory and not far removed from a confidence trick, be sure I share your suspicions. The question before us is: Do we believe in neutrinos? We would not be alone if we didn't. Neutrinos are essential to the modern quantum theory, however, and their existence is assumed as a matter of course when describing nuclear reactions, yet not even their owners seem to be very sure about them. When first invented by Pauli they had about the same mass as an electron (so as to share the missing energy equitably, on average); then suddenly it was proved that they could have no rest mass, but must be like some kind of non-radiant, indetectable photon. However, to make up for that they must be spinning – "but not *mechanically*, of course, since there is no structure there to spin". More recently it has been declared that they probably do have rest mass but very, very little (actual amount unspecified), and that there must be at least four different kinds of them. It does not add up to a very convincing story.

From the theorists' viewpoint the delightful thing about neutrinos is that they are virtually indetectable. Being so light, and electrically neutral, it is said that most of them fly right through the planet Earth, touching neither nucleus nor electron and leaving no trace of their passage. (There is another logical inconsistency here too, but we needn't labour every one!). Very occasionally a particle counter registers inside a 12ft-thick steel box near the target area of the big CERN accelerator at Geneva, and this effect, like some others, is attributed to a neutrino collision because "it couldn't be anything else". Then one day the astrophysicists discovered that, according to current theory, the Sun should be pouring out neutrinos at a calculable, fabulous rate; and accordingly an enormous neutrino detector was built in the United States especially to look for them, deep below ground in a diamond mine where unidentified particles would be unlikely to be mistaken for neutrinos and confuse the results.

That experiment was reported in 1976. It detected fewer than one-tenth of the neutrinos of solar origin that it was expected to detect, and maybe none; there is no assurance that the very few nuclear reactions that it did detect were actually due to neutrinos. The astrophysicists have been sent away to do all their sums again. But why should the poor *astro*-physicists take the blame for this negative result? What if Pauli's adventurous speculation should have been wrong, and his postulated neutrino never existed after all? To the theorists such a thought really is unthinkable: for if, after weighing the evidence, we were to determine that on balance of probabilities we did not believe in neutrinos, then we would be suggesting that the atomic nucleus might not be "quantized" (into discrete energy levels, type two). And that thought in its turn would strike at the roots of every modern theory about the physics of elementary particles.

Now I said at the beginning that little was to be gained by attacking established theories and thereby triggering all their devotees into uncompromising battle in their defence. That line is, in modern parlance, "counter-productive". It is much better to examine miracles – physical phenomena that we do not in truth understand, although our various theories may be willing to offer glib but scarcely plausible "explanations" of them at the drop of a hat. Surveying modern physics, it is in the territory of the elementary particles that miracles are thickest on the ground. Vast sums of money and immense efforts of mind have been spent on particle physics over the past fifty years. Each new atom smasher, when eventually it is made to run, generates a host of new problems *but solves no old ones*. There has been no credible outcome from all this outlay. Instead, we find all manner of hypothetical entities cluttering the contemporary letterpress – "as charmèd quarks, evincing isospin", for example – concepts which are supported by no physical evidence, untested and *in principle* untestable experimentally. (Pau-

Indeterminacy and elementary particles

The influence of the wave theory was paramount in the arguments which led to the denial of causality. The most obvious example of this – also historically the first – was the doctrine that an electron, as an elementary physical particle, was amorphous and structureless because it was "really" a wavepacket of de Broglie waves. The logical error at the centre of this is identifiable as such without difficulty. Thereafter the technique of bending experimental results to fit in with pre-conceived theoretical notions became established, with the general acceptance of the *ad hoc* postulate of the neutrino. The wilful misinterpretation of the meaning of the Indeterminacy Principle then heralded a final rejection of physical discipline, leading to the invention of "virtual processes" which violate the conservation laws whenever convenient, as exemplified by the "prediction" of the meson. Having got away to such an inauspicious start the study of elementary particles had little chance of recovery; the rather obvious failure of theoretical physics in this area, due to its domination by "quantum" metaphysics and mysticism, is scarcely surprising.

li's neutrino gave only a first glimpse into this modern fantasy world.) Particle physics today is in an almost impenetrable mess, infinitely more confused and less coherent now than it was when Chadwick discovered the neutron in 1932. I wonder why?

It seems to me possible that the lamentable state of this area of physics may reflect, and indeed be the consequence of, its domination by the metaphysical ideas of the "quantum theory" of the Copenhagen School. A quotation from a popular modern textbook (no names, no pack-drill!) may provide a convenient example for analysis:-

"*Because of* the Heisenberg uncertainty principle in quantum mechanics, a particle cannot have a definite position in space-time and a definite energy and momentum. The more localised the particle is in space-time, the larger the uncertainty in its energy and momentum. So that, *virtual processes which do not conserve energy and momentum can occur* over very small intervals in space and time *by virtue of the Heisenberg uncertainty principle*, provided they are followed by processes which ensure conservation of energy and momentum for the whole process." (My italics)

There, good friends, you have it all. The student is being told, *ex cathedra*, that it is legitimate for him to postulate any "virtual process" in his theories (by which is invariably meant a process that violates the conservation laws) *provided he is not found out*! Perhaps, philosophically, we have asked for this: we live in an indisciplined, lawless age, where logical consistency and honesty are no longer demanded. The fundamental error in the passage quoted, which is no misprint but a faithful transcription of currently-established doctrine, lies in the statement that a particle "cannot have" a definite position in space-time and a definite energy and momentum; here is the false doctrine of the Indeterminacy of Nature, rather than the legitimate indeterminacy of *measurement*.

That the misinterpretation was deliberate is well evidenced. In 1935, by an *exact* application of the "virtual process" argument quoted above, Hideki Yukawa "predicted" the likely existence of a mesotron or *meson* (medium-sized particle) – a manifestation of nuclear binding energy which might appear externally in the guise of a discrete particle when an atomic nucleus was disrupted. The meson was duly discovered experimentally and its track photographed two years later, an obvious and brilliant success for the doctrine of haziness. Unfortunately some 35 different kinds of meson are now known (by count dated 1973), and the mechanism of the conservation-dodging "virtual process" as it was argued by Yukawa can reasonably account for only one of them.

The unexplained plurality of mesons represents only the tip of the iceberg. The total of recorded elementary particles exceeds 85 (1973 figure)*. I consider myself to be just as radical a thinker as the next man, not at all old-fashioned, and I am quite willing to believe that the 60 or more of the particles currently listed which have immeasurably short life-times – in the trade they are sometimes called "resonances" rather than particles, with good reason – are simply the undifferentiated, non-specific explosion debris of sub-nuclear disintegrations: isolated, fast-flying packages of energy which are of the wrong mass to form themselves into mechanically stable or partially-stable structures (≡ "particles"), and which are *actually* dissipating, spreading out into space and effectively vanishing before our very eyes. (This would correspond to a loss of detectable energy from the local system, although the conservation law would not be violated in the universe as a whole). I would not expect such ephemeral, neutrino-like things to be "quantized".

What of the remaining elementary particles, of at least 25 known species, whose lifetimes range from the 10^{-10} seconds or so of the principal baryons to the all-time stability of the proton and the electron? (Why are they stable? Why are all the others unstable?). The established dogma of today's "quantum theory" holds that it is improper to ask (or answer) questions about their structures, which can never be observed; but what about their masses, which are very accurately measurable? How, and why, are the masses – or internal energies – of these elementary particles, building-blocks of the physical world, related to each other? Current microphysical theory offers no answers to such fundamental questions, and has made only one memorable prediction (the "omega minus" particle, forecast by extrapolation). It invented a series of qualities for elementary particles which, it held, "must be" quantized plus/minus like spin and therefore "must be" conserved. One of these qualities it called parity. It did not even blush when the first honest experiments showed that parity was *not* conserved. Instead it went on to devise – via relativity theory, if you please! – yet another indetectable particle, a tachyon which *always* travels faster than light . . .

In view of the immense efforts that have been expended in its area, current microphysical theory would seem to have been something of a failure. "Microphysical entities are hazy", we are told by eminent men, "and one should not ask old-fashioned questions about them". Surely such haziness is more likely to lie in human minds than in fundamental physics?

* Over 200 now, ten years later. Is this progress?

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continued from page 59

Mr Andersen, who lives in Denmark, works as a field engineer installing and reparing computer systems. He retains a keen interest in planning and constructing his own designs.

a while. At a tape speed of 19.05cm/s the roller will make 5.619 revolutions per second. The timing disc, which is mounted below the roller, has 16 slots (Fig. 2) and therefore produces an output frequency of 5.619×16=89.912Hz. This is counted down to 0.999Hz, which is near enough to 1Hz. The transducer was mounted in place of the tape tension arm.

The tape motion sensor is located underneath the right-hand reel motor (Fig.3). Its timing disc and timing components (Fig. 4) are designed to output a pulse train when the machine is in the play mode and to supply a logic 'high' to the control circuits in the fast wind and rewind modes. It is important that the disc is made as accurately as possible and that the components are chosen appropriately: otherwise the circuit may not detect the exact moment when the tape stops moving, especially if the direction of tape travel is changed directly from one way to the other.

Interfacing the tape recorder function switches to the control logic is done by using the quad line receiver SN75189, which is useful for this purpose because its imputs can withstand up to ± 30V. Equivalent devices are DS1489 (National Semiconductor) and MC1489 (Motorola).

The counter-display section is conventional, except that it is capable of counting both up and down and that the minutes progress to 99 instead of 59. In the present design it was considered undesirable that the minutes counter should go below zero if a rewind beyond the initial starting point took place. Therefore the dotted circuitry was added to ensure that the minutes counter stops at zero when rewinding. In the prototype, this feature was made optional by inserting a dil switch pack. Reset is derived either from a manual switch or from an optional clear leader detector. The variable resistor is adjusted for a 50% duty-cycle at pin 7 of the LM311 during rewind.

The clock requires a stable power supply of 5V at 1A. Proper bypassing of the logic, especially the counters, will be necessary. WW

Assembly language programming

Many microprocessors respond to over 100 machine-code instructions – the 6809 responds to 1464 – and remembering these instructions in hexadecimal form is for most impossible. Assembly-language memory aids used to overcome this programming difficulty are the subject of Bob Coates' second tutorial article.

by R. F. Coates

Hexadecimal-form numbers discussed at the end of last month's article improve the legibility of binary codes used by the processor but illustrate machine code and not assembly language. The following example demonstrates the progression from machine code to assembly language.

- Load accumulator with data in hexadecimal address 40
- Add accumulator contents to data in address 41
- Store the result in address 42

Binary-form numbers used by the 6805 microprocessor to carry out this program are as follows.

10110110
01000000
10111011
01000001
10110111
01000010

This is the only number form that the processor can understand instructions but the binary instructions may be represented in hexadecimal form as follows.

B6 40 BB 41 B7 42

Hexadecimal numbers are easier to assimilate and make programming mistakes easier to spot. Instructions entered on the Picotutor keypad in hexadecimal form are converted to binary by part of the processor-eprom monitor program before they are stored in memory for subsequent use by the microprocessor. Hexadecimal-form numbers are not the ideal solution to the programming problem though; the 6805 has 205 instructions and the 6809 has 1464 and remembering these in hexadecimal form remains difficult to say the least.

Instruction-code mnemonics

As a memory aid, each instruction is assigned an abbreviation relating to the language familier to the operator (in this case English). These assembly-language instruction names are called mnemonics and should in some way describe the function of the instruction. All manufacturers provide a set of mnemonics for their microprocessor instruction sets. There is nothing special about the mnemonics chosen and one could invent one's own but it makes sense to adhere to a standardized set.

Usually the mnemonics chosen are obvious. For instance with the 6805 a load-accumulator instruction is represented by LDA and jump-to-subroutine is represented by JSR. Unfortunately some are not so obvious; with the 6800, transferring the contents of accumulator A to accumulator B is quite logically TAB but transferring the contents of accumulator A to the condition-code register is represented by TAP. With the Z80 microprocessor EXX meaning exchange alternate registers doesn't leave one much the wiser either.

Fortunately, 6805 mnemonics are fairly obvious and apply to equivalent instructions on all eight-bit microprocessors from Motorola which helps one apply experience gained with one microprocesor to another; in machine-code terms instructions used with processors in the range may vary but mnemonics used to represent them stay the same. Standard Zilog and Motorola mnemonics will be used in this series. Computer assemblers usually require a prefix or suffix to denote hexadecimal numbers; these symbols, usually a $ prefix or an H suffix, will only be used where necessary.

Using 6805 mnemonics, the previous example is written in assembly language as

LDA 40
ADD 41
STA 42

with abbreviations LDA, ADD and STA representing load accumulator, add and store accumulator respectively. Like the hexadecimal-to-binary conversion performed by the Picotutor, translation between assembly-language mnemonic programs known as source code and hexadecimal machine-language programs known as object code is a task that can be performed by a microprocessor. Assembly-language programs are usually keyed directly into a microcomputer and translated by an 'assembler' program but such translations are involved and outside the scope of Picotutor. Consequently, our source programs are translated manually using a conversion table.

Programming tables

Microprocessor manufacturers produce tables giving all the instruction mnemonics with their machine-code equivalents such as the ones shown for the 6805. These tables, essential for assembly-language programming, are usually included in microprocessor data sheets.

With mnemonics added, our simple program is now more understandable but is still not self explanatory. Comments added to explain the program flow will make its operation clear and ease reference to the program at a later date. To do this, a table is drawn with columns representing various statements or 'fields' or the instructions. Column headings from left to right are as follows.

Label field
Operation code or mnemonic field
Operand or address field
Comment field

Labels, like comments, are optional and are used to make the programs easier to read. They indicate points in the mnemonic source file such as the start of a subroutine which is jumped to from a different part of the program. This point will have to be specified in the machine-language object code as an address but as this address is not known before the program is assembled it is substituted by a label. The label indicating the start of the routine is also used in place of the address (in the address field) of the instruction that causes

Instruction tables for the 6805. Most ▶ register/memory instructions use two operands, one for the accumulator or index register and the other obtained from memory. Read-modify-write instructions read a memory location or register, modify or test its contents and send the modified value back to memory or the register. When certain conditions are met, branch instructions divert the program. Bit-manipulation instructions are described in the text and control instructions control the processor during program execution.

Register/memory instructions

Function	Mnem.	Addressing Modes: Immediate Op	#	~	Direct Op	#	~	Extended Op	#	~	Indexed (No Offset) Op	#	~	Indexed (8-Bit Offset) Op	#	~	Indexed (16-Bit Offset) Op	#	~	Boolean Operation	Condition Code H	I	N	Z	C
Load A from Memory	LDA	A6	2	2	B6	2	4	C6	3	5	F6	1	4	E6	2	5	D6	3	6	M → A	●	●	∧	∧	●
Load X from Memory	LDX	AE	2	2	BE	2	4	CE	3	5	FE	1	4	EE	2	5	DE	3	6	M → X	●	●	∧	∧	●
Store A in Memory	STA	—	—	—	B7	2	5	C7	3	6	F7	1	5	E7	2	6	D7	3	7	A → M	●	●	∧	∧	●
Store X in Memory	STX	—	—	—	BF	2	5	CF	3	6	FF	1	5	EF	2	6	DF	3	7	X → M	●	●	∧	∧	●
Add Memory to A	ADD	AB	2	2	BB	2	4	CB	3	5	FB	1	4	EB	2	5	DB	3	6	A + M → A	∧	●	∧	∧	∧
Add Memory and Carry to A	ADC	A9	2	2	B9	2	4	C9	3	5	F9	1	4	E9	2	5	D9	3	6	A + M + C → A	∧	●	∧	∧	∧
Subtract Memory	SUB	A0	2	2	B0	2	4	C0	3	5	F0	1	4	E0	2	5	D0	3	6	A − M → A	●	●	∧	∧	∧
Subtract Memory from A with Borrow	SBC	A2	2	2	B2	2	4	C2	3	5	F2	1	4	E2	2	5	D2	3	6	A − M − C → A	●	●	∧	∧	∧
AND Memory to A	AND	A4	2	2	B4	2	4	C4	3	5	F4	1	4	E4	2	5	D4	3	6	A • M → A	●	●	∧	∧	●
OR Memory with A	ORA	AA	2	2	BA	2	4	CA	3	5	FA	1	4	EA	2	5	DA	3	6	AVM → A	●	●	∧	∧	●
Exclusive OR Memory with A	EOR	A8	2	2	B8	2	4	C8	3	5	F8	1	4	E8	2	5	D8	3	6	A ⊕ M → A	●	●	∧	∧	●
Arithmetic Compare A with Memory	CMP	A1	2	2	B1	2	4	C1	3	5	F1	1	4	E1	2	5	D1	3	6	A − M, A→A, M→M	●	●	∧	∧	∧
Arithmetic Compare X with Memory	CPX	A3	2	2	B3	2	4	C3	3	5	F3	1	4	E3	2	5	D3	3	6	X − M, X→X, M→M	●	●	∧	∧	∧
Bit Test Memory with A (Logical Compare)	BIT	A5	2	2	B5	2	4	C5	3	5	F5	1	4	E5	2	5	D5	3	6	A • M	●	●	∧	∧	●
Jump Unconditional	JMP	—	—	—	BC	2	3	CC	3	4	FC	1	3	EC	2	4	DC	3	5	EA → PC	●	●	●	●	●
Jump to Subroutine	JSR	—	—	—	BD	2	7	CD	3	8	FD	1	7	ED	2	8	DD	3	9	PC → (SP), EA → PC	●	●	●	●	●

Read/modify/write instructions

Function	Mnem.	Addressing Modes: Inherent (A) Op	#	~	Inherent (X) Op	#	~	Direct Op	#	~	Indexed (No Offset) Op	#	~	Indexed (8-Bit Offset) Op	#	~	Boolean Operation	Condition Code H	I	N	Z	C
Increment	INC	4C	1	4	5C	1	4	3C	2	6	7C	1	6	6C	2	7	A + 1 → A; X + 1 → X; M + 1 → M	●	●	∧	∧	●
Decrement	DEC	4A	1	4	5A	1	4	3A	2	6	7A	1	6	6A	2	7	A − 1 → A; X − 1 → X; M − 1 → M	●	●	∧	∧	●
Clear	CLR	4F	1	4	5F	1	4	3F	2	6	7F	1	6	6F	2	7	0 → A; 0 → X; 0 → M	●	●	0	1	●
Complement	COM	43	1	4	53	1	4	33	2	6	73	1	6	63	2	7	$\bar{A}$ → A, $\bar{X}$ → X, $\bar{M}$ → M	●	●	∧	∧	1
Negate (2's complement)	NEG	40	1	4	50	1	4	30	2	6	70	1	6	60	2	7	0 − A → A; 0 − X → X; 0 − M → M	●	●	∧	∧	∧
Rotate Left Thru Carry	ROL	49	1	4	59	1	4	39	2	6	79	1	6	69	2	7	C ← b7 … b0 ← C	●	●	∧	∧	∧
Rotate Right Thru Carry	ROR	46	1	4	56	1	4	36	2	6	76	1	6	66	2	7	C → b7 … b0 → C	●	●	∧	∧	∧
Logical Shift Left	LSL	48	1	4	58	1	4	38	2	6	78	1	6	68	2	7	C ← b7 … b0 ← 0	●	●	∧	∧	∧
Logical Shift Right	LSR	44	1	4	54	1	4	34	2	6	74	1	6	64	2	7	0 → b7 … b0 → C	●	●	0	∧	∧
Arithmetic Shift Right	ASR	47	1	4	57	1	4	37	2	6	77	1	6	67	2	7	b7 … b0 → C	●	●	∧	∧	∧
Test for Negative or Zero	TST	4D	1	4	5D	1	4	3D	2	6	7D	1	6	6D	2	7	M − 0	●	●	∧	∧	●

Control instructions

Function	Mnemonic	Inherent Op	#	~	Boolean Operation	Condition Code H	I	N	Z	C
Transfer A to X	TAX	97	1	2	A → X	●	●	●	●	●
Transfer X to A	TXA	9F	1	2	X → A	●	●	●	●	●
Set Carry Bit	SEC	99	1	2	1 → C	●	●	●	●	1
Clear Carry Bit	CLC	98	1	2	0 → C	●	●	●	●	0
Set Interrupt Mask Bit	SEI	9B	1	2	1 → I	●	1	●	●	●
Clear Interrupt Mask Bit	CLI	9A	1	2	0 → I	●	0	●	●	●
Software Interrupt	SWI	83	1	11	PC, A, X, CC → (PC)	●	1	●	●	●
Return from Subroutine	RTS	81	1	6	(SP) → PC	●	●	●	●	●
Return from Interrupt	RTI	80	1	9	(SP) → PC, A, X, CC	?	?	?	?	?
Reset Stack Pointer	RSP	9C	1	2	$7F → SP	●	●	●	●	●
No-Operation	NOP	9D	1	2	None	●	●	●	●	●

Condition code symbols

H	Half Carry (from bit 3)
I	Interrupt Mask
N	Negative (sign bit)
Z	Zero
C	Carry/Borrow
●	Not Affected
∧	Test and Set if True, Cleared Otherwise
?	Load CC Register from Stack
0	Bit = 0 (cleared)
1	Bit = 1 (Set)

Branch instructions

Function	Mnemonic	Relative Addressing Mode Op	#	~	Branch Test	Condition Code H	I	N	Z	C
Branch Always	BRA	20	2	4	None	●	●	●	●	●
Branch Never	BRN	21	2	4	None	●	●	●	●	●
Branch IFF Higher	BHI	22	2	4	CVZ = 0	●	●	●	●	●
Branch IFF Lower or Same	BLS	23	2	4	CVZ = 1	●	●	●	●	●
Branch IFF Carry Clear	BCC	24	2	4	C = 0	●	●	●	●	●
(Branch IFF Higher or Same)	(BHS)	24	2	4	C = 0	●	●	●	●	●
Branch IFF Carry Set	BCS	25	2	4	C = 1	●	●	●	●	●
(Branch IFF Lower)	(BLO)	25	2	4	C = 1	●	●	●	●	●
Branch IFF Not Equal	BNE	26	2	4	Z = 0	●	●	●	●	●
Branch IFF Equal	BEQ	27	2	4	Z = 1	●	●	●	●	●
Branch IFF Half Carry Clear	BHCC	28	2	4	H = 0	●	●	●	●	●
Branch IFF Half Carry Set	BHCS	29	2	4	H = 1	●	●	●	●	●
Branch IFF Plus	BPL	2A	2	4	N = 0	●	●	●	●	●
Branch IFF Minus	BMI	2B	2	4	N = 1	●	●	●	●	●
Branch IFF Interrupt Mask Bit is Clear	BMC	2C	2	4	I = 0	●	●	●	●	●
Branch IFF Interrupt Mask Bit is Set	BMS	2D	2	4	I = 1	●	●	●	●	●
Branch IFF Interrupt Line is Low	BIL	2E	2	4	IRQ = 0	●	●	●	●	●
Branch IFF Interrupt Line is High	BIH	2F	2	4	IRQ = 1	●	●	●	●	●
Branch to Subroutine	BSR	AD	2	8	None	●	●	●	●	●

Boolean operation symbols

0	Cleared
1	Set
M	Memory
A	Accumulator
X	Index Register
n	Bit #
+	Arithmetic Plus
−	Arithmetic Minus
•	Logical AND
v	Logical Inclusive OR
⊕	Logical Exclusive OR
→	Is Transferred to

Other symbols

Op	Operations Code (Hex)
~	Number of MPU Cycles
#	Number of Program Bytes
Mnem.	Mnemonic Abbreviation
A	Accumulator
X	Index Register

Bit manipulation instructions

Function	Mnem.	Addressing Modes: Bit Set/Clear Op	#	~	Bit Test and Branch Op Code	#	~	Boolean Operation	Condition Code H	I	N	Z	C
Branch IFF Bit n is set	BRSET n (n = 0…7)	—	—	—	2 • n	3	10	Mn = 1	●	●	●	●	∧
Branch IFF Bit n is clear	BRCLR n (n = 0…7)	—	—	—	01 + 2 • n	3	10	Mn = 0	●	●	●	●	∧
Set Bit n	BSET n (n = 0…7)	10 + 2 • n	2	7	—	—	—	1 → Mn	●	●	●	●	●
Clear bit n	BCLR n (n = 0…7)	11 + 2 • n	2	7	—	—	—	0 → Mn	●	●	●	●	●

the program to jump to the subroutine. Labels should be limited to six characters as this is the maximum allowed by most computer assemblers.

The operation-code column (mnemonic field) contains the instruction mnemonic and the operand column (address field) contains any further information required for the instruction to be carried out. In our program all instructions require additional information to specify ram addresses of the data to be acted upon. With instructions such as load accumulator where data is not loaded from an address location, the required data byte is specified immediately after the operation code in the object-code program. Other instructions may require no further information, such as TAB on the 6800 which transfers the contents of accumulators A and B. Table 1 shows the program in its expanded form.

Numbers shown in this and subsequent tables are in hexadecimal form unless otherwise indicated. Microcomputer assemblers often require a dollar symbol or letter H to identify hexadecimal numbers.

This is a complete assembly-language source program, and the next step is to assemble it. This requires two further columns in the table to list the machine-code equivalent of the instruction and the hexadecimal address at which the program is to be stored in the microcomputer memory. Ram addresses from 24 to 6F (hexadecimal) are available in the Picotutor to store such programs. Addresses 40-42 are used to store data and the program must not overlap these so the obvious place to store the program is at the beginning of the memory, address location 24.

But should we enter the program and then run it, the processor will look for another instruction after the last one in the program and find only random data which will make it run out of control (ram locations can settle at any value after switch on). This could corrupt either the program or data and the Picotutor reset button will probably have to be pressed to direct the processor back to the monitor program. A more orderly way of terminating the program is to end it with a jump back to the monitor which will allow the result of the operation to be examined. Such a jump instruction is

JMP START Jump to monitor start

The start label in the operand/address field represents the monitor restart address which will vary according to the micropro-cessor and monitor program used. On the Picotutor, this address is 80. With machine-code equivalents included, the program is as shown in Table 2.

Table 2. When assembly is complete, two further columns contain addresses and instructions in hexadecimal form.

Address	Machine code	Label	Op-code	Operand	Comments
24	B640	ADDTWO	LDA	40	load accumulator from address 40
26	BB41		ADD	41	add to contents of 41
28	B742		STA	42	store result in 42
2A	BC80		JMP	START	jump to monitor start

In this example, each instruction requires two bytes, one the operation code (op-code) and the other the data address, so when we fill in the hexadecimal numbers for the program address, each line increments by two (left-hand column). The number of bytes for each instruction varies between one and three according to the number of bytes of additional information that the instruction requires.

From now on, all tables shown will be in this form. It is wise to adopt this method of constructing tables not only because it helps one understand the flow of the program, but also because computer assemblers produce such tables. Printed programming forms are available.

Running the program

To run the previous program on the Picotutor, the machine code (object code) must be entered first at the specified addresses. After switch-on a dash at the left-hand side of the display indicates that the unit is ready to accept a command, so press the memory-open key (mo) which will result in the seven-segment equivalent of an m appearing on the display, indicating that a three-digit address is awaited. When the first address of the program is entered, 024, irrelevant data will be displayed. The first byte of the program, B6, is now entered and the step-up key (an arrow) pressed to close location 24 and open location 25. Byte 40 is now entered, and the process repeated until the last byte of the program, 80, is entered at memory location 02B. Now the reset button is pressed to terminate the memory-open command.

Keying in mo 024 and pressing the step up key will allow the program to be checked. Providing that new data is not entered, pressing the step up or down keys will not alter the contents of the address locations. Before running the program, data that the routine has to act upon must be entered. For this example memory locations 40 and 41 are filled with 04 and 05 respectively. Now, with the dash sign displayed, press the go key and type in the starting address of 024. The dash should now reappear.

When the go key is pressed and the starting address entered, the microprocessor stops running the monitor program and runs the program starting at the specified location. The monitor program, keyboard and display stop functioning during this time until the last instruction is reached when control is returned to the monitor program and the dash reappears. If the program is correct, the location storing the result of the addition (mo 042) will hold the value nine. Try running the program again but with different values in locations 40 and 41, remembering that the numbers added and hence the result are in hexadecimal form.

Table 1. Writing assembly language as a table with comments makes it easily understood.

Label	Op-code	Operand/address	Comments
ADDTWO	LDA	40	load accumulator from address 40
	ADD	41	add it to the contents of address 41, store result in accumulator
	STA	42	store result at address 42

Other microprocessors. Two accumulators are available on 6800 and 6809 processors, so the program has to specify which one is to be used. Our example uses accumulator A as follows.

1000	B61040	LDAA	1040
1003	BB1041	ADDA	1041
1006	B71042	STAA	1042
1009	7E7D97	JMP	START

Data addresses require two bytes (1040-1042) whereas only one byte was needed in the previous program because high-order address bytes of 00 do not need to be specified for the 6805 (explained later). Monitor start address 7D97 in the last line of the program is for the Nanocomp (see *Wireless World*, January and July 1981) and will need to be altered to suit the computer concerned.

For the Z80 the program needs to be altered slightly as it is not possible to add the accumulator contents directly to those of a memory location. Instead a pair of general-purpose 8-bit registers are loaded with the address of the data and the accumulator content is added to data in the memory location whose address is contained in the register pair, Table 3.

Points to note in this version are that load mnemonic LD is used for both loading and storing and requires two operands, the first signifying the destination and the second the source. The first line means load the accumulator with the contents of memory location 2040. Parentheses are used to indicate that the register is to be loaded with data contained at the address location specified. In line two, parentheses are not used so the HL register pair is loaded with address value 2041 for use as a

Table 3. Z80 assembly language equivalent of Table 2.

2000	3A4020	LD	A,(2040)	load acc. from address 2040
2003	214120	LD	HL,2041	load second operand address into HL
2006	86	ADD	A,(HL)	add acc. to operand pointed to by HL
2007	324220	LD	(2042),A	store result at address 2042
200A	C30000	JP	0000	jump to monitor start

pointer for the add instruction. The fourth line stores the contents of the accumulator at address location 2042.

Operand addresses are written with the low-order byte first when assembled – a common source of errors when assembling manually. Addresses and the monitor-start location may need altering to suit your system.

Addressing modes

We have already seen that it is necessary to address memory locations to retrieve or store data, but so far only one method for the 6805 has been described. Six basic addressing modes available on Motorola products are

immediate
extended
direct
indexed
inherent
relative.

Immediate. In this addressing mode the operand of the instruction is present in the byte immediately following the op-code of the instruction in the object code. A hash sign immediately before source-code operand denotes this form of addressing, for example A66F LDA #6F will load the accumulator with value 6F. The operand is always eight bits on the 6805, but on other processors it may be 16 bits. On the Z80 for example 214120 LD HL,2041 loads the HL register pair (two by eight bits) with the 16bit value 2041. Op-code 21 requires two further bytes, 4120, to form a 16bit operand. Sixteen-bit operands are sometimes used with 6800 and 6809 processors.

Extended. Here, two bytes immediately following the op-code represent the address of data to be used as the operand. These bytes form a 16bit address for Z80 or 6800/9 processors or an 11 to 13bit address for various versions of the 6805 (remaining bits are unused). For example B61040 LDAA 1040 will load accumulator A with the contents of address 1040. Absence of a prefix implies extended as opposed to immediate addressing. This mode is known as absolute addressing with the Z80 and brackets differentiate it from the immediate mode, e.g. 3A4020 LDA, (2040).

Direct. This is a version of extended addressing. If the most-significant byte of an extended address is 00 then direct addressing can be used and the most-significant byte need not be specified, resulting in a one byte saving in memory space. Although the range is limited to addresses 0000 to 00FF, this mode can save a considerable amount of memory space on the 6805 since operand addresses are usually in ram or i/o ports within this range. An example of direct addressing for the 6805 is B640 LDA 40.

An extension to this idea on the 6809 is an eight-bit direct register which holds the most-significant address byte. Instead of being fixed at 00, this byte may be altered by the program. There is no equivalent to this mode on the Z80.

Indexed. In direct and extended-addressing modes, the address of data which forms the operand is specified but here the address is contained in an index register called a pointer. A similar concept used with the Z80 appeared earlier – 86 ADD A,(HL) – where the accumulator content is added to data in an address location pointed to by two bytes in the HL-register pair.

But with indexing it is also possible to specify an offset which is added to the contents of the index register to form the effective operand address. This offset is contained in an immediate byte(s) for the 6805 as follows.

```
AE78      LDX     #78
E604      LDA     4,X
```

In the first line, the eight-bit index register is loaded with immediate operand 78 and the second line loads the accumulator with the contents of memory address 7C (78+4) without altering the index register contents. Sixteen-bit offsets may also be used; for example

```
AE78      LDX     #78
D60146    LDA     146,X
```

will load the accumulator from address 1BE. Operation codes E6 and D6 are used to signify eight and 16bit offsets respectively. A special case exists when the offset is zero in that F6 LDA 0,X replaces E600 LDA 0,X. Operation code F6 for indexed addressing with no offset is peculiar to the 6805.

The 6800 has a 16bit index register but only allows eight-bit offsets. Although the 6809 has only two index registers (X and Y), two stack pointers (S and U) may be used as index registers; indexing modes of this processor are beyond the scope of this article. The Z80 has two 16bit index registers, IX and IY.

Inherent. This type of addressing is used when it is obvious from the nature of the instruction that no further operand or address is required to complete it, as for example with SEI, set interrupt mask, RTS, Return from subroutine, and CLRA which clears the accumulator.

Relative. Branch and conditional-branch instruction use relative addressing. With these instructions, sequential processing stops and the program branches either forward or backward to another point depending on the value of a displacement byte. The displacement byte is a signed two's complement number which is added to the program counter after it has been incremented to point to the next sequential instruction. This byte allows branches of between 127 and −128 steps from the current program position by modifying the value in the program counter.

With the 6809, displacements represented by 16 bits may be used allowing the program to branch to any position in a 65Kbyte memory.

The six addressing modes above apply to all the processors that I have mentioned (8080 has no relative-addressing mode). In addition, the 6809 has many more addressing modes but for our purposes, the ones covered will suffice. Two further addressing modes are only available on the 6805.

Bit set/clear. This allows a single bit of any byte in address-page zero (0000-00FF) to be set or cleared without affecting any other bit in that byte.

Bit test and branch. A specific bit of any byte in address-page zero may be tested and cause a branch or not, depending on the result of the test.

These two modes are useful in control applications since they allow single i/o lines to be specified. A similar form of bit manipulation is possible using the Z80.

BOOKS

Handbook of Antenna Design, Volume 1, Editors: A. W. Rudge, K. Milne, A. D. Olver, and P. Knight, 708 pages, Hardback, Peter Peregrinus, £42.
Written by a multi-national group of antenna experts, this book constitutes volume 15 of the IEE Electromagnetic Waves Series. It presents the principles and applications of antenna design with particular emphasis on recent developments. Fundamental theory and analytical techniques are explained in detail where appropriate and there is extensive design data with examples of practical application. A wide range of antennae are dealt with from very low frequencies to millimetric waves and from satellite communications to radar and broadcasting.

Complete Guide to Videocassette Recorder Operation and Servicing, By John D. Lenk, 365 pages, Hardback, Prentice-Hall, £19.50.
This book provides a practical approach to servicing and trouble-shooting v.c.rs with special emphasis on Beta and VHS recorders. Starting from basic principles, the author describes an easy step-by-step method to service the machines including a section on any special tools that may be required and their operation. An American book, it describes NTSC machines, but it is applicable to PAL systems.

Peak-to-peak bar/dot indicator

Depending on the frequency of the input, the instrument provides a led bar or moving-dot display of pk-pk voltage

by A. J. Ewins

The circuits presented here are for a 31-led bar/dot meter which indicates the peak-to-peak range of signals with frequency content from 0 to 10 kHz and amplitudes between ±1.5V peak. At frequencies greater than 100Hz the meter gives a bar indication extending over the range of the peak negative to peak positive values of the input signal. At frequencies below 1 Hz the meter gives a moving dot display rang-

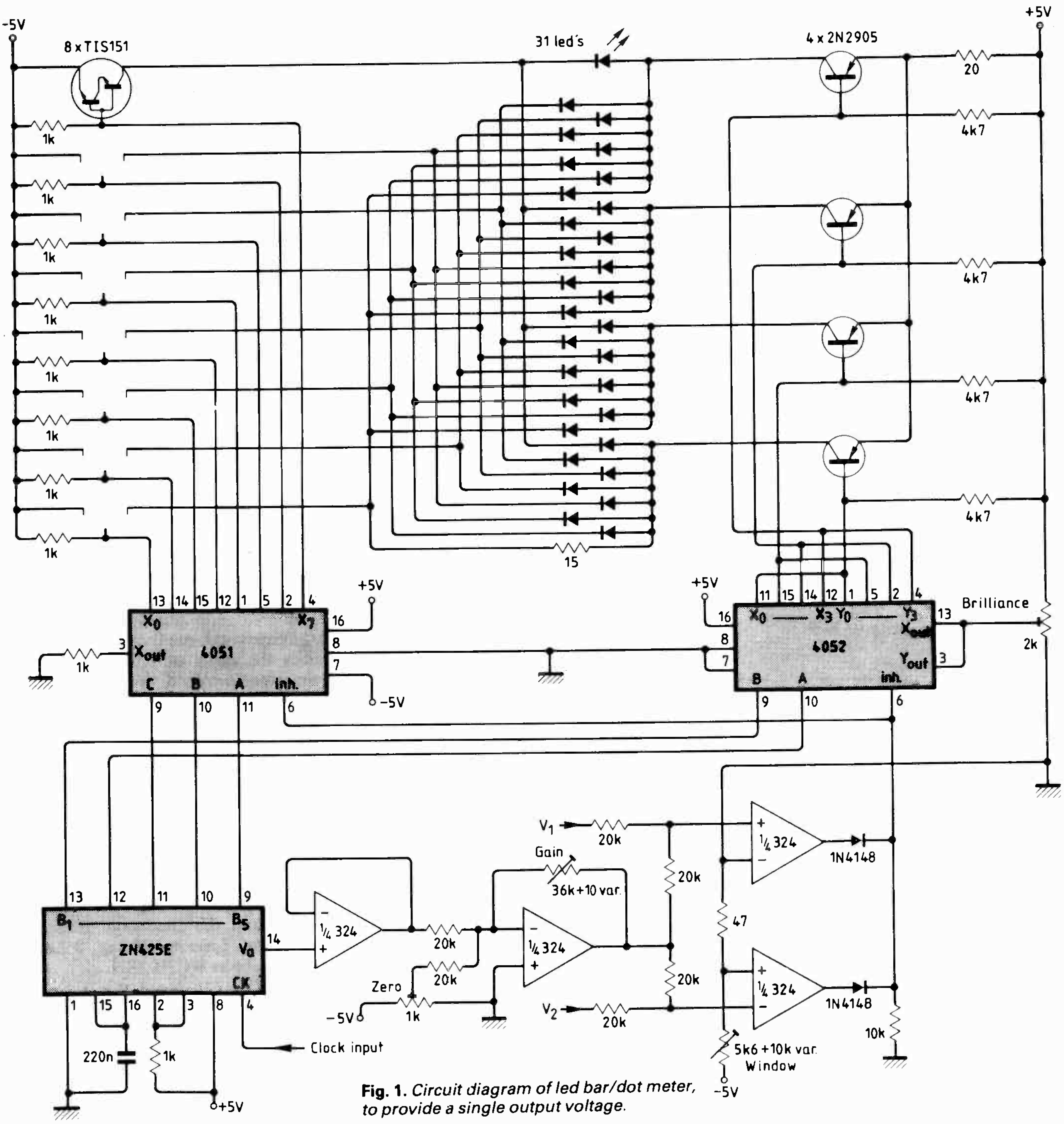


Fig. 1. *Circuit diagram of led bar/dot meter, to provide a single output voltage.*

ing over the peak-to-peak levels of the input signal. The display may be generally likened to that of a signal on the 'y' axis of an oscilloscope with no timebase. The display is able to indicate both the a.c. and d.c. content of a signal, the d.c. content of a signal with a high-frequency component merely shifting the displayed bar in the direction of the d.c. offset.

The circuit of Fig. 1, on its own, produces a bar display extending over the range of the two input voltages, V_1 and V_2, where $+2.5V>V_2 \geq V_1>-2.5V$. When an input voltage is applied simultaneously to V_1 and V_2, a single dot is displayed which indicates the amplitude of the applied voltage. The circuit of Fig. 2 produces two output voltages, V_{min} (V_2) and V_{max} (V_1), representing the peak negative and peak positive values of the signal applied to its input. The circuit has a gain of 5/3 to amplify input signals of ±1.5V peak to an output level of ±2.5V.

Circuit operation

The heart of the circuit of Fig. 1 is the d-to-a converter i.c., ZN425E. With a suitable clock oscillator (see Fig. 3) at its clock input, the five most significant bits of its 8-bit counter output are used to multiplex the 31 leds via the two c.m.o.s. multiplex i.cs, 4051 and 4052, and the p-n-p and n-p-n transistors. Whether or not a led is turned on as it is addressed is determined

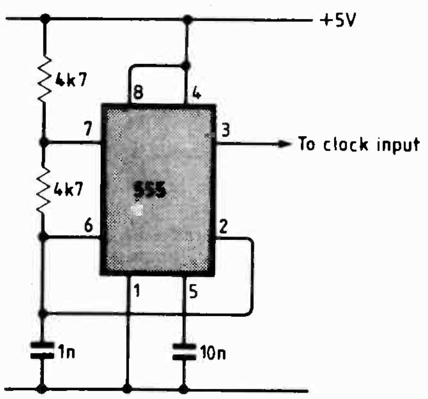
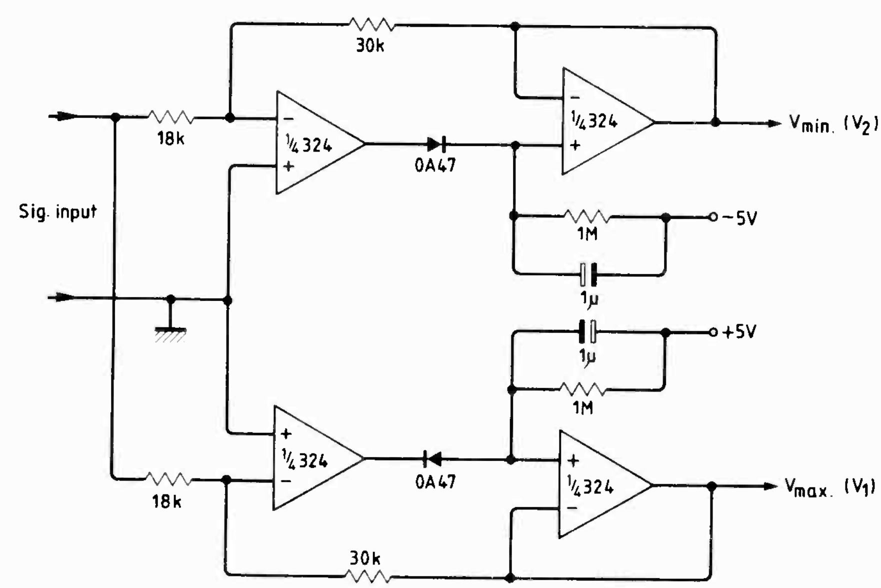


***Fig 3.** Clock oscillator.*

***Fig. 2.** Modification to produce two outputs.*



by the logic level on the INH input of both multiplex i.cs. The ZN425E also produces a 256-step analogue ramp voltage output in sequence with its digital counter. Buffered by the first op. amp., amplified by a factor of about 2 and offset by the second op. amp., the resulting output is a negative ramp falling from +2.5V to −2.5V. (The 'offset' control can be used to produce a negative ramp of 5V pk-pk anywhere between ±5V, enabling the centre zero of the display to be shifted from one end of the scale to the other.) This ramp voltage is mixed with the two input voltages, V_1 and V_2, separately, and applied to two comparators. The result of this is that when the instantaneous value of the ramp voltage (inverted) lies *outside* the range of V_1 and V_2, the INH level is at logical 'I' and an addressed led will be off. When the instantaneous value of the ramp voltage lies *inside* the range of V_1 and V_2, the INH level is a logical '0' and an addressed led will be turned ON. Thus only those leds which give an indication of an analogue voltage between V_1 and V_2 are lit as they are addressed. One comparator is referenced to zero volts and the other to a small negative voltage. This ensures that just one led is lit, giving a dot display, when V_2 equals V_1.

The four 2N2905 transistors are connected as emitter followers when addressed and provide a constant current source to the leds. The value of the constant current is determined by the common 20 ohm emitter resistor and the voltage applied to the transistor bases. The 'brilliance' control determines the base voltage and hence controls the value of the constant current, which may be adjusted to any value between 0 and 200 mA. The eight n-p-n transistors act as switches to sink this current through the selected led. The average current that a led sees is 1/32 of the constant current value. The leds used in the original design were end-stackable types from Farnell Electronic Components, types CQX10-4 (red), CQX11-4 (green) and CQX12-4 (yellow). Although shown as single transistors, for convenience, the TIS151 devices are in fact Darlington pairs from Texas Instruments. An alternative to these transistors would be an array i.c. such as the ULN2801A, which is an 18-pin device containing 8 n-p-n Darlington pairs intended for just such an application.

Only 31 leds are used in the display, though 32 are addressable. The reason for omitting the *first* led is twofold. Firstly, the first led is always dimly lit due to the finite time of the fly-back of the ramp voltage; secondly, 31 leds give a very convenient display with one used as a zero indication, and fifteen in each positive and negative direction providing an indication in 100mV steps. The resolution of the display is, in fact, better than 100 mV. This results from a graduation in the illumination intensity of adjacent lens as the signal level changes from one 100 mV step to the next. When the signal level lies exactly halfway between 100 mV steps at, say, 350 mV, then the adjacent 300 mV and 400 mV leds will each be half lit. It is possible to estimate when one led is ¼ lit and the adjcaent led is ¾ lit. A resolution of about 25 mV can thus be achieved.

Finally, using the dock oscillator of Fig. 3, the leds are scanned about once every 2½ms. WW

LITERATURE RECEIVED

Several volumes have been added to the range of technical literature published by Texas Instruments. Among them are new data books on mos memory deivces, microcomputer components and power semiconductors and an educational guide to applications of electronics in motor vehicles. A booklet describing these and other technical publications is available from Texas Instruments Ltd, P.O. Box 50, Market Harborogh, Leicester.

A new Sprague Semiconductor Chip catalogue is now available from the company's UK chip distributor, Hy-Comp Ltd, at 7 Shield Road (Ashford Industrial Estate), Ashford, Middlesex, TW15 1AV.

A 12-page catalogue from BICC-Vero describes the range of pluggable telephone connectors designed by the company for British Telecom. The connectors have features which, according to the makers, make them suitable for other applications, such as with sensors, keyboards and hand-held controllers. BICC-Vero Connectors, Parr, St Helens, Merseyside.

A directory covering more than 200 product categories is contained in a guide to British manufacturers of electronic capital equipment. The booklet is available free of charge from the Electronic Engineering Association, Leicester House, 8 Leicester Street, London WC2H 7BN.

Microprocessor systems and instruments for energy management are among many new additions to a large catalogue of equipment available for rental from Livingston Hire Ltd, Shirley House, 27 Camden Road, London NW1 9NR.

Two-metre transceiver

Comprising a.f. amplifier and tone generator circuits, this section of the multi-mode transceiver is the tenth and final module. Wiring information completes the hardware description in this penultimate article.

by T. D. Forrester, G8GIW

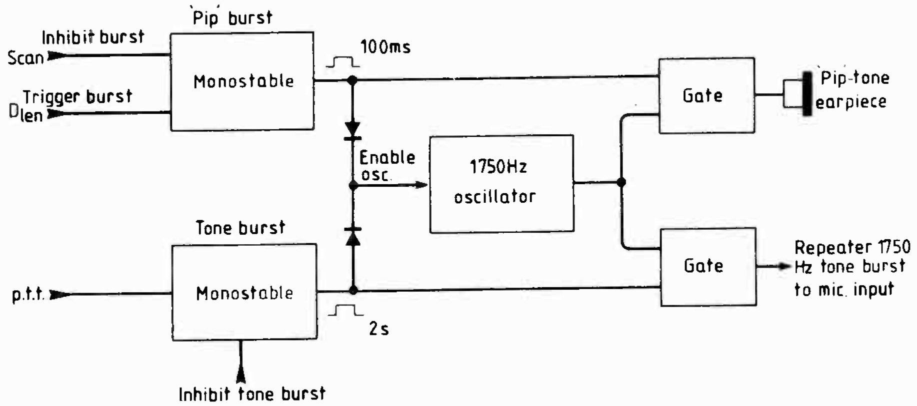
In addition to providing a tone burst and a.f. preamplification, module 10 generates a 'pip' when the frequency is changed. Dual monostable IC_{1000} is wired to give outputs of around 2s and 100ms to initiate tone-burst and pip signals respectively. Two-second pulses enable the tone-burst oscillator formed by half of IC_{1001} through a diode OR gate, the resulting signal appearing at pin 3 of IC_{1001}. Before leaving the module, the tone-burst signal is filtered and attenuated by $R_{1009,1010}$ and $C_{1005,1006}$. A potentiometer sets the tone-burst level feeding the f.m. microphone amplifier.

To prevent operation of the tone burst in any mode other than repeater, the 2s monostable is disabled at pin 13 of the i.c. by a low signal from the mode switch. This disable signal comes from the switch wafer used for driving the start transistor of module 3.

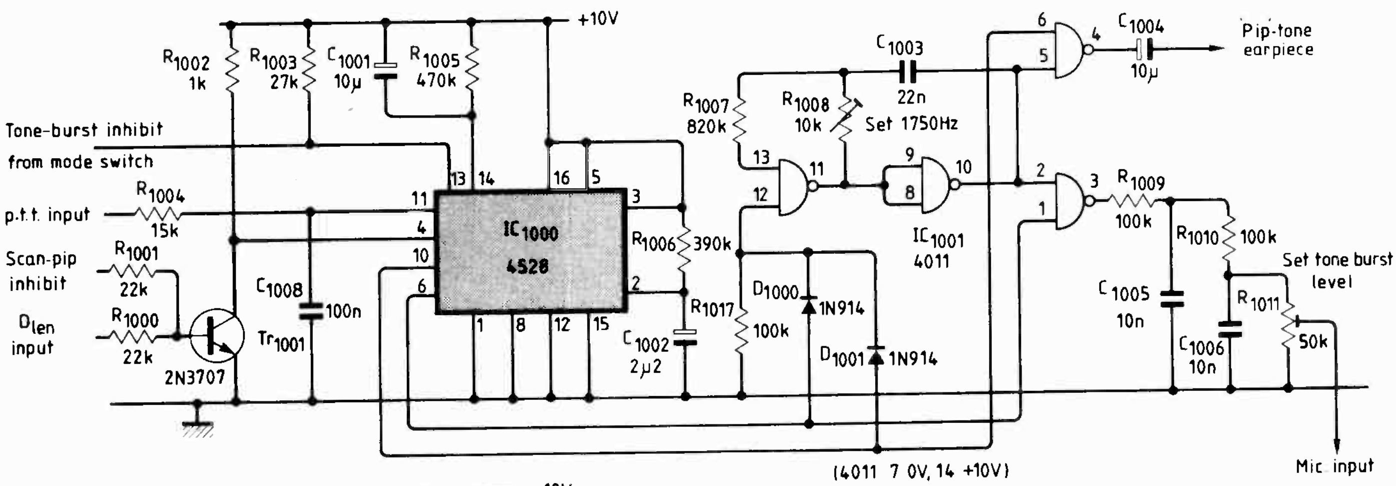
The other half of the dual monostable provides a short pip which drives a miniature ear-piece located behind the front panel to indicate frequency changes. Pulses from this half of the monostable also turn the tone-burst oscillator on through the diode-OR gate but now the output is directed through a different NAND gate to the earpiece. When data is sent to the synthesizer by the microprocessor, D_{len} control line goes high; this line is used to trigger the pip monostable through buffer transistor Tr_{1001}. In scan mode, the buffer transistor is inhibited to avoid the annoyance of continual pips.

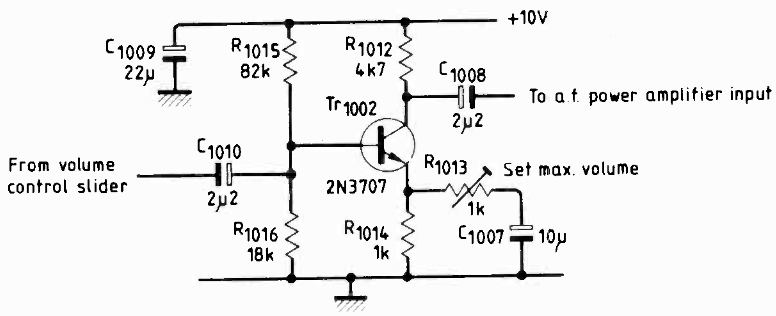
Tone-burst frequency is set at 1750Hz by R_{1008}. To set the frequency, pin 12 of IC_{1001} may be taken high so that the oscillator runs continually. A conventional a.f. preamplifier formed by Tr_{1002} lifts the level of the audio signal to suit the a.f. power amplifier. Gain of this stage is adjusted using R_{1013}.

Front-panel wiring is detailed in the diagram. The mode switch used has two wafers each with two-pole, six-way

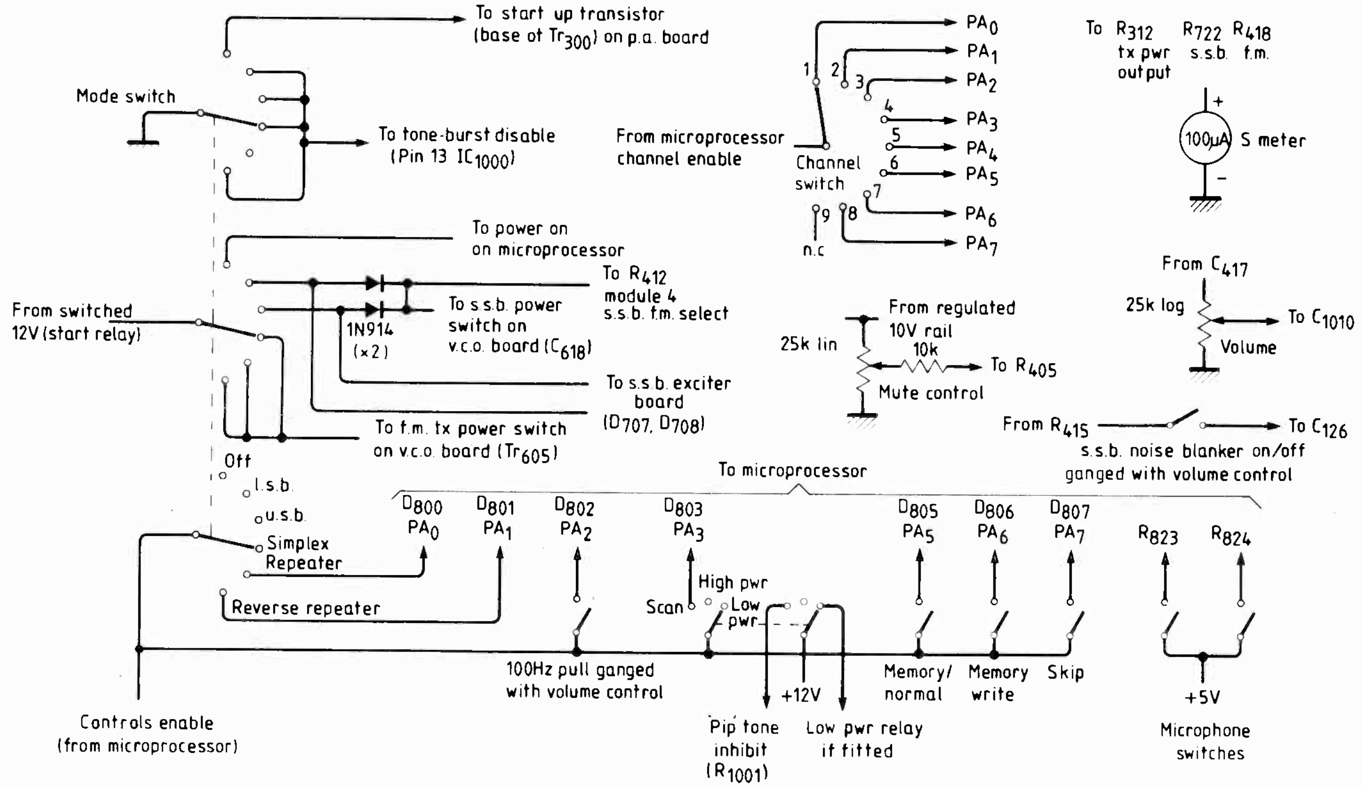


Tone-burst generator block diagram shows how the oscillator is gated to provide both a 1750Hz signal for the repeater and a short audible tone indicating changes in frequency.





Audio preamplifier and tone generator circuits – module 10. Dual c.m.o.s. monostable IC_{1000} generates pulses of 2s and 100ms for respectively gating the tone-burst oscillator, IC_{1001}, and a short tone fed to an earpiece to indicate changes in frequency. Tr_{1002} is the a.f. preamplifier.



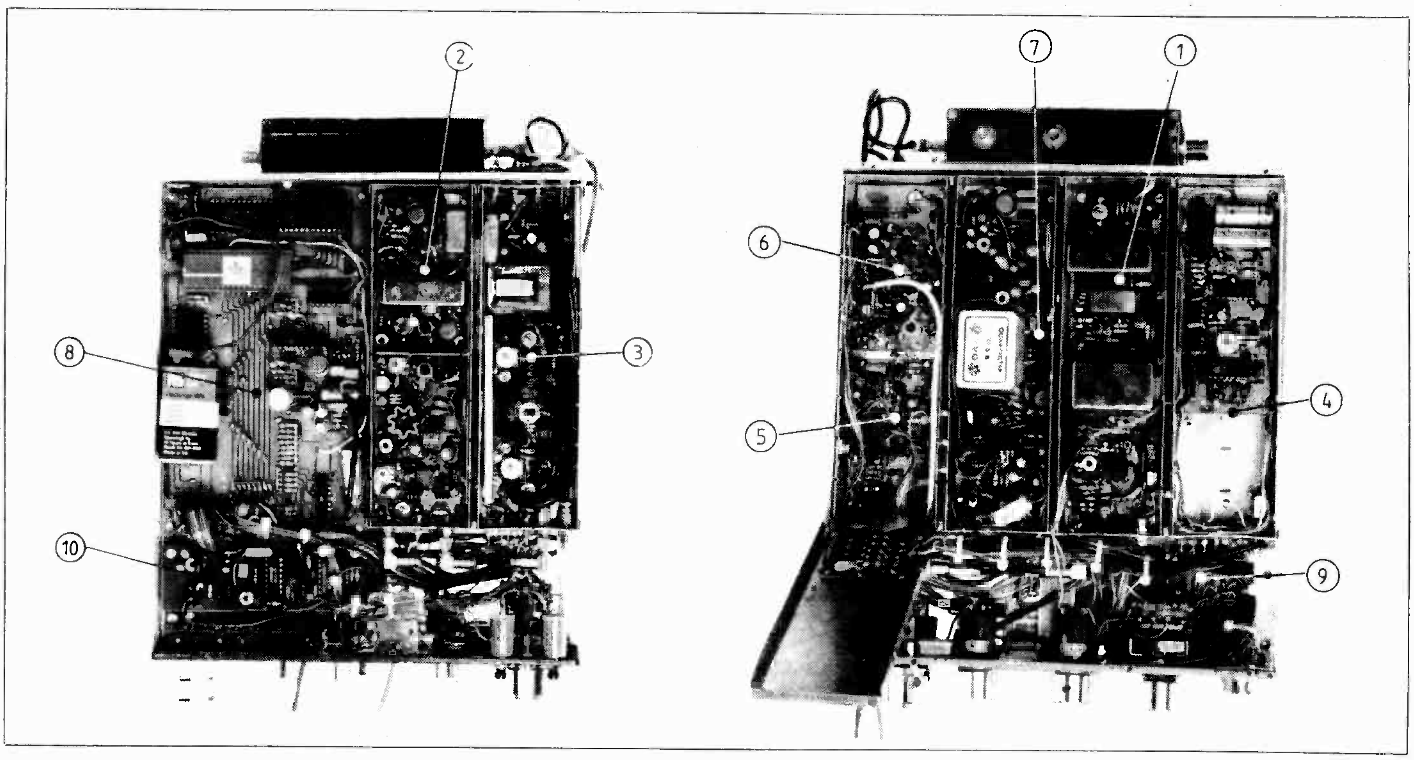
Wiring diagram for the multi-mode transceiver front panel. Mode switch is a four-pole six-way type and channel switch is a single-pole twelve-way type, of which only nine ways are used. The 100μA edgewise meter and these switches (Mini Maka) are available from RS Components. Sub-miniature toggle switches are used for normal/memory and scan high/low controls, one a single-pole change-over type (53-00200) and the other a double-pole change-over type (53-00201). Miniature push-button switches (53-00300) are used for memory-write, skip and up/down mike controls. Both potentiometers include double-pole pull-to-make switches (48-25320 log., 48-25319 lin.). These components can be obtained from Ambit using part numbers in brackets.

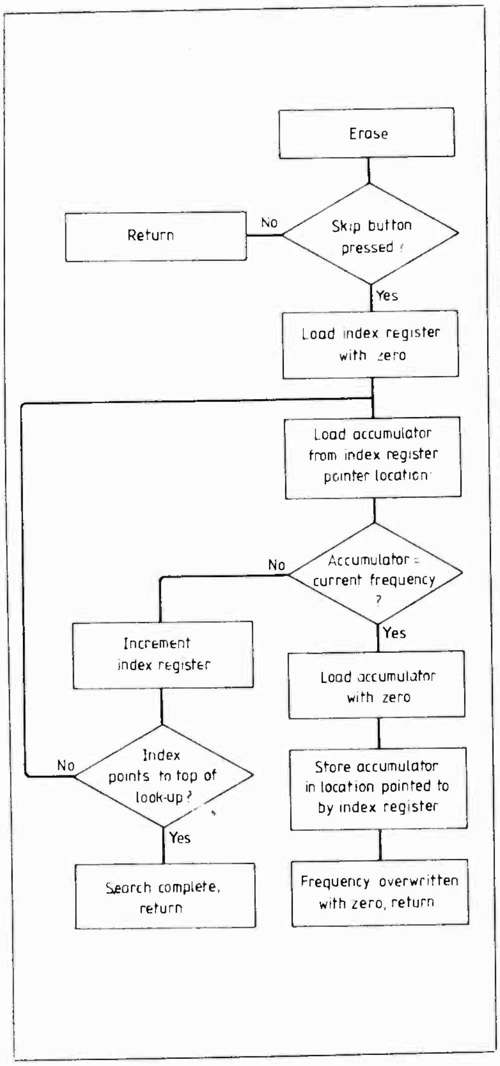
contacts so a spare pole is available for enhancements.

As can be seen from the photographs, the transceiver is constructed as two halves above and below a centre plate made from ⅛in aluminium alloy. On the top left-hand side of this plate is the microprocessor p.c.b. and directly in front of it the display-driver board. To the right of it is the screened transmit-converter module and to the right of that the transmitter final stage, start relay and power regulators, also screened. Teko boxes were used to house the modules.

Four more screening boxes are mounted on the underside of the plate housing from left-to-right the v.c.o. and synthesizer, s.s.b. receive-transmit/f.m.-exciter, receive-converter and f.m. i.f. modules. The module on the back of the transceiver houses an inductively-coupled band-pass filter and the antenna change-over relay. As all the r.f. modules are screened separately, there is no reason why the layout described should be adhered to but in terms of access and ease of construction, the module positioning described is believed to be optimum.

Front and rear panels are also made from ⅛in aluminium sheet and secured to the tapped centre plate by 8BA screws. Aluminium sheet of 20s.w.g. was used to





Resistors

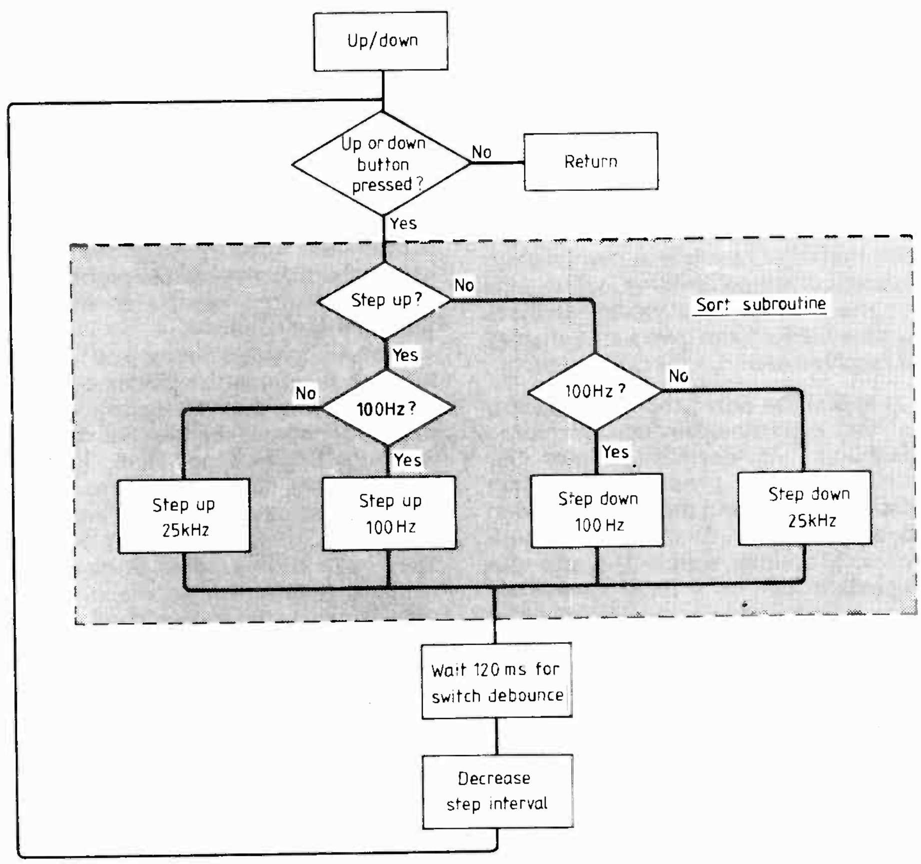
1000,1001	22k
1002,1014	1k
1003	27k
1004	15k
1005	470k
1006	390k
1007	820k
1008	10k sub-min preset
1009	100k
1011	50k sub-min preset
1012	4.7k
1013	1k sub-min preset
1015	82k
1016	18k
all 1/4W, 5%	

Capacitors

1000	100n disc
1001,1004, 1007	10μ tantalum, 16V
1002,1008, 1010	2.2μ tantalum, 16V
1003	22n polyester
1005,1006	10n disc
1009	22μ tantalum, 16V

Two 2N3707 transistors, two 1N914 diodes and two i.cs, a 4528 and a 4011, complete module 10.

Prescaler SAA1058 and p.l.l. SAA1056 (module 5) can be obtained from Macro Marketing for £3.02 and £4.15 respectively, excluding vat and £2 postage and packing. The company's address is 396 Bath Road, Slough, Berks SL1 6JD.



Transceiver modules

1 **receiver converter, 144MHz to 9MHz** *November 1982*

2 **transmit converter, 9MHz to 144Mhz** *December 1982*

3 **transmit power amplifier and power regulators** *December 1982/January 1983*

4 **f.m.-i.f. discriminator, squelch, noise blanker, a.f. power amp** *January 1983*

5 **synthesizer logic** *January/February 1983*

6 **synthesizer voltage-controlled oscillator, power change over** *February 1983*

7 **s.s.b. 9MHz transceiver, 9MHz f.m. exciter** *February 1983*

8 **microprocessor control and interfaces** *March 1983*

9 **frequency-display driver** *March 1983*

10 **1750Hz tone-burst and receive a.f. preamp** *April 1983*

make a base plate and three-sided cover. Letter transfers were used to annotate the front panel which is protected by a tough plastic film.

Software

Flow charts illustrated here break down the main program given last month to help one understand how the transceiver operates. Mnemonics relate to assembly language used for the transceiver program.

Referring to the erase flow chart, if squelch lifts while the transceiver is scanning, the microprocessor checks whether or not the channel concerned is to be ignored (skipped). If so scanning continues but if not, scanning stops for a while. Pressing the skip button during this pause will cause the channel to be skipped over on the next scan.

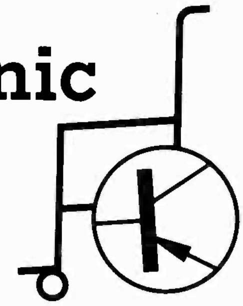
A subroutine called Erse erases channels from the skip list as follows. During normal operation, i.e. with the set tuned to the desired frequency using the up/down buttons, it is possible to erase a certain frequency by tuning it in and pressing the skip button. This causes the microprocessor to search through its skip list and compare the frequencies in it to the one tuned. When the values match, the frequency in the skip list is overwritten with a zero. On the next scan, the microprocessor stops at this frequency to allow one to listen in.

Two buttons on the microphone allow the set to be tuned up or down in frequency for both normal operation and memory storage. Frequency increments depend on the position of the 100Hz/25kHz switch ganged to the volume potentiometer. In the up/down flow chart, a subroutine called sort tests which direction the frequency is to be stepped in and whether the steps are 100Hz or 25kHz. If either the up or down button is kept pressed, the rate at which the frequency steps up or down increases until the button is released.

To be concluded.

COMPETITION

Design an electronic device to aid the disabled



A recent visit to a travelling showcase of aids for the disabled indicated how simple many of the devices were: levers to extend normally difficult-to-operate switches or dials; clamps to grip jars or bottles so that they may be opened more easily; various rods and hooks to aid people to dress themselves. At the other end of the scale, microcomputer hardware and software are being used in imaginative ways to aid severely handicapped people: providng voices to those unable to speak and enabling those unable to move to interface with the world.

Many examples spring to mind; the Possum allows, by the use of simple push switches, the disabled to operate a computer. We have received details of a single-board microcomputer which has been used to operate switches on the reception of whistle tones. The well-known Turtle enables children unable to move to experience spatial dimensions by directing the robot around the floor. And computer graphics can perform a similar function on a tv screen. We have reported in the News pages recently the Viewscan system which can scan printed matter and display it on a c.r.t. with enlarged characters for the partially-sighted; we also reported on the micro-controlled wheelchair designed by Dan Everard for use by his daughter who suffers from spinal muscular atrophy.

This last example brings us to an important point. The chair was designed to help a specific person even though it would be of use to many others. Entrants in the *Wireless World* 'Design an electronic device to help the disabled' competition should be encouraged to contact the people who need the aids, to find out what those needs are and to work in cooperation with the 'end user' so that these objectives are best fulfilled. It would be pointless to re-invent the wheel, so it is well worth checking that the device being designed does not already exist. On the other hand there may be ways of improving the wheel so that it runs more smoothly or is easier to use.

Communication is of course one problem. The autobiography of Joey Deacon needed three people to write it: Joey himself, his friend Harry, who was the only person able to interpret the sounds that Joey made, and a third who could operate a typewriter with one finger. Christy Brown was discovered to be a fine poet after he had learned to communicate by typing with his foot. It must be horrifyingly frustrating to have an intelligent mind trapped inside an incapable body: Joey and his friends were cared for in a mental institution not because of their mental disabilities but chiefly through their inability to communicate.

Physical mobility is always a problem. For example, many disabled people need to wear elastic stockings but there is no device readily available to help them to get them on or off unaided. This is outside the scope of our competition but it does illustrate a simple problem in search of a solution. Reward toys, like the teddy bear whose eyes light up when a deaf child speaks, are in great demand, as are all toys that offer physical or mental exercises to disabled children. Other aids for the deaf include visual feedback systems, which can give a c.r.t. display of received sound, especially speech.

It should be noted that most electrical and electronic devices overcome disabilities of 'normal' people. Our voices can only propagate a certain distance. To extend the range we need to amplify it or to carry it through wires. Machines supply the strength we lack or can carry us at speeds we cannot run. Various optical devices enable us to see further or observe things that we cannot see. Calculators are useful when we run out of fingers to count on and computer memories can store vast quantities of data which may be recalled and manipulated in ways beyond the scope of human brains. Aids for the disabled are really just extensions of the same techniques; they enable the handicapped to do things that they otherwise cannot do.

The competition is very straightforward. All you need to do is fill in and send us the entry form which just indicates that you are interested in taking part. The form must be returned before June 30th. The actual design must be submitted to the Editor by 1st October, 1983. An entry must include a statement of the design objectives; an overall description of the device; detailed circuit description and diagrams; a model of the device or that unique part of it which demonstrates its operation and feasibility. The judges will be a group of eminent engineers and doctors and they will be looking for originality and benefit to the handicapped; the potential for production; elegance or engineering design; the electronic content; design reliability and freedom from excessive maintenance; simplicity of operation and the safety of the device. They are also looking for a specifically electronic device so a software package will not be acceptable, although software may be necessary to operate the hardware and should be included if this applies. The competition will be coordinated from the *Wireless World* editorial office and we are planning to include progress reports on the projects in these columns.

Useful contacts may be found through local council offices or libraries who can put you in touch with disabled peoples centres or homes. REMAP, Engineering Help for the Disabled, has 90 branches throughout the UK. Their headquarters are at 25 Mortimer Street, London W1N 8AB. They have a large panel of engineers who are working for the disabled and are willing to offer help and advice.

It should be noted that aids for the handicapped need a fundamental approach to tackling a problem and that devices can be produced which are not only helpful for the disabled but may improve ergonomically facilities for us all. Please enter the competition. You may produce a device which is of great help to many people.

A full list of the rules and an application form are included in our advertisement on page 108.

In praise of software

H. D. Baecker

Like the old "nature vs nurture" controversy it is always fun to return to "software vs hardware". Professor Zissos would have us beware of systems swaddled in software (or some such phrase), and whilst it is all too true that the software overhead on many systems is intolerable it does not follow that junking that software will improve matters. In practice this term "software" covers two rather distinct sets of tools, programming languages and operating systems, and it is as well to consider them separately. We'll start with programming languages.

The pristine argument against the use of high-level programming languages is that a skilled machine code programmer using the native instruction set of a computer can write a program that is significantly more efficient (in terms of execution time or storage occupancy or both) than will be generated as object code by a high-level language compiler. The assertion is doubtless true. Unfortunately its utility depends on the availability of "skilled machine code programmers". Such scant evidence as we have suggests that only 25% of those who call themselves so skilled can in fact do better than a compiler. In addition, the demand for programmers is increasing at about 50% annually, whilst the supply is increasing by only 18% annually. That increased supply, is, too, at the novice, unskilled, end of the spectrum of expertise.

So the systems designer and implementor who chosses to rely on machine coding of the applications package just faces the hurdle of hiring adequately skilled programming staff. And then, in a sellers' market, of retaining them.

The immediate advantage of choosing a high level language such as Pascal or Fortran for applications programming is that the implementor has a choice from a much larger pool of skills. It just is a fact of life that the number of good Pascal programmers on the market is much greater than that of machine code programmers. And they are not such prima donnas either!

But a number of other advantages accrue fromt he use of a high level language. If partway through the production run it is economic to replace the microprocessor chip by another then the software does not have to be rewritten but only recompiled. As staff changes it is necessary for newcomers to familiarize themselves with the existing applications programs so as to be able to maintain and modify them. This is much easier and quicker if these programs are written in a high level language, because programs written in a high level language are a little more self-documenting. Also, they neither depend on the local features of a particular chip nor on a particular programmer's quirks in laying out data structures, etc.

The penalty of using a high level language then will be a slower executing program and usually a more extensive object program requiring more rom to accommodate it. Should execution time be critical it is usually passable to substitute a faster microprocessor chip, at extra cost. The relevant question is whether, over the total lifetime of the system, the initial cost of a faster microprocessor and of added rom exceeds the savings gained from the use of a high level programming language. Remember, programmers expect regular salary increases, chips don't.

Should it be the case that the system under consideration is already employung the fastest technology available then it will be necessary to stick with machine coded programs. It is precisely those users stuck with this need who will be most predatory on the market for skilled machine code programmers and will determine the costs incurred by others. It would therefore be prudent to rely on alternative programming talent.

It is true that you will find some extremely gifted programmers in academic or civil service posts where the salaries are significantly below market norm, so clearly salary is not the only determinant in attracting and holding talent. Further investigation will show that the freedom to experiment in these positions is the attraction, situation that cannot prevail in the successful completion of economic application packages. Under conditions of politically imposed "wages freeze" one can predict that talent will migrate to academic, etc., from the marketplace.

Now to the question of operating systems. As long as a given processor is executing only a single process or task the whole time the presence or absence of an operating system can be a matter of taste. The moment two or more processes share the processor an operating system is mandatory in order to schedule access to processor resources by the processes and to protect the processes from mutual interference. The question of whether or not to employ an operating system is then empty, the question becomes whether to use the vendor's standard operating system, or whether to turn to an off-the-shelf product available from some software house for that microprocessor, or whether to write one's own system.

The usual objection to a vendor's operating system is that it is too rich, too extensive, for the needs of the present project. This may be so, but it is usually possible to generate a local version of the system that includes only those facilities needed locally. Indeed, this freedom may be an important factor in choosing a particular microprocessor. Software house operating systems often have the advantage that compatible versions are available for several ranges of microprocessors, making processor substitution easier. The supposed advantage of writing one's own operating system, that it will contain nothing but the bare bones required for the job and so will interpose no unnecessary overhead, is illusory. Six months hence the next upgrade of the microprocessor system will demand a new function of the operating system, and since the private operating system was so specifically designed to eliminate overhead there will be no hooks to hang the new function from.

Implementation and installation decisions in computing are rarely made solely on the basis of technical merit. Computers are tools, and other concerns of the tool users have to be satisfied. There is no doubt that the world's most widely sold computer architecture is not the world's most efficient or powerful or elegant. But its original vendor was deemed financially secure enough to proffer the support needed by customers. In implementing a microprocessor based system it may be that doubling the hardware cost of the basic system may have a negligible effect on the sale price, that software and engineering support costs are far more significant. If this is the case, and if the costs of seniors and actuators are fixed, then minimizing the initial and ongoing software costs may be the most practical way to economize.

Such a turn of events should come as no surprise. The most successful, the most reliable, technological system we have, one we take obsolutely for granted most of the time, is the worldwide telephone system. Its success and reliability depend not on local innovativeness but on slavish standardization. We are a bare 32 years beyond the commissioning of the first general purpose electronic digital computers, and it may seem premature to throttle development by adopting standardized tools, such as existing high level languages or operating systems.

H. D. Baecker is in the dept of computer science, University of Calgary, Canada.

IBM Selectric to TRS80 interface

Along with an assembly language program which is kept in high memory, this interface is all that is needed to have letter-quality printing. As the printer uses typing elements that can easily be changed, what more could a computerist want? Speed? Not so fast, it prints at 60 words a minute, but oh what print, says Tony Scarpelli.

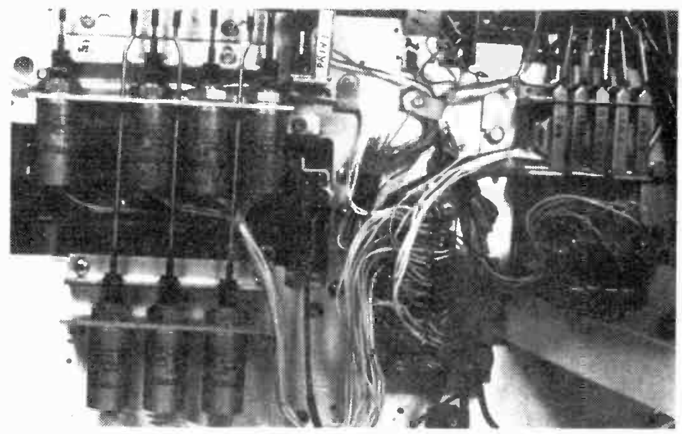
by Anthony T. Scarpelli

Brian Bateman has already shown how to interface a TRS80 computer to a five-level teletype. His article* inspired me to design and build my own interface that uses relatively inexpensive hardware and even cheaper software to drive an IBM Selectric I/O printer. If less than $500, which includes the printer, turns you on then read on.

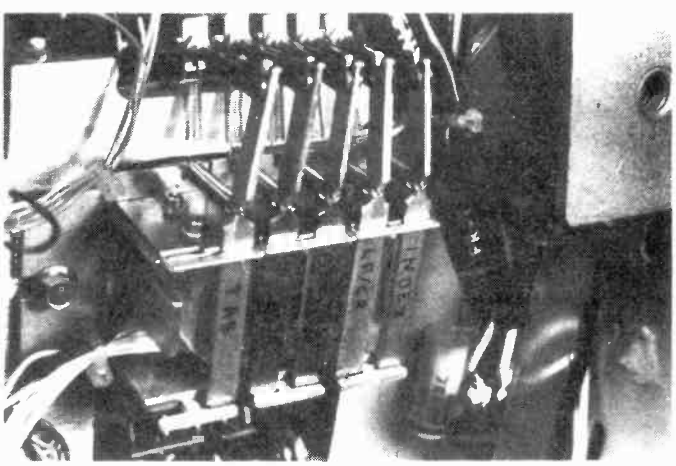
I was in the market for a printer. I had to choose a unit that was either dot matrix or letter-quality. As I was into writing articles, I decided on high quality printing; but, a new letter-quality printer can run into the couple of thousands of dollars. Then an ad from CFR Associates of Newton, NH caught my eye, who were selling used IBM Selectric I/O printers for $395. That was inspiring, and I ran down there and picked a unit up that was taken out of a Wang word-processing system.

These printers contain the driver solenoids that select the various characters and do the other normal functions such as spacing and printing. The unit was in great shape and probably still had a few more thousands of miles of printing left in it, and only a few minor adjustments got it printing excellently. A call to my local IBM representative got me an account and the ability to get manuals and parts with no hassle; and with great speed. A list at the end of the article gives the numbers of the manual and tools needed to do any type of

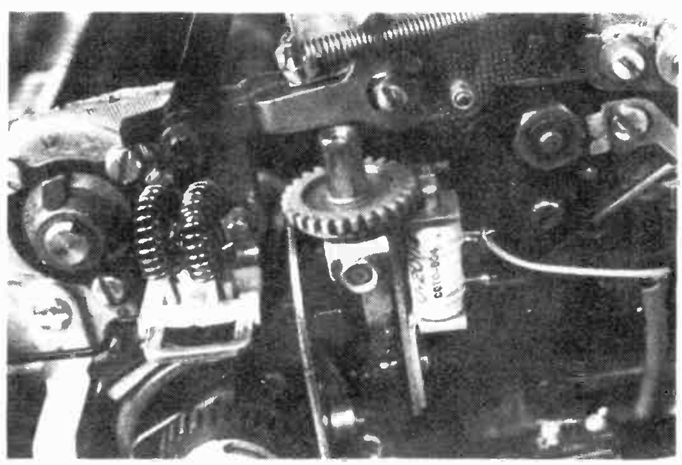
1. Originally from a Wang word processor system and ending up as a surplus bargain, this IBM Selectric I/O printer can be used as a letter quality printer in a computer system. Though it can be used as a keyboard as well as a standard typewriter, in this application it is strictly an output device.



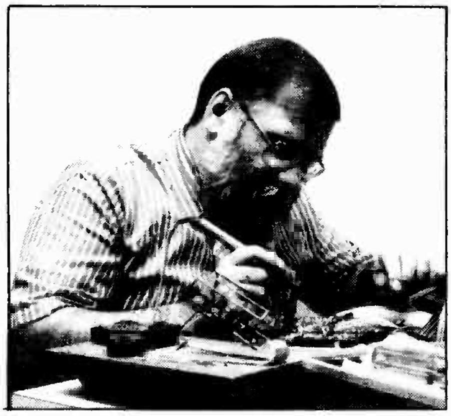
2. Character-select solenoids determine which character is to be printed and are held-in as the print solenoid is energized. Function solenoids are on the right. Tab and back space are not used in this application, but could easily be put into service.



3. Not much power is needed to drive the function solenoids, and during initial testing they can be manipulated by hand.



4. Carriage movement detector coil detects pulses from the gear which rotates as long as the carriage moves. Pulses are amplified and integrated to produce a signal used by the computer to detect this movement.



Tony Scarpelli is senior biomedical electronics technician at the Maine Medical Center in Portland, Maine, the largest hospital in the largest city in the state. He collaborates with other hospital departments in the design of various electronic projects, such as interfaces that connect computers to various types of medical equipment, and is presently working on a computerized environmental control unit for quadraplegic patients.
His electronic career started at the age of three when his father introduced him to a crystal radio. Most of his work has been in medical electronics, repair, and research. He has gone from valves, through transistors and integrated circuits, and has finally landed in the world of computers. He has published computer programs, reviews, and other material in a number of American journals. Fluent in Z80, 8080, and 6502 assembly languages, as well as Basic, Forth, and Mumps, he edits a computer club newsletter, Byte Babble, and spends most of his free time at the keyboard writing programs, articles, and learning new computer languages. He feels that people have only just begun to touch on the computers potential, and its use as a mind amplifier is still to be fully realized.

adjustment on these IBM machines. The manual is essential for an understanding of this very complicated mechanism, and for any troubleshooting in case of malfunction.

With the machine working, and with the circuit supplied with the unit, I started on the design of the hardware circuits to drive the solenoids. I am a simple person so I decided to make the circuit as simple as possible so that even I would be able to understand it. I also wanted to make it from parts from my local Radio Shack† store so that I wouldn't have to wait six weeks just to get an i.c. If you have the parts on hand, or have a less expensive outlet for the parts, by all means go that route if you wish. I just happen to have a store in town.

The printer has six character-select solenoids, and five other function solenoids that would have to be driven by the computer. I decided that each of the function solonoids would get an output port. The printer also has a carriage-movement detector which would also get a port. I use this detector to speed up the printing by holding up the program during carriage returns. When the carriage returns from a great distance, you don't want any printing going on, but when it has to return from a short distance, you don't want to wait for a timing loop to finish.

When you want to have your computer talk to the outside world, the first thing you have to decide is whether you want to use ports or use a memory-mapped system. If you go memory mapped, that is the computer thinks anything external is just part of its memory, you have to deal with 16 address lines. Because this wasn't necessary and would only add complexity and expense to the system, I decided on ports which only use eight address lines. There are 255 ports available with these eight addresses, and as no. 255 is already used by the TRS80, and no. 254 is used by my speed-up circuit, I used numbers 247 to 253. These are easy to decode as we shall see in a minute.

The next consideration as far as the outside world is concerned is that all address lines and data lines have to be buffered. This does two things: it helps protect the output of the computer, and it gives the output more drive capability. Fig. 1 shows all the buffered lines that are used in my interface. Notice that the designation OUT*, for example, is how Radio Shack indicates an active low signal – it is easier to type than the normal way, you can see. Other than the eight address lines and eight data lines, only OUT*, which indicates something is going out of a port, IN*, which indicates something is coming in, and SYSRES*, which is the system reset, are the only computer-generated signals needed.

Fig. 2 shows the first port I designed and will be used as the example of how all the ports work, and also how you can go about getting your own computer to touch the outside world. First give the port a number, in this case 253, or FD in hexadecimal and 1111 1101 in binary. I called it the space port as it will drive the space solenoid. It is decoded with an eight-input nand gate: when all its inputs go high the output goes low. As line A1 is the only low line, we can make it high by going through an inverter so that only when the address FD is on the address bus will the output of the gate go low. In the assembly language program, the instruction OUT (C), A causes data in the A register to be put onto the data bus just after the address in the C register is put onto the address bus, while

*Using five-level teleprinters with a TRS80; by Brian Bateman, *Microcomputing*, Jan, 1980.
†Tandy in the UK.

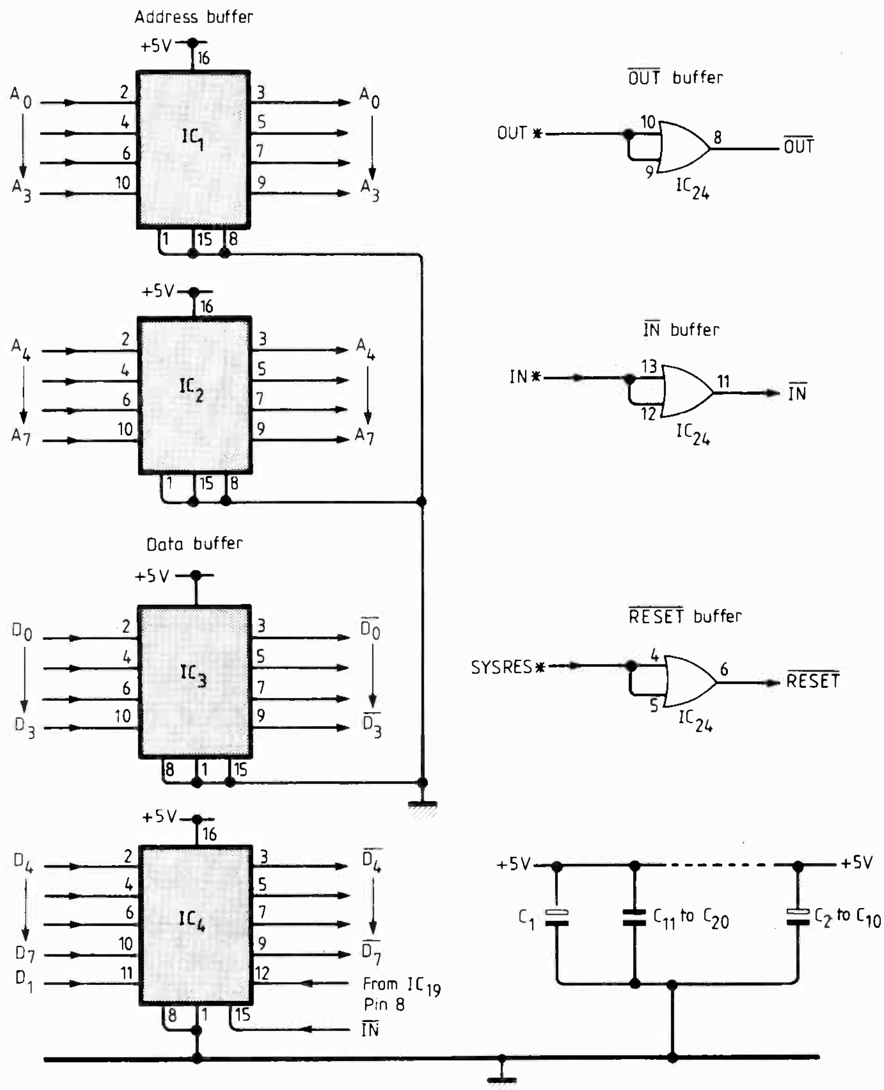
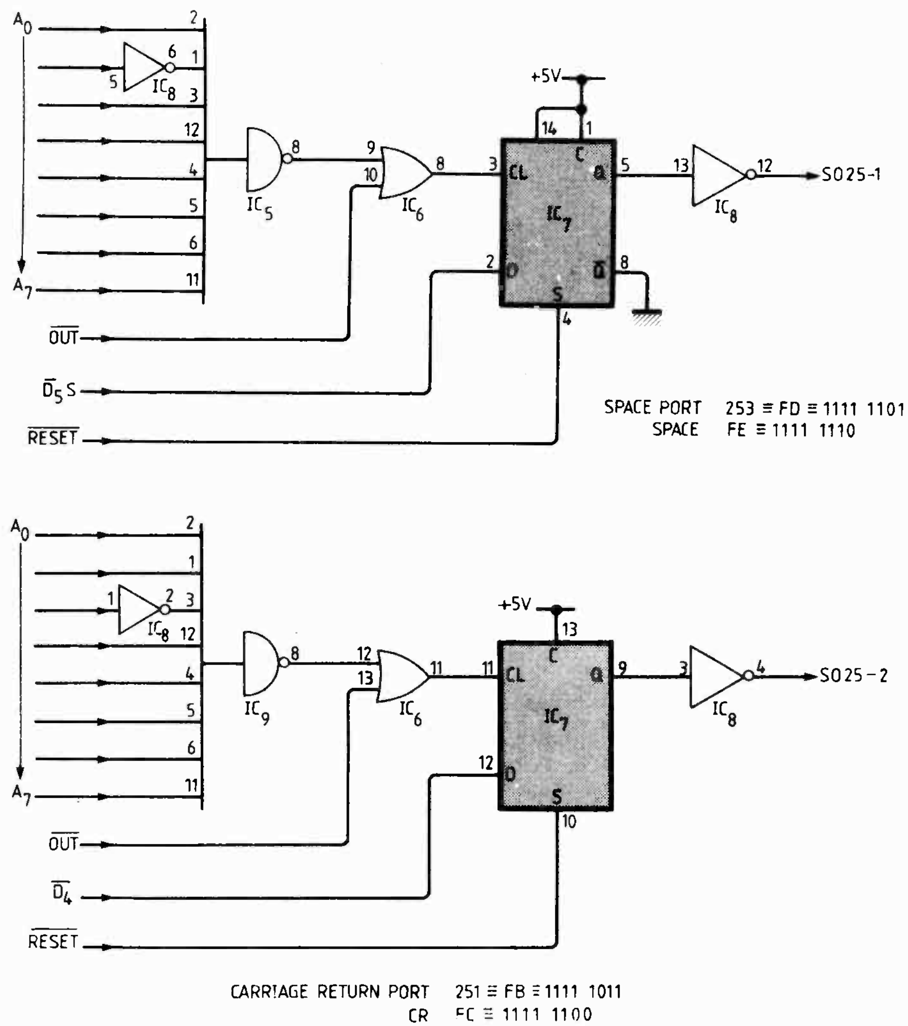
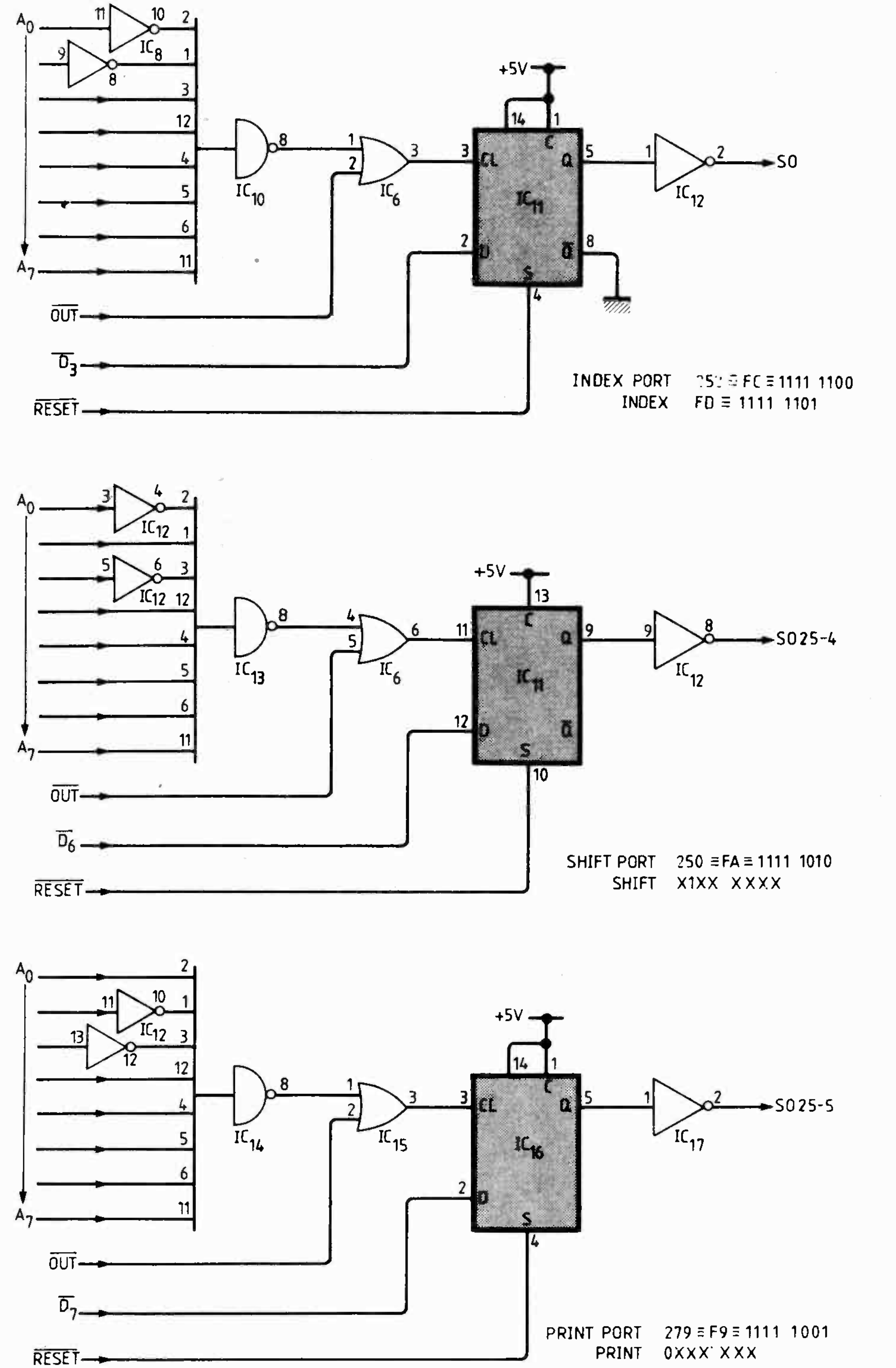


Fig. 1. *Buffer i.cs interface the expansion port of the TRS80 to the printer driver circuits. They increase the drive output from the computer and help keep any problems occuring in the driver from reaching the computer. Also shown are the bank of capacitors distributed around the board for filtering and de-spiking, a necessity for t.t.l. integrated circuits.*





Figs 2-6. *Space port decoding, circuit Fig. 2 top left, drives the space solenoid. Eight address lines along with the OUT* signal give a specific port address. Low signal on the single data line is passed to the output when the port is addressed. Carriage return port decoding circuit Fig. 3, bottom left, drives solenoid that produces a carriage return. Index port decoding circuit Fig. 4, top right, drives index or line feed solenoid. Shift port circuit Fig. 5, centre right, is configured to decode signals to drive the shift solenoid for upper case. Print port circuit Fig. 6, right, decodes the signal to drive the print solenoid.*

at the same time the OUT* line goes low. In Fig. 2, a space was given the hex number, FE, which is 1111 1110 in binary, of which bit five is 1. FE is the data in the A register so what happens is this: when that instruction is encountered, first the address FD in the C register goes out on the address bus. So the output of the eight-input gate goes low. Then the data FE in the A register goes out on the data bus, and we pick up D5* (bit 5) which has been inverted by IC_4 and present it to the D input of a D flip-flop, as you can see from Fig. 1. (There was no real reason to use bit 5; I just needed a 1 here.) Then the OUT* line goes low, and as this line is connected to one input of an or-gate and the output of the eight-input gate is connected to the other the output of this or-gate goes low. Now the 74LS74 flip-flop transfers any level on its D input to its Q output when its clock input goes from low to high. So after a short time the instruction is finished and the OUT* line goes back high and thus causes the or-gate to go back high and the 0 on the D input gets put onto the input of the inverter just before all the data disappears. So that little bit of data has been saved or latched by the D flip-flop and can now be used to good purpose: to cause the output of the inverter to go high, which thus turns the driver transistor on and pulls in the space solenoid. Of course, if the solenoid stayed pulled in, all we would get would be spaces, so the assembly language program has some timing to do and also some unlatching, but we'll get to that shortly.

This is about the simplest way for your computer to communicate with the outside world in a structured way. Fig. 3 to 6 are similar except for the address decoding and the input and output connections. Fig. 7 shows the character port and is very similar to the others but has six data inputs and will drive all the character select solenoids at the same time. One of the questions I had about driving transistors was whether these latches could drive a power transistor directly. The fan out for these 74LS175s is the same as an inverter, and I haven't had any drive problems at all. Fig. 8 is the carriage movement port. When this port is addressed, and the output of the carriage movement detector is low, and the IN* line is low, a high is sent out on D1, thus nothing happens. However when the carriage is moving, a low goes out on D1, which is detected by the program, and

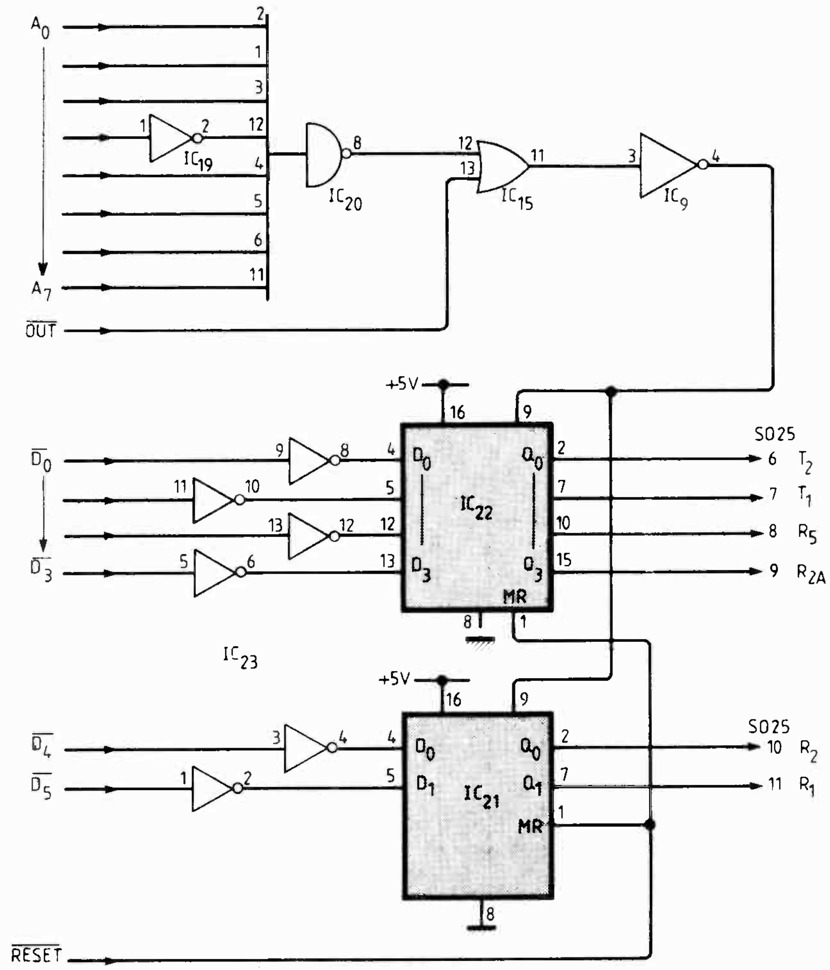


***Fig. 7.** Character port circuit accepts more than one data line. The seven address lines are decoded for port number F7H. When this port is addressed, the signals on the six data lines are sent to the character driver solenoids. A six level or correspondence code is used to determine the character to be printed.*

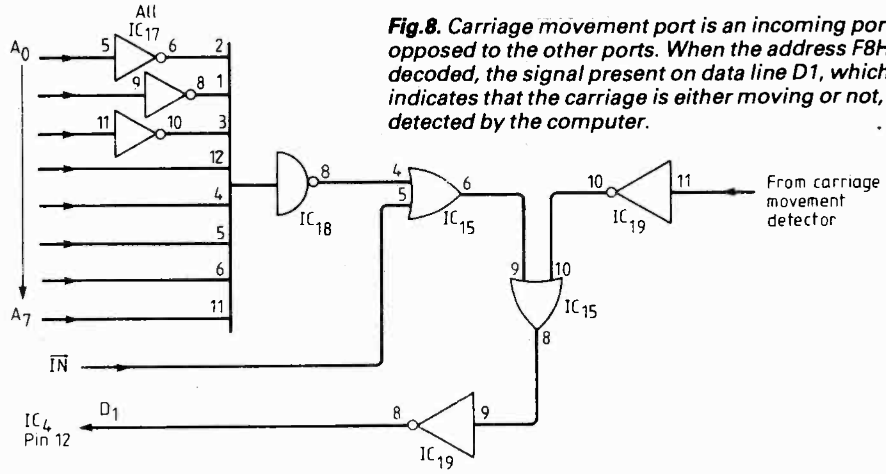


***Fig. 8.** Carriage movement port is an incoming port as opposed to the other ports. When the address F8H is decoded, the signal present on data line D1, which indicates that the carriage is either moving or not, is detected by the computer.*

Parts list
IC1, 2 74LS367 hex 3-state buffer
IC3, 24 74LS368 hex 3-input inverter buffer
IC4, 6, 15 74LS32 quad 2-input or-gate
IC8, 12, 17 19 23 74LS04 hex inverter
IC5, 9, 10, 13, 14, 18, 20 74LS30 8-input nand-gate
IC7, 11, 16 74LS74 dual D-type flip-flop
IC21, 22 74LS175 quad D flip-flop
IC25 LM3900 quad Norton op-amp
Tr_1 to Tr_{11} n-p-n transistor (RS2018)
R1 R11 100Ω
R12, 14, 17, 22 10kΩ
R13 47kΩ
R16 150kΩ
R18, 19, 20 1MΩ
R21 12kΩ
R15 330Ω
R23 100kΩp.c.b. control
C1-10 10μF 35V electrolytic
C11-29 50nF ceramic
C30, 31 4.7μF 35V electrolytic
C32 10nF ceramic
SO1-19 14-pin wire-wrap sockets
SO20-27, 16-pin wire-wrap sockets
SO28 22-pin dual edge-card socket
Experimental p.c. board
16-pin DIP jumper cable
4×8½ in i.c. perforated board
TRS80 edge connector
IBM parts list
Selectric I/O typewriter, model 745
Service manual, no241-5737-0 ($9.40)
Adjustment parts manual, no.241-59990-0 ($4.10)
Parts No./Price list, Form No.S241-51558-4 ($0.55)
Cycle tool, part no.9900427 ($0.60)
Gauge, part no.9900575 ($11.50)
Typing element ANSI-OCR-B, part no.1167185 ($18)

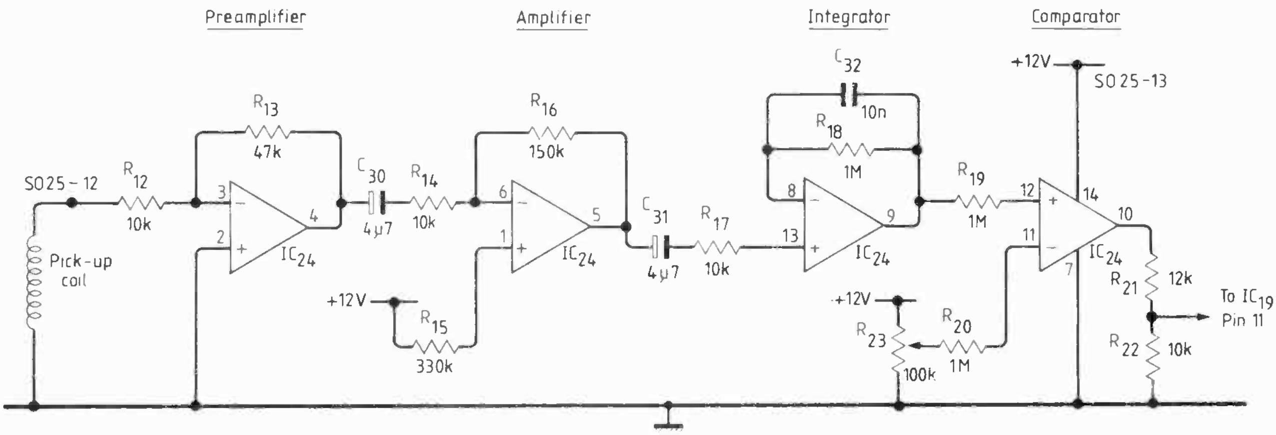


Fig.9. Carriage movement detector circuit produces a high or low level depending on whether the carriage is moving or not. See text for explanation of its operation.

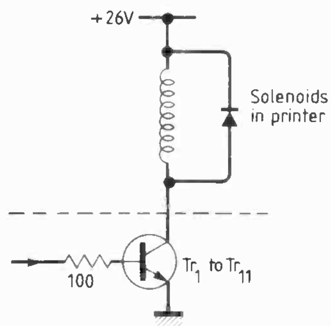
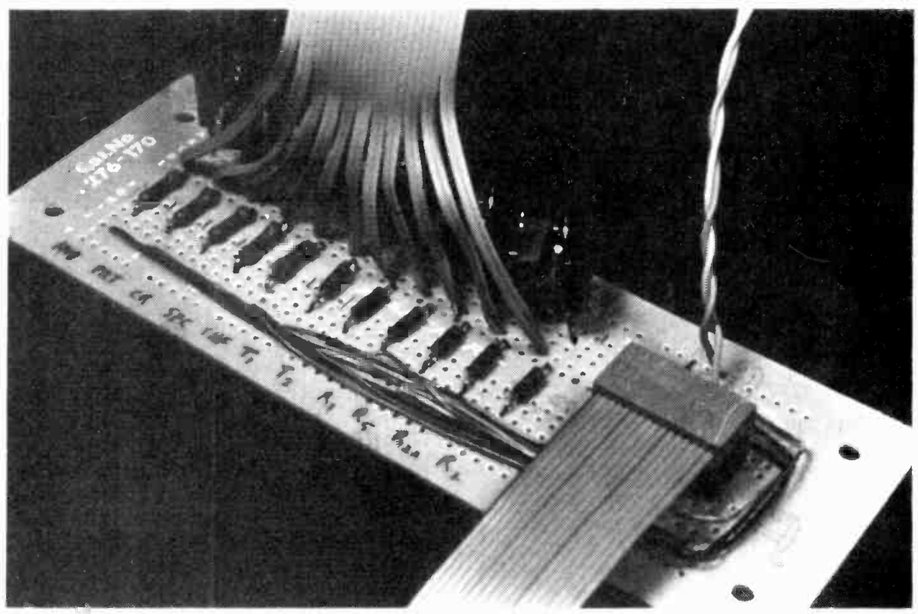
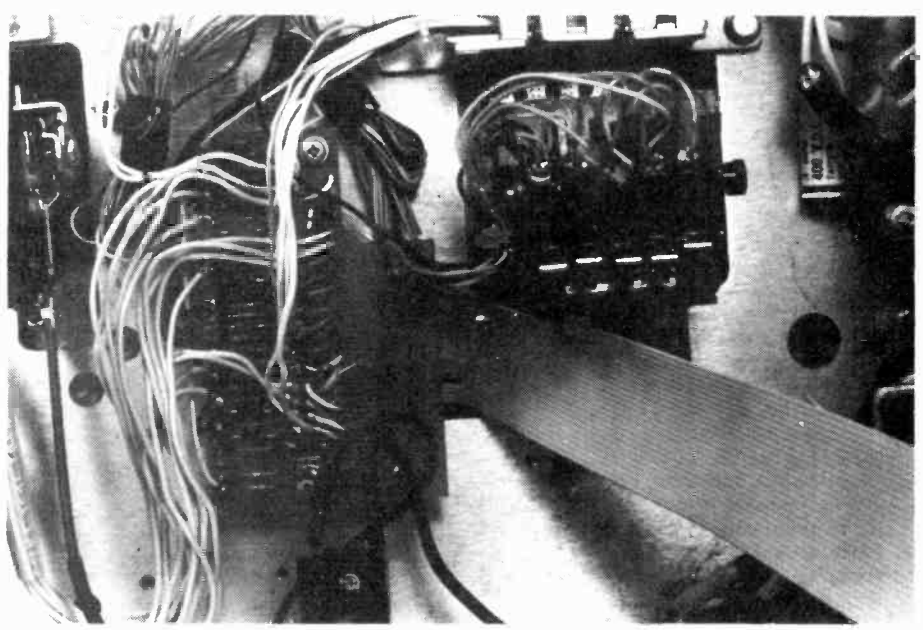


Fig. 10. Each of the eleven solenoids are driven by this transistor driver.



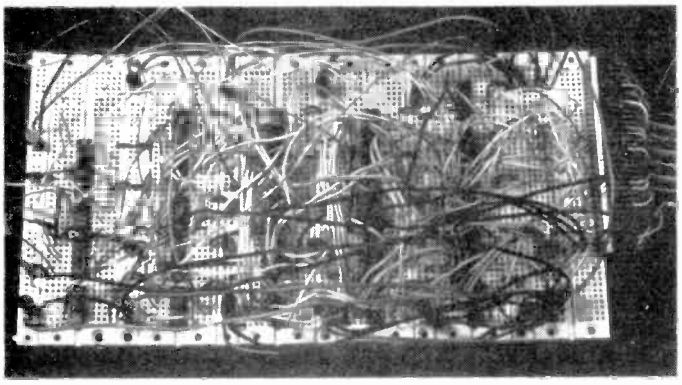
5. In the driver transistor board the ribbon cable going off toward the top goes to the diode board in the printer, the other ribbon cable to the interface board. The twisted pair is for power.



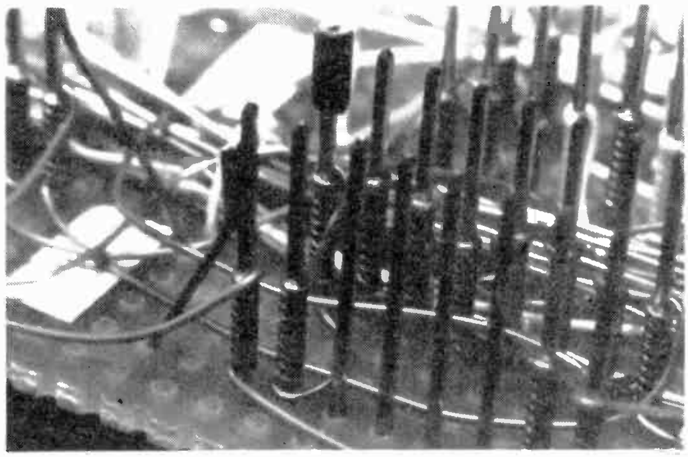
6. Diode board inside the printer already had diodes connected across the solenoids, and this saved installing them on the driver board. If this board is missing on your unit, you must install diodes across the solenoides to protect the transistors.

Table 1. Computer to interface cable

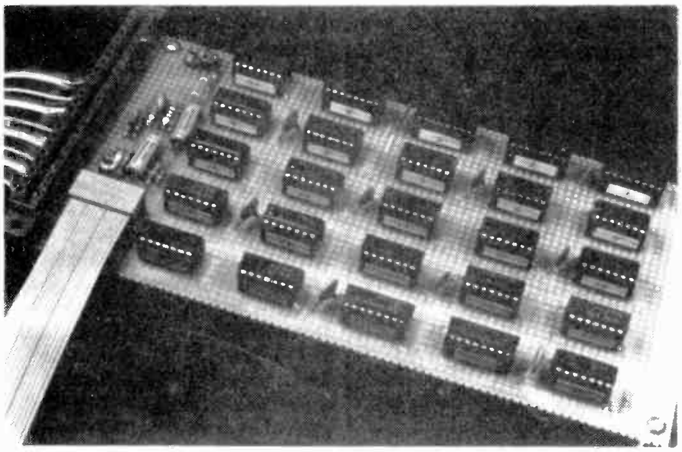
RS-PIN	Signal	44-pin
1	RAS*	1
2	SYSRES*	A
3	CAS*	2
4	A10	B
5	A12	3
6	A13	C
7	A15	4
8	GND	D
9	A11	5
10	A14	E
11	A8	6
12	OUT*	F
13	WR*	7
14	INTAK*	H
15	RD*	8
16	MUX	J
17	A9	9
18	D4	K
19	IN*	10
20	D7	L
21	INT*	11
22	D1	M
23	TEST*	12
24	D6	N
25	A0	13
26	D3	P
27	A1	14
28	D5	R
29	GND	15
30	D0	S
31	A4	16
32	D2	T
33	WAIT*	17
34	A3	U
35	A5	18
36	A7	V
37	GND	19
38	A6	W
39	+5v	20
40	A2	X



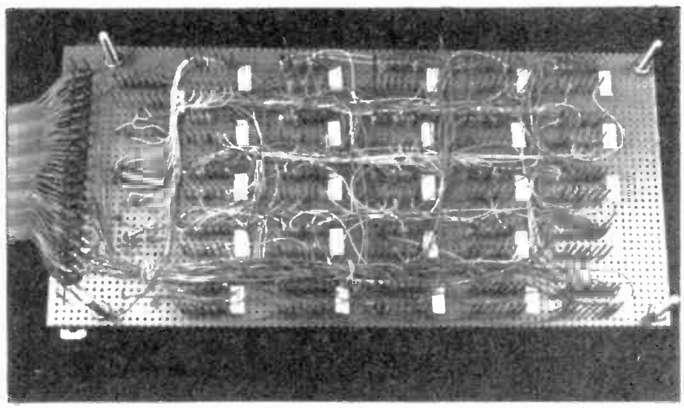
7. This shot shows the orginal breadboard during the design stage of the interface. If the circuit works like this, it will definately work when it's neat!



9. Wirewrapping method is good to use when doing a one-off board using a lot of i.cs. I used wire that doesn't need to be stripped first: the process of wrapping cuts the insulation.



8. This is what the completed interface board looks like. All the i.cs are numbered, and there is a connector available for future expansion. The ribbon cable coming off the bottom goes to the driver transistor board, and the other goes to the computer.



10. This is what the bottom of the completed wirewrapped board looks like. All the i.cs are numbered, and four different coloured wires are used, blue for ground, red for +V and white and yellow for the signals.

Photographs: Anthony and Bonnie Scarpelli

causes a delay loop to hold up the program. We'll get into the program shortly to see how this works exactly.

The carriage movement detector, Fig. 9, is one i.c. long, using a quad LM3900 op-amp. The detector coil is connected to an amplifier that picks up the small sine wave produced by the gear which revolves whenever the carriage is in motion. A second amplifier produces a square wave which then goes into an integrator and gives a d.c. level output. This level is detected by a comparator to produce a t.t.l.-level output to the input of an inverter. A small potentiometer on the negative input of the comparator adjusts the trigger level. If you don't have a small control, two fixed resistors can be used after you have found the right ratio.

The only hardware left to discuss are the driver transistors. Fig. 10 shows what is in the printer, and also how the driver transistor is connected into the system. A 25V transformer, rectifier, and capacitor is all that is needed to power the solenoids. The driver transistor board is simple to consttuct, and hs a connector on it that goes to the interface board. Plus 12 volts goes to this board for the carriage movement detector. The ribbon cable goes out to a connector, which then goes to the diode board in the printer. This diode board, photo 6, has all the wiring that goes to the solenoids, and my ribbon cable goes directly to it. The +25V supply which is more like 35V out of the unloaded power supply, is also connected to this board.

Interface board construction

Transistor-transistor logic is very noisy to work with and the kind of construction used in my original blendboard, Fig. 1 doesn't help. Cute, and all we need is a little tomato sauce. But if you can get it to work like this, you have a better chance of it working in the final version. Although I installed a number of capacitors on my semi-final version, I had to put on a whole bunch more so that practically every i.c. had a 50nF connected to its power connections, plus some 10μF on each power bus. I probably overdid it, but it is a very quiet board now, and all wirewrapped. The sockets were stuck on the board with hot-met glue and all numbered, both on the sockets themselves, and on the bottom of the board. All pin 1s were given a small piece of wire insulation for identification. This is very helpful when wirewrapping during those late and wee hours of the morning. I wirewrapped with the OK tool that eliminates stripping the wire, and really speeds up the process, photo 9. You can only wrap two levels due to the height of the recommended eight wraps. But this is sufficient, and the redundancy increases the reliability of the wrap; I have yet to find a bad wrap after hundreds of pins.

The board as shown in photo 8 shows the completed interface. It holds 25 sockets and the motion-detector components. The cable from the computer is soldered to a 44pin connector with wirewrap pins (see Table). The cable is the only component that I didn't get from Radio Shack, but can be purchased from Hobby World, (see parts list). I used the 44-pin connector because they are easy to get, and also this will allow me to add various peripherals and more memory to the system by building a motherboard and connecting it to this single connector. You can see in photo 10 bottom of the completed board, a little more organized, but it still could use some sauce.

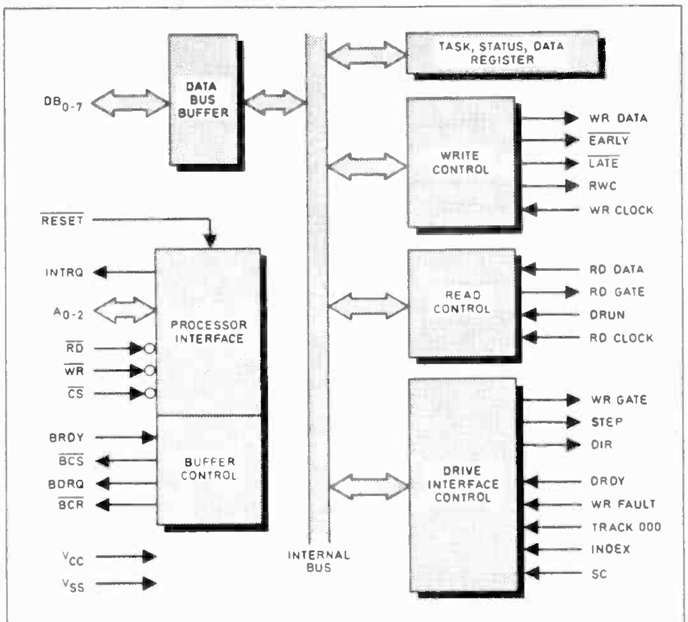
To be continued with assembly language program.

NEW PRODUCTS

WINCHESTER DISC CONTROLLER

Designed for many of the popular Winchester interfaces, the Intel 82062 controller translates parallel data from a microprocessor to a 5Mbit/s m.f.m. encoded serial bit stream. It also provides the drive control logic and control signals, and integrates much of the logic needed to implement a Winchester disc control subsystem.

The 82062 is controlled by the host c.p.u. with six high-level commands: Restore, Seek, Read Sector, Write sector, Scan i.d. and Write format. It can transfer multiple sectors and operates in 128, 256, 512, and 1024-byte sector lengths. It has a 7-byte sector length extension for external error correction. All this is housed in a standard 40-pin d.i.p. and operates from a single 5V power supply. MEDL Distribution, East Lane, Wembley, Middlesex HA9 7PP. **WW301**



WINCHESTER DISK CONTROLLER SCHEMATIC

WW301

CAESIUM FREQUENCY STANDARD

Accuracy of 3 in 10^{11} is claimed for the FE-5440 caesium beam primary frequency standard. It uses a comparison-and-control system in which a caesium transition frequency (9.19 . . . GHz) is used to stabilize the output frequency of a voltage controlled quartz crystal oscillator of 14.59 . . . GHz. The synthesizer permits instantaneous setting of frequency to within 2×10^{-12}. Rugged construction ensures that it meets military standards for reliability, test, construction and r.f.i, and the modular approach means that any module may be changed within 15 minutes. The caesium beam tube lasts for at least three years.

The instrument is also provided with a time clock to give hours, minutes and seconds with seconds and minutes pulses which may be output to drive external clocks. Other putputs are standard and sinusoidal frequencies of 5MHz and 1MHz and a square-wave output of 3MHz. Wessex Electronics Ltd, 114-116 North Street, Downend, Bristol BS16 5SE. **WW302**

SOLDER FUME EXTRACTOR

Solder fumes can cause respiratory problems so it is important that they should be kept away from the faces of those people who are continually using soldering irons. The Adcola Polysorb MK2 incorporates twin variable-speed fans to draw the fumes away from an operator and pass them through an active charcoal filter. As a bonus the unit also provides a controllable light and an output socket for power, either 240 or 24V.

The unit is metal with steel support poles to attach it to the bench. It runs on a.c. mains rated at 240V. Adcola Products Ltd, Adcola House, Gauden Road, London SW4 6LH. **WW303**

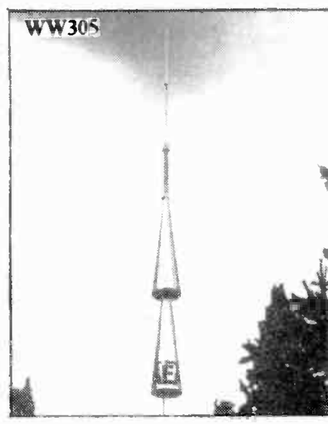
MANUALS PREPARED

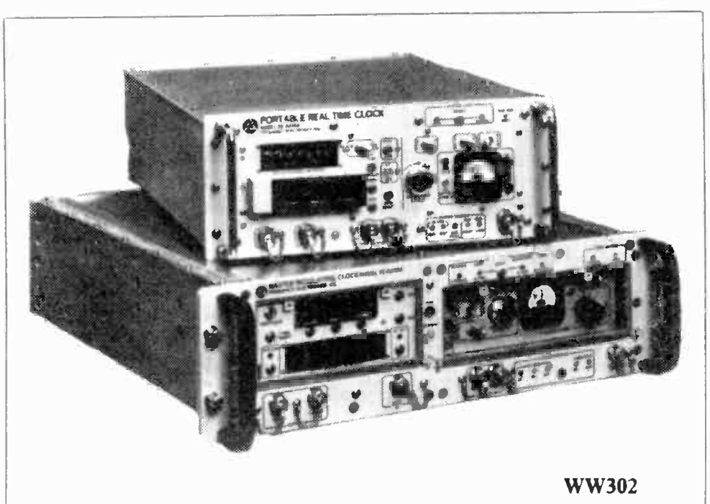
Having a good product to market isn't necessarily the end of the road. Presentation is also important and this includes technical literature and manuals. Woodcote Technical Services specialize in the production of technical manuals for the instruction and training of machine operators and fitters. Their service includes technical illustrations, sales literature and other literature for mechanical, electrical and electronic equipment.

Woodcote aims to provide the end user with a full appreciation and understanding of the often very complex equipment he has just purchased. To do this it is necessary to improve the effectiveness of the information required rather than merely recording it. Good illustrations should be supported by a minimum of clear, concise text, a principle that is often ignored in technical manuals, Woodcote Technical Services, Bramshott House, 139 High Street, Epsom, Surrey KT19 8EQ. **WW304**

DECOUPLED ANTENNAE

A radiation pattern that is absolutely horizontal and not 10-15° above the horizon is claimed for the AEA Isopole omnidirectional antennae which are used in the 2m and 70cm bands. The reason for this achievement is the feed line decoupling system with cones that prevent any radiation from the feed line. This means that distant f.m. transmitters and repeaters can be reached which would otherwise require a very large vertical omnidirectional or a beam antenna. Two models are available: the


WW305


WW302


WW303

Isopole 144 and the Isopole 440 which cost £32.50 and £49.00 respectively, including v.a.t. ICS Electronics Ltd, PO Box 2, Arundel, West Sussex BN18 0NX.

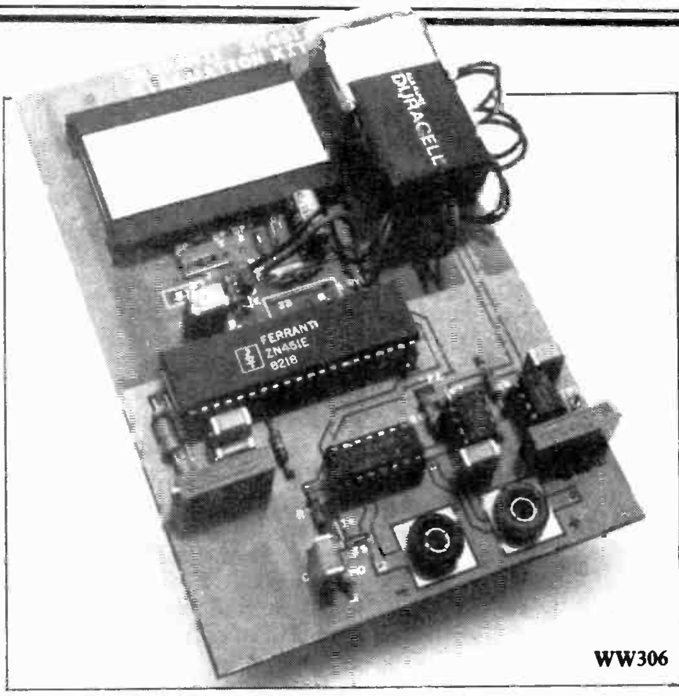
WW305

DVM EVALUATION KIT

To permit prospective customers to evaluate the capabilities of the ZN451 digital voltmeter, Ferranti have produced an evaluation kit.

The monolithic d.v.m. has a facility whereby external components may be included into the auto zero loop; output signals are provided to control external auto zero switches so that op.amps or other signal conditioning circuits can be included in the loop to boost input impedance or improve sensitivity down to 1.999mV full scale. The kit and further details are available from Ferranti Electronics Ltd, Fields New Road, Chadderton, Oldham, Lancs OL9 8NP.

WW306



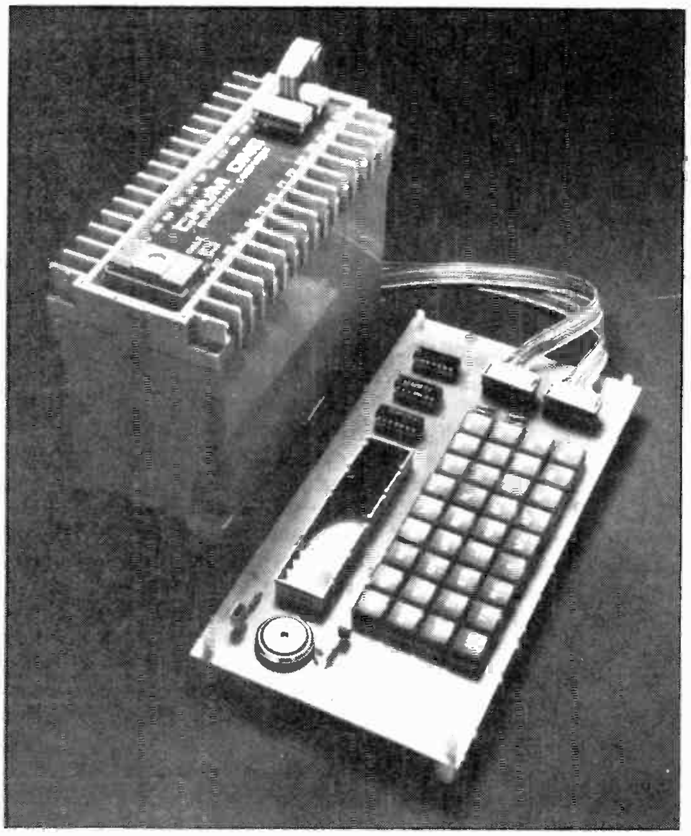
WW306

COMPUTER CONTROL FOR £170

Chum One comes with its own operating system, keyboard and alphanumeric one-line display. It may be programmed in Basic or in Z80 machine code to provide machine control or data logging and it may be used in education.

The standard unit consists of four analogue inputs, one analogue output, 16 programmable digital inputs/outputs, four programmable timers/counters, a serial digital input and a serial digital output. Up to 6K of non-volatile ram is provided and the function of the computer can be altered instantly by inserting a programmed eprom into the external top socket. Programs and data can be loaded or saved on cassette tape through the serial input/output. Warwick Design Group, 12 St George's Road, Leamington Spa, Warwicks CV31 3AY.

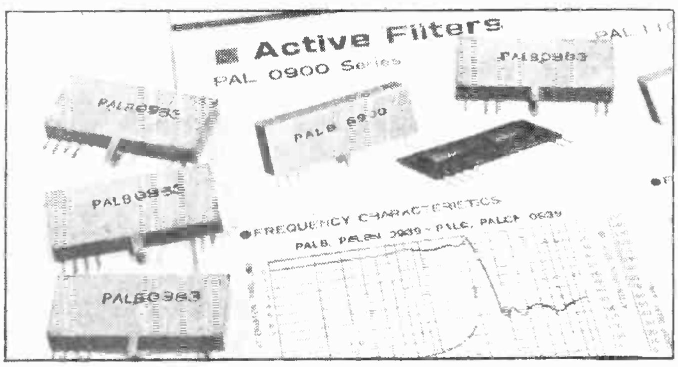
WW307



THICK-FILM LOW PASS FILTERS

A range of audio-band low-pass filters have been designed by Toko for use with digital audio equipment. The PAL0900 series are all 20kHz active filters which are intended to optimise the phase response from p.c.m. coded digital audio discs. They are available with a variety of terminating impedances and with stopband attenuations up to −95dB. Ambit International, 200 North Service Road, Brentwood, Essex CM14 4SG.

WW308



GRAPHICS GENERATORS

Designed to be adapted to almost any 8 or 16-bit microprocessor the GVP (for Graphics Video Processor) 65 is a single board circuit which can generate a 512×512 pixels display interlaced or 256×256 non-interlaced. It can plot at up to 1,500,000 dots/s, can generate ASCII character which may be tilted or changed in size and pictures may be coloured using 4,913 pre-programmed colour patterns. The commands include pen/eraser selection, pen/eraser up or down, clear screen, light pen handling instructions, memory access and writing, block drawing in different sizes, vector drawing, colour and intensity selection, colour mapping, mixing and removing, characters or figures may flash on and off and there are synchronizing and configuration commands.

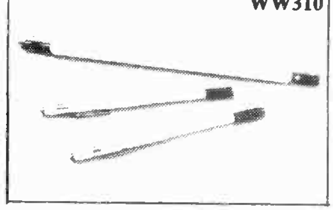
GVP 65 generates t.t.l. compatible RGB, B/W and composite sync video signals. Many GVPs can be synchronized together to build up a picture image. Greatech Electronics Ltd, Hay Lane, Braintree, Essex CM7 6ST.

WW309

SCREW STARTERS

One of the bugbears of assembly and maintenance of electronic equipment is the limited access to the screws that hold it together. We can usually get them out, but the difficulty is in re-assembly. Screw starters which can grip the screw

WW310



while it is being positioned are very useful and three are available from Toolrange. The D2 is for slotted screws, the PD-10 for cross-slot (Phillips) heads. These are both pocket-sized with a pen-clip. The D -1 is longer and double-ended for both slotted and Phillips heads. Toolrange Ltd, Upton Road, Reading, Berks RG3 4JA.

WW310

If you would like more information on any of the items featured here, enter the appropriate WW reference number(s) on the mauve reply-paid card.

RANDOM ECHOES

By Chirp

WORDS

I dare say we all use certain words without bothering too much about their meanings. They sound right and seem to fit the context and, indeed, fall into common usage; yet sometimes the accepted meaning is far from that given in the dictionary.

The most useful ones are not in the dictionary at all, and they can be given any meaning that happens to be appropriate. Take the noun "snodgett", for example. Do you know what a snodgett is? No, of course you don't, but it is a very handy universal word to use as the name of almost anything when you can't think of what to call it.

A snodgett on your car chassis gets in the way of your spanner when you are struggling with the nut that holds your broken exhaust pipe. Or, in contrast, the are four quite handsome snodgetts on the ornamental wall clock over our fireplace. And again, there is the snodgett in a video amplier's frequency response that causes overshoot on a fast rise pulse.

It's a very handy word, "snodgett". I strongly recommend that you take it into your vocabulary and use it whever you get stuck for a suitable noun. Eddie Spinks has a universal adjective, "hydrofluvious", but I think it sounds a bit pompous.

However, it was not the non-dictionary words that prompted this literary outburst so much as the misuse of well-established words. In particular, have you noticed how the word "sophisticated" is now fashionable as a kind of universal adjective to imply some degree of vague cleverness associated with its subject. It appears in all kinds of technical sales literature and even in serious technical articles. We frequently read of sophisticated techniques, circuits, machines and the like. And I must confess to having used the word myself in such context without really appreciating its meaning. But, being a bit of a pedant, when I realized my ignorance I looked up the word in the Concise Oxford Dictionary. The entry reads:

Sophisticate (v.t. & i.) involve in sophistry; mislead thus; deprive of simplicity; make artificial (p.p.) worldly-wise; adulterated (wine, etc).

Not very nice, is it? I see now why these "very sophisticated" computer systems often seem to be full of anomalies, using advanced technology (whatever that means) to achieve results that seem utterly inconsequential. Are they actually intended to mislead? And, as for these "highly sophisticated" weapons that we read about – one wonders whether they are designed to deceive the enemy or the chaps at the sending end. Probably the only one to be deceived is the fool who looks up the word in the dictionary. Everyone else assumes a meaning relating to cleverness of design, which is just what the authors intend.

WORDS AND MUSIC MAESTRO

They're at it again with gimmicky automobile electronics. This time it's not an entirely Japanese venture but the new British Leyland Maestro. I overheard a fragment of a television programme the other day in which there was a short piece of leaked information about this car, which, I gather, has not even been announced under the Maestro name yet.

Anyway the programme included a statement that the more superior versions would feature an audio readout of dashboard information. Do we call this a "Speakout"? This feature is, of course, in addition to such refinements as electric windows and remotely controlled door mirrors.

As I understood the announcement, the car will speak out such information as speed, fuel level, engine temperature etc., but the report was brief and gave no information about the way in which the driver interrogates the system.

Perhaps no interrogation is necessary. Perhaps the thing is programmed to blurt out the information at preset intervals or when an alarm situation occurs; e.g., "We're nearly out of petrol!" Perhaps it announces the speed as each decade multiple m.p.h. is reached – either accelerating or decelerating. If so, it could be quite dramatic when you have just pulled out of a lay-by and you are trying to reach the speed of the traffic before the dual carriageway peters out.

In the report that I heard, there was no mention of a microprocessor, but you may be sure that the whole system depends on at least one of these devices. No modern electronic system amounts to much without one. So we are naturally led to speculate on the conversational ability of the car of the future as more-and-more data processing power is compressed into smaller-and-smaller devices.

I read quite recently about a Japanese heavy goods vehicle with solid-state television cameras mounted at "blind" locations on the truck body and a c.r.t. in the cab to augment the conventional rear-view mirrors. We also read of computer programmes for interpretation of the signals from t.v. cameras to exact meaningful information and act upon it. At present such systems are confined to the field of metrology and machine-tool control, but who knows what the future may bring.

With the general trend towards the use of high technology for totally frivolous purposes, it is possible that the techniques mentioned will one day be combined to enable the car itself to utter those helpful comments currently made by ones passengers; e.g., "All clear left . . . if you're quick", "That's a police car you're overtaking" and "Why is that fool dripping with water shaking his fist?"

Such technical developments could ultimately do away with the need for passengers altogether, and one could, perhaps, look forward to the optional electronic "hitch-hiker" which gives an authentic account of all the lifts he's ever thumbed while you are trying to listen to the test match commentary on Radio 3.

GETTING THE MESSAGE

One of the advantages of the printed (as against spoken) word is its immunity to the effects of mispronunciation, extraneous noise, imperfect hearing and, in the case of telecommunications, frequency limitations and distortion.

I was not surprised to read, therefore, about a miniature alphanumeric terminal, complete with keyboard, v.d.u. screen, and printer, for use with mobile radio. The article said it is for applications where integrity of the message is very important. It offers most of the advantages one associates with the telex, and perhaps it is another step in a trend towards transmission of written information rather than relying on speech.

It is bound to be more reliable because the transmitted signal is so much simpler. When you come to think of it, spoken language is an extraordinarily complex way of communicating, even by comparison with the arbitrary shapes of the letters in our alphabet. In the face-to-face conversational environment the sounds are supported by facial expression and gestures, which are inevitably lost in sound-only transmission. So, for communication of information, as distinct from emotion, the trend is to the Telex and Teletext and Viewdata.

Or is it? I've just read a feature about computer controlled voice recognition systems and electronic speech synthesizers. This is really high technology stuff, where the human operator speaks to the machine and the machine talks back. I must admit that the voice recognition systems described were mainly concerned with access-control applications and carcase grading in an Australian abattoir. But the prediction was the development of voice operated data terminals, where you interrogate the computer verbally and its synthetic voice answers.

If the computer misunderstands your accent, no doubt it will ask you to "spell it out" using the approved phonetic alphabet. And if you misunderstand, I recommend you call for a print out – unless, of course, you are using the telephone, when it will probably end up with smoke signals.

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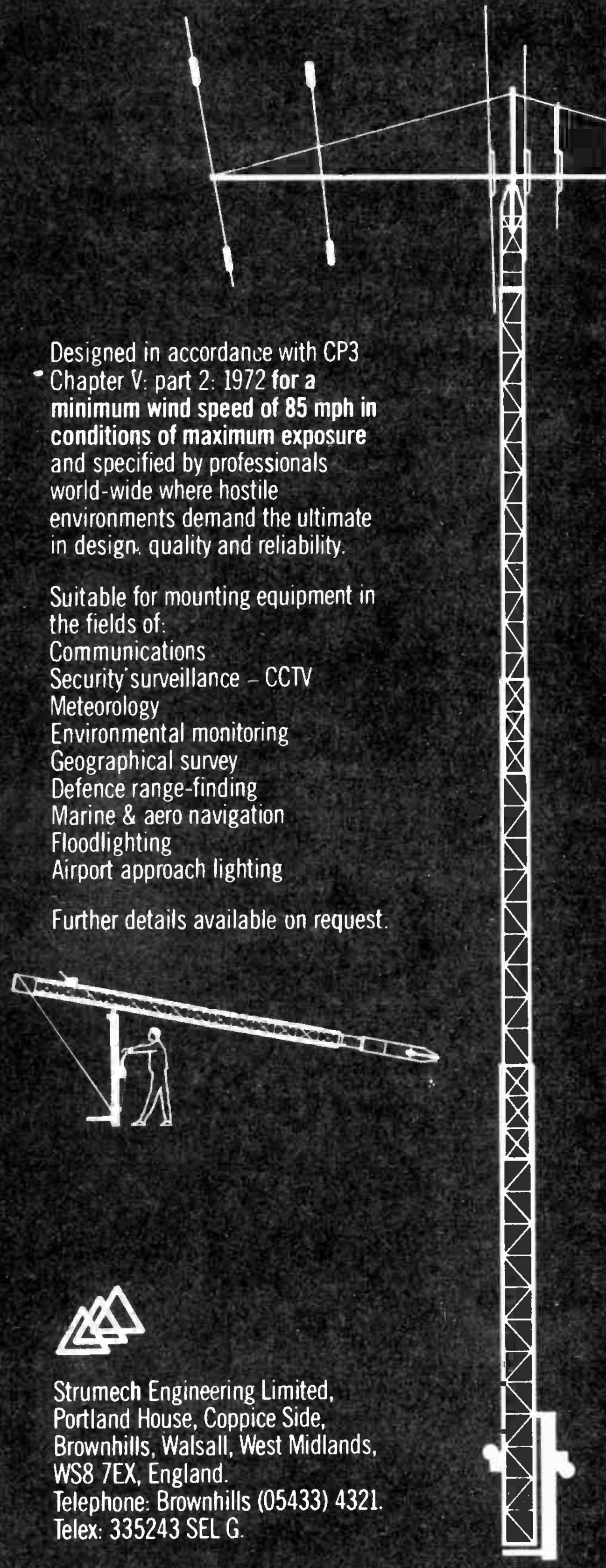

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ECH84	0.80	PCL82	0.95	1X2B	1.40	6JS6C	3.70	30PL14	2.45		
ECL80	0.70	PCL84	0.90	2D21	1.10	6K7	0.80	35L6GT	1.40	**IC**	
ECL82	0.75	PCL86	0.75		1.85*	6KD6	4.50	35W4	0.80	SN5402N	0.28
ECL83	1.40	PCL805/85	0.95	2K25	16.95	6L6M	2.80	35Z4GT	0.80	SN5410F	0.32
ECL85	0.80	PD500/510	4.30		24.50*	6L6G	2.50	50C5	1.15	SN5470F	0.48
ECL86	0.90	PFL200	1.10	2X2A	2.50	6L6GC	2.65	50CD6G	1.35	SN54196J	1.20
EF37A	2.15		2.80*	3A4	0.70	6L6GT	1.25	75B1	1.25	SN7407N	0.29
EF39	1.25	PL36	1.10	3AT2	2.40	6L7G	0.65	75C1	1.70	SN7408N	0.18
EF80	0.65	PL81	0.85	3B28	12.00	6L18	0.70	76	1.60	SN7445P	0.85
EF83	1.75	PL82	0.70		19.50*	6LQ6	2.95	78	1.20	SN74453P	1.10
EF85	0.60	PL83	0.60	3D6	0.50	6LD20	0.70	80	1.95	SN7453N	0.18
EF86	0.75	PL84	0.95	3D22	23.00	6KG6A	2.70	85A2	1.40	SN74L73N	0.38
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EF96	0.60	PL519	4.90	5B/255M	14.50	6SK7	0.95		68.50*	SN74123N	0.42
EF183	0.80		6.10*	5B/258M	12.50	6SL7GT	0.85	829B	14.00	DM74123N	0.38
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EF812	0.75	PY33	0.70	5R4GY	1.80	6SR7	1.10	866A	3.80	CX4	0.95
EFL200	1.85	PY80	0.70	5U4G	0.75	6SQ7	0.95	866E	6.25	SN76013N	1.80
EH90	0.85	PY81/800	0.85	5V4G	0.75	6V6G	1.50	931A	13.80	SN76003N	1.60
EL32	1.10	PY82	0.65	5Y3GT	0.95	6V6GT	0.95	954	0.60	SN76033N	1.35
EL34	1.80	PY83	0.80	5Z3	1.50	6X4	0.95	955	1.20	MC6800P	5.80
	2.90*	PY88	0.60	5Z4G	0.75	6X4WA	2.10	956	0.60	MC68B00P	
EL37	4.60	PY500A	2.10	5Z4GT	1.05	6X5GT	0.65	957	1.05		6.40
EL82	0.70	PY809	6.45	6/30L2	0.90	6Y6G	0.90	1625	1.80	MC14511BA	
EL84	0.80	PY801	0.80	6AB7	0.70	6Z4	0.70	1629	1.85		2.20
EL86	0.95	QQV03/10	3.20	6AC7	1.15	7B7	1.75	2051	2.90	B1702AL	3.30
EL90	1.00		7.50*	6AG5	0.60	8BN8	2.95	5763	4.80	MM6300-IJ	
EL91	4.20	QQV03-20A		6AH6	1.15	9D2	0.70	5842	7.50		3.80
EL95	0.80		21.50	6AK5	0.85	9D6	2.90	5881	3.90	MCM6810AP	
EL504	1.70	QQV03-25A		6AK8	0.60	10C2	0.85	5933	6.90		3.40
EL803	5.90		36.50	6AL5	0.60	10F18	0.70	6057	2.20	6340-1J	3.60
EL509	3.95	QQV06/40A		6AL5W	0.85	10P13	1.50	6060	1.95	MIC945-5D	0.28
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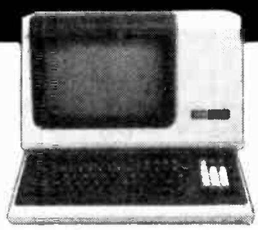

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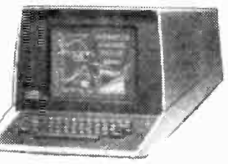

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[63 ASCII character set]
Graphics Matrix: 1024X × 1024Y
Baud Rate: 75 thru 4800. Interface: Standard RS232
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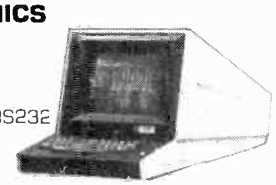
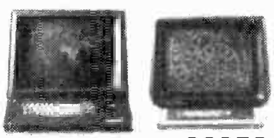
4010-1 HIGH RESOLUTION GRAPHICS DISPLAY TERMINAL



Alphanumeric Mode: 35 × 74 characters
[63 ASCII character set]
Graphics Matrix: 1024X × 1024Y
Baud Rate: 110 thru 9600. Interface: Standard RS232
Thumbwheel crosshair cursor. Intergral Stand
£2750

4014-1 and 4015-1 HIGH RESOLUTION BIG (19") SCREEN GRAPHICS DISPLAY TERMINALS



Alphanumeric Mode: up to 133 × 64 characters
[94 ASCII character set or 188 ASCII + APL on model 4015]
Graphics Mode: 4096X × 4096Y
[includes enhanced graphics option]
Interface Standard RS232
Thumbwheel crosshair cursor. Integral Stand

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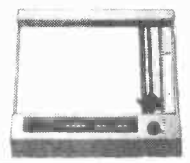

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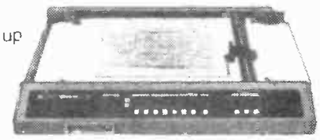

Microprocessor Controlled high speed plotting up to 17" × 22" with built-in joystick control.
Standard RS232 Interface
Baud rates 110-9600
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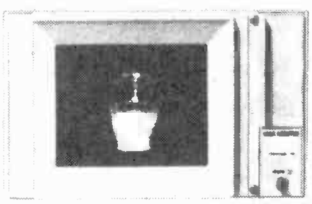

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BC114	0.15
BC115	0.18
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BC125	0.18
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BC135	0.15
BC136	0.19
BC137	0.19
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BC148	0.12
BC149	0.13
BC157	0.13
BC158	0.13
BC159	0.13
BC167	0.11
BC170	0.11
BC171	0.11

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2G302	1.00
2G306	1.00
2N404	1.30
2N696	0.32
2N697	0.32
2N698	0.32
2N705	1.25
2N706	0.25
2N708	0.25
2N930	0.25
2N1131	0.30
2N1132	0.30
2N1302	1.20
2N1303	0.80
2N1304	1.20
2N1305	1.00
2N1306	1.50
2N1307	1.10
2N1308	1.75
2N1309	1.20
2N1613	0.32

2N1671	5.00
2N1893	0.32
2N2147	4.00
2N2148	3.75
2N2218	0.32
2N2219	0.32
2N2220	0.20
2N2221	0.20
2N2222	0.20
2N2223	4.25
2N2368	0.25
2N2369A	0.25
2N2484	0.25
2N2646	0.50
2N2904	0.32
2N2905	0.32
2N2906	0.21
2N2907	0.21
2N2924	0.26
2N2925	0.22
2N2926	0.15
2N3053	0.26
2N3054	0.55
2N3055	0.65
2N3440	0.70
2N3441	0.85
2N3442	1.25
2N3614	2.20
2N3702	0.11
2N3703	0.11
2N3704	0.11
2N3705	0.11
2N3706	0.11
2N3707	0.11
2N3708	0.10
2N3709	0.11
2N3710	0.10
2N3711	0.10
2N3771	1.40
2N3772	1.60
2N3773	1.80

2N3819	0.30
2N3820	0.39
2N3823	0.60
2N3866	1.00
2N3904	0.17
2N3905	0.17
2N3906	0.17
2N4058	0.20
2N4059	0.20
2N4060	0.16
2N4061	0.16
2N4062	0.16
2N4124	0.16
2N4126	0.16
2N4286	0.15
2N4288	0.18
2N4289	0.18
2N5457	0.32
2N5458	0.32
2N5459	0.32
2S017	10.00
2S019	12.00
2S026	25.00
2S103	1.50
2S302	2.00
2S303	1.50
2S322	3.50
2S324	3.50
2S701	2.00
2S745A	0.95
2S746A	0.95

VALVES

A1834	9.00
A2087	13.50
A2134	17.50
A2293	16.00
A2426	18.75
A2521	22.50
A2900	22.50
A3343	45.00
AZ31	2.75
AZ41	2.60
BK448	114.90
BK484	155.35
BS90	58.00
BS452	60.00
BS810	60.00
BT5	58.95
BT17	151.00
BT19	44.05
BT29	349.15
BT69	354.80
BT95	129.00
CBL31	4.00
CL33	4.00
CY31	3.00
C1K	20.00
C3A	22.00
C3JA	22.00
DA41	25.00
DA42	18.70
DAF91	1.75
DAF96	1.75
DET22	35.00
DET24	49.00
DF91	1.75
DF96	1.75
DK91	1.75
DK92	2.00
DK96	1.75
DL92	2.00
DL94	1.75
DL96	1.75
DLS10	14.00
DLS15	12.50
DLS16	12.50
DLS19	12.50
DM70	2.00
DM71	2.00
DM160	4.75
DY87	1.50
DY802	1.50
E55L	22.00
E80CC	8.81
E80CF	11.27
E80F	13.58
E80L	13.37
E81CC	8.00
E81L	12.57
E82CC	8.10
E83CC	8.40
E86C	8.25
E88C	8.25
E88CC	8.00
E90CC	8.61
E90F	9.90
E91H	6.25
E92CC	8.75
E99F	9.10

E130L	18.50
E180CC	10.50
E180F	9.90
E182CC	13.25
E186F	11.50
E188CC	8.25
E280F	22.51
E283CC	12.00
E288CC	17.50
EA52	32.25
EA76	2.50
EABC80	1.25
EAC91	3.50
EAF42	2.50
EAF801	2.00
EB41	4.00
EB91	1.50
EBC33	2.50
EBC41	2.50
EBC81	1.50
EBC90	1.25
EBF80	1.50
EBF83	1.75
EBF89	1.50
EBL31	6.00
EC90	1.25
EC91	8.00
EC92	1.75
EC157	325.40
ECC33	4.50
ECC35	4.50
ECC40	4.50
ECC81	1.75
ECC82	1.75
ECC83	1.75
ECC84	1.75
ECC85	1.75
ECC86	2.50
ECC88	2.10
ECC89	2.00
ECC91	8.93
ECC189	2.10
ECC807	1.75
ECC808	3.50
ECF80	1.55
ECF82	1.50
ECF86	2.50
ECH35	3.00
ECH42	3.50
ECH81	[illegible]
ECH83	2.50
ECH84	2.50
ECL80	1.50
ECL81	1.75
ECL82	1.50
ECL83	3.00
ECL84	1.50
ECL85	1.50
ECL86	1.75
EF37A	5.00
EF39	2.75
EF40	5.00
EF41	3.50
EF42	4.50
EF50	2.50
EF54	5.00
EF55	3.50
EF80	1.75
EF83	4.00

EF85	1.75
EF86	1.75
EF89	2.50
EF91	2.95
EF92	6.37
EF93	1.50
EF94	2.50
EF95	5.99
EF98	2.00
EF183	2.00
EF184	2.00
EF804S	12.00
EF805S	9.80
EH90	1.75
EK90	1.50
EL32	2.50
EL33	4.00
EL34MU1	3.00
EL36	2.50
EL41	2.80
EL42	2.50
EL81	5.25
EL83	6.00
EL84	2.25
EL86	2.75
EL90	2.25
EL91	9.69
EL95	2.00
EL156	25.00
EL360	8.50
EL500/504	3.00
EL509	7.00
EL821	13.00
EL822	13.97
EM34	5.00
EM80	2.50
EM81	2.50
EM84	2.00
EM85	2.75
EM87	2.50
EN32	17.46
EN91	7.50
EN92	6.96
EY51	2.75
EY81	2.50
EY83	2.50
EY84	9.24
EY86	1.75
EY88	1.75
EY500A	3.00
EY802	1.75
EZ35	1.75
EZ40	2.50
EZ41	2.50
EZ80	1.50
EZ81	1.50
EZ90	2.00
FW4-500	3.50
FW4-800	3.50
G1.371K	35.00
G551K	12.00
G180.2M	17.50
G240.2D	12.00
G400.1K	17.50
GN4	9.00
GN4A	9.00
GS16	16.00
GT1C	15.00
GU50	20.00

GU51	20.00
GXU1	15.35
GXU2	30.00
GXU3	25.00
GXU4	44.50
GXU50	20.00
GY501	3.00
GZ32	2.50
GZ33	4.75
GZ34	3.00
GZ37	4.75
KT61	5.00
KT66	8.00
KT88	11.00
KTW61	2.50
KTW62	2.50
KTW63	2.50
M8079	12.34
M8080	8.25
M8081	9.82
M8082	9.69
M8083	8.58
M8091	10.43
M8096	6.80
M8097	8.10
M8098	6.15
M8099	8.00
M8100	9.52
M8136	10.23
M8137	10.23
M8140	6.00
M8141	6.50
M8142	8.75
M8144	7.50
M8149	6.50
M8161	9.35
M8162	10.40
M8163	8.25
M8190	5.00
M8195	10.85
M8196	7.50
M8204	7.05
M8212	11.37
M8223	6.00
M8224	6.30
M8225	4.50
M8248	14.03
MD2901	60.00
MU14	2.50
MX119	55.00
MX123	72.00
MX145	56.70
MX151	17.25
MX152	131.25
MX161	152.25
MX163	20.25
MX164	25.52
MX166	147.00
MX168	48.00
N78	15.00
OA2	3.25
OA3	2.50
OA4	6.00
OB2	4.35
OB3	2.50
OC2	4.35
OC3	2.50
OD3	2.50
OZ4	3.50

PC86	2.50
PC88	2.50
PC95	1.75
PC97	1.75
PC900	1.75
PCC84	1.50
PCC85	1.50
PCC88	2.00
PCC89	1.75
PCC189	2.50
PCC805	1.60
PCC806	1.60
PCE82	2.00
PCF80	2.00
PCF82	1.50
PCF86	2.50
PCF87	2.00
PCF200	3.25
PCF201	3.25
PCF801	2.50
PCF802	2.50
PCF805	1.70
PCF806	1.70
PCF808	1.70
PCL82	2.00
PCL83	3.00
PCL84	2.00
PCL85	2.50
PCL86	2.50
PCL805/85	2.50
PD500	6.00
PE06-40N	30.00
PFL200	2.50
PL36	2.50
PL81	1.75
PL81A	2.00
PL82	1.50
PL83	2.50
PL84	2.00
PL504/5	2.50
PL508	2.50
PL509	6.00
PL519	6.00
PL801	1.50
PL802	6.00
PY33	2.50
PY81	1.75
PY82	1.50
PY83	2.50
PY88	2.00
PY500A	3.00
PY800	1.50
PY801	1.50
QQV02-6	16.50
QQV03-10	14.00
QQV03-20A	48.38
QQV06-40A	48.38
QQV07-50	66.90
QQZ06-40A	62.20
QU37	12.50
QV03-12	6.80
QV04-7	3.50
QV08-100	136.85
QY3-65	54.26
QY3-125	60.40

QY4-250	73.15
QY4-400	76.80
QY5-500	175.00
QY5-3000A	335.00
QZ06-20	32.70
R10	6.00
R17	3.00
R18	3.00
R19	9.24
R20	2.50
RG3-250	32.68
RG3-250A	32.68
RG3-1250	59.50
RG4-1250	61.60
RG4-3000	99.45
RR3-250	40.00
RR3-1250	45.75
S11E12	65.00
S130	6.00
S130P	6.00
STV280-40	14.00
STV280-80	21.00
SU41	5.00
SU42	10.00
TD03-10	35.00
TD03-10F	35.00
TT15	35.00
TT21	23.00
TT22	23.00
TT100	60.00
TY2-125	60.00
TW4-400	71.40
TY4-500	98.35
TY5-500	175.00
TY6-800	188.00
TY6-5000A	375.00
TY6-5000B	395.00
TY6-5000W	325.00
TY7-6000A	374.00
TY7-6000W	303.60
TZ40	25.00
U18-20	3.50
U19	13.75
U25	2.50
U26	2.50
U37	12.00
UABC80	1.25
UAF42	2.50
UB41	3.00
UBC41	2.25
UBF89	1.50
UCC84	1.75
UCC85	1.85
UCF80	2.00
UCH42	2.50
UCH81	2.50
UCL82	1.75
UCL83	2.75
UF41	2.00
UF42	2.10
UF80	1.75

UF85	1.75
UF89	2.00
UL41	3.50
UL84	1.75
UM80	2.00
UY41	2.25
UY85	2.25
VLS631	15.00
XG1-2500	45.80
XG2-6400	141.90
XG5-500	26.60
XG2-6400	162.00
XR1-1600A	53.75
XR1-3200	81.97
XR1-3200A	
XR1-6400	102.00
YD1120	395.00
YD1240	351.00
Z759	25.00
ZM1000	8.00
ZM1001	8.00
ZM1020	9.00
ZM1021	9.00
ZM1022	9.00
ZM1023	9.00
ZM1040	19.36
ZM1041	16.66
ZM1042	17.77
1B3GT	3.00
1B24	25.00
1B35A	48.00
1B63	64.00
1R5	1.75
1S5	1.75
1T4	1.75
2AS15	11.50
2C39A	60.00
2C43	70.00
2D21	3.25
2E26	8.25
2J42	98.00
2J55	175.00
2J70A	383.00
2J70B	336.00
2K25	125.00
3-400Z	85.00
3-500Z	85.00
3A5	3.00
3B24	11.00
3B28	15.35
3B29	20.00
3B240M	17.50
3B241M	17.50
3C23	25.00
3C45	24.50
3CX100A5	47.00
3E29	45.00
3S4	2.00
3V4	1.75
465A	60.00
4-125A	60.00
4-250A	80.00
4-400A	87.00
4B32	20.00

4C35	78.00
4CX250B	40.00
4CX350A	73.00
4X150A	60.00
4X150D	56.00
5B254M	35.00
5B255M	35.00
5C22	160.00
5J180E	1650.00
5R4GY	3.50
5U4G	3.00
5U4GB	2.50
5V4G	2.50
5Y3GT	2.50
5Z3	4.00
5Z4G	2.50
5Z4GT	2.50
6-30L2	1.75
6AB4	1.75
6AB7	3.00
6AC7	3.00
6AF4A	4.25
6AG7	3.00
6AH6	5.00
6AK5	7.10
6AK6	2.50
6AL5	1.50
6AM4	4.00
6AM5	9.69
6AM6	6.00
6AN5	4.75
6AN8A	3.50
6AQ5	2.25
6AS6	8.66
6AS7G	8.75
6AT6	1.25
6AU5GT	5.00
6AU6	2.50
6AV5GA	4.50
6AV6	1.50
6AX5GT	3.00
6B7	3.25
6B8	3.25
6BA6	1.50
6BA7	5.00
6BA8A	4.00
6BC4	4.00
6BE6	1.50
6BH6	2.50
6BJ6	2.25
6BK4	4.50
6BL6	85.00
6BL7GT	4.50
6BM6	115.00
6BN6	2.00
6BQ7A	3.50
6BR7	6.00
6BR8A	3.50
6BS7	6.00
6BW6	6.00
6BW7	1.50
6BX7GT	5.00
6BZ6	2.75
6C4	1.25
6CB6A	2.50
6CD6GA	5.00
6CG7	2.50
6CH6	13.00
6CL6	3.75

6CW4	8.00
6D2	1.50
6DK6	3.00
6DQ6B	4.75
6EA8	3.00
6EB8	2.50
6EW6	2.25
6F6	3.00
6F23	1.60
6F28	1.60
6F33	33.50
6H1	14.00
6H2N	2.75
6H3N	2.75
6H6	3.00
6J4	5.50
6J6	8.93
6J7	4.75
6K4N	2.50
6K6GT	2.75
6K7	3.00
6K8	3.00
6KD6	7.00
6L6G	3.00
6L6GA	2.25
6L6GT	2.25
6L6GC	2.50
6L7	2.50
6N2P	2.50
6N3P	2.50
6N7	3.00
6P25	4.00
6Q7	3.75
6R7	3.25
6SA7	3.00
6SC7	2.75
6SF7	2.50
6SH7	3.00
6SJ7	3.25
6SK7	3.50
6SK7GT	3.00
6SN7GT	3.00
6SQ7	3.40
6SR7	4.00
6SS7	2.75
6U5G	3.50
6U8A	2.25
6V6GT	2.25
6X4	2.00
6X5GT	1.75
7B7	2.50
7C5	4.00
7C6	2.50
7H7	4.00
7R7	4.25
7S7	3.50
7Y4	2.25
7Z4	2.00
11E3	55.00
12AH8	5.00
12AT6	1.50
12AT7	1.75
12AU6	2.50
12AU7	1.75
12AV6	2.50
12AV7	3.50
12AX7	1.75
12AY7A	4.00
12B4A	3.50

12BA6	2.50
12BE6	2.50
12BH7	1.50
12BY7	3.00
12E1	20.00
12E11TT	170.00
12E14	35.00
13E1	20.00
19H4	27.50
19H5	47.50
24B9	67.25
30C15	2.00
30C17	2.00
30C18	2.00
30F5	1.60
30FL1/2	1.38
30FL12	1.80
30FL14	2.00
30L1	1.50
30L15	2.00
30L17	2.00
30P4	2.50
30P19	2.50
30PL1	3.00
30PL14	1.80
30PL15	1.80
35W4	1.00
50C5	1.50
75B1	6.05
75C1	3.50
85A1	7.50
85A2	4.45
90AG	12.96
90AV	12.96
90C1	6.00
90CG	14.54
90CV	15.45
92AG	12.96
92AV	12.96
95A1	8.45
150B2	6.50
150B3	8.35
150C2	3.25
150C4	6.00
211	35.00
723AB	125.00
803	25.00
805	45.00
807	3.75
811A	18.33
812A	18.33
813	125.86
833A	193.16
866A	20.03
872A	20.00
922	6.00
931A	18.52
1624	4.00
1625	3.50
2050	17.46
4212E	300.00
4212H	300.00
5544	81.97
5545	102.00
5551A	114.90
5552A	155.35
5642	9.00
5654	3.00
5651	4.45

5670	4.50
5675	28.00
5687	6.00
5696	4.50
5718	7.50
5725	5.50
5726	11.37
5727	7.05
5749	2.50
5751	4.00
5763	4.50
5814A	4.00
5840	4.00
5842	12.00
5876A	31.50
5879	5.00
5886	12.50
5963	2.50
5965	3.50
6005	2.25
6021	4.50
6057	10.23
6058	12.34
6059	6.00
6061	6.00
6063	3.75
6064	8.58
6067	10.23
6072	6.00
6080	14.00
6097A	235.00
6097B	200.00
6146A	8.25
6146B	8.25
6159B	19.00
6189	9.55
6201	11.40
6442	20.00
6883B	17.54
6973	4.00
7025	3.00
7551	6.25
7586	12.00
7587	18.50
7609	56.00
7868	6.00
7895	12.00
8005	110.49
8068	14.00
8122	90.00
8136	2.50
8417	6.00
18042	11.53
18045	10.49

Tested Ex-Equipment

4CX250B	6.50

BASES

B7G unskirted	0.22
B7G skirted	0.30
B9A unskirted	0.22
B9A skirted	0.30
Int Octal	0.35
Loctal	0.55
Nuvistor base	0.75
8 pin DIL	0.15
14 pin DIL	0.15
16 pin DIL	0.17
Valve screening cans all sizes	0.30

CRTs

2AP1	8.50
2BP1	9.00
3BP1	12.00
3DP1	5.00
3EG1	10.00
3FP7	6.00
3GP1	6.00
3JP1	8.00
3JP2	8.00
3JP7	10.00
3KP1	15.00
3RP1	35.00
3WP1	20.00

5ADP1	35.00
5BP1	10.00
5CP1	10.00
5CP1A	40.00
5FP15A	15.00
5UP7	25.00
DG7-5	63.32
DG7-31	58.07
DG7-32	58.07
DH3-91	56.83
DH7-11	113.12
VCR97	12.00
VCR138	12.00
VCR138A	12.50
VCR139A	8.00

VCR517A	10.00
VCR517B	10.00
VCR517C	10.00

Tube Bases Prices on application

INTEGRATED CIRCUITS

7400	0.16
7401	0.17
7402	0.17
7403	0.17
7404	0.18
7405	0.18
7406	0.43
7407	0.43
7408	0.20
7409	0.20
7410	0.17
7412	0.29
7413	0.32
7416	0.32
7417	0.32
7420	0.18
7422	0.20

7423	0.33
7425	0.30
7427	0.30
7428	0.43
7430	0.17
7432	0.30
7433	0.40
7437	0.32
7438	0.32
7440	0.32
7441	0.90
7442	0.72
7447AN	1.17
7450	0.18
7451	0.18
7453	0.18
7454	0.18

7460	0.18
7470	0.38
7472	0.33
7473	0.38
7474	0.38
7475	0.54
7476	0.42
7480	0.56
7482	0.75
7483	1.00
7484	1.05
7486	0.39
7490	0.60
7491	0.82
7492	0.60
7493	0.60
7494	0.82

7495	0.73
7496	0.82
7497	3.15
74100	1.54
74107	0.45
74109	0.73
74110	0.51
74111	0.71
74116	1.85
74118	1.00
74119	1.54
74120	0.83
74121	0.43
74122	0.62
74123	1.18
74125	0.58
74126	0.58
74128	0.63
74132	0.72

74136	0.51
74141	0.89
74142	2.30
74143	2.60
74144	2.60
74145	1.00
74147	2.00
74148	1.76
74150	1.80
74151	0.94
74154	1.80
74155	0.90
74156	0.90
74157	0.75
74159	2.20
74170	2.40
74172	4.40
74173	1.42
74174	1.60

74175	1.02
74176	1.16
74178	1.36
74179	1.36
74180	1.20
74190	1.90
74191	1.90
74192	1.90
74193	1.90
74194	1.25
74195	1.20
74196	1.35
74197	1.35
74198	2.70
74199	2.30
76013N	1.76
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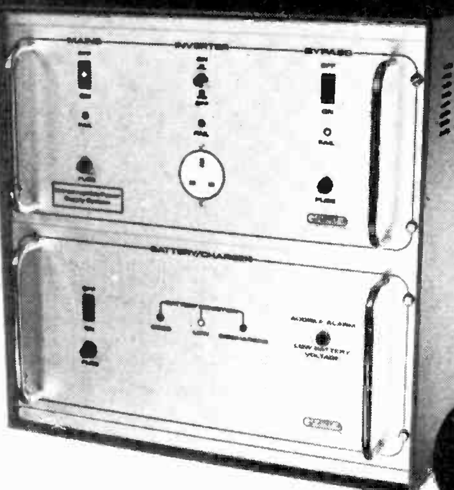

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7425	18p
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74LS165	50p
74LS166	60p
74LS168	85p
74LS169	85p
74LS170	70p
74LS173	55p
74LS174	40p
74LS175	40p
74LS181	90p
74LS183	120p
74LS190	36p
74LS191	36p
74LS192	36p
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74LS195	35p
74LS196	45p
74LS197	45p
74LS221	50p
74LS240	55p
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74LS242	55p
74LS243	55p
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74LS248	55p
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74LS253	30p
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74S114	90p
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4022	45p
4023	13p
4024	32p
4025	13p
4026	80p
4027	20p
4028	40p
4029	45p
4030	15p
4031	125p
4032	80p
4033	125p
4034	140p
4035	45p
4036	275p
4037	110p
4038	110p
4039	290p
4040	40p
4041	40p
4042	40p
4043	40p
4044	40p
4045	105p
4046	50p
4047	45p
4048	50p
4049	24p
4050	24p
4051	45p
4052	60p
4053	50p
4054	90p
4055	90p
4046	90p
4059	450p
4060	55p
4063	90p
4066	27p
4067	225p
4068	14p
4069	14p
4070	14p
4071	14p
4072	14p
4073	14p
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4096	70p
4097	290p
4098	90p
4099	100p
4500	575p
4502	60p
4503	45p
4504	75p
4505	400p
4506	35p
4507	35p
4508	130p
4510	45p
4511	45p
4512	48p
4514	120p
4515	110p
4516	55p
4518	40p
4520	50p
4521	90p
4522	120p
4526	60p
4527	60p
4528	50p
4532	70p
4534	400p
4536	270p
4538	90p
4539	70p
4543	75p
4553	245p
4555	35p
4556	35p
4557	300p
4560	120p
4566	160p
4568	250p
4569	170p
4572	30p
4583	90p
4584	40p
4585	75p
40014	40p
40085	90p
40097	45p
40102	140p
40103	170p
40105	110p
40106	40p
40109	100p
40110	275p
40163	60p
40174	50p
40175	75p
40193	75p
40244	160p
40245	180p
40257	160p
40373	180p
40374	160p
14495	300p
14500	700p
14599	290p

COUNTERS

74C925	£4
74C928	£6
7216B	£16
ZN1040	670p

[illegible]

4 way	70p
6 way	85p
8 way	90p
10 way	145p

Most items despatched by return of post

Ask for our detailed price list

LINEAR ICs

AD7581	1150p
ADC0808	990p
AN103	200p
AY1-0212	700p
AY1-1313	668p
AY1-1320	225p
AY1-5050	99p
AY3-1270	750p
AY3-1350	350p
AY3-8910	440p
AY3-8912	625p
AY4007D	680p
AY5-3600	680p
AY5-4007D	£6
CA3028A	120p
CA3019	80p
CA3046	70p
CA3048	220p
CA3059	285p
CA3060	350p
CA3080E	70p
CA3086	48p
CA3089E	200p
CA3090AQ	375p
CA3130E	90p
CA3130T	110p
CA3140E	50p
CA3140T	90p
CA3160E	100p
CA3161E	150p
CA3162E	450p
CA3189E	300p
CA3240E	110p
CA3280G	200p
D7002	480p
DAC1408-8	£2
HA1366	195p
HA1388	270p
ICL7106	700p
ICL7660	200p
ICL7611	95p
ICL8038	300p
ICM7216B	£16
ICM7217	750p
ICM7555	80p
ICL7611	90p
LC7120	300p
LC7130	325p
LC7137	270p
LF347	150p
LF351	48p
LF353	95p
LF356P	95p
LF357	110p
LF13331	100p
LM10C	325p
LM301A	25p
LM308N	75p
LM310	120p
LM311	70p
LM318	300p
LM319	215p
LM324	30p
LM334Z	90p
LM335Z	140p
LM339	50p
LM348	65p
LM358P	60p
LM377	175p
LM380	75p
LM381AN	180p
LM382	120p
LM386	90p
LM387	120p
LM389	95p
LM391	150p
LM392N	60p
LM393	100p
LM394CH	300p
LM709	36p
LM710	50p
LM711	70p
LM725	300p
LM733	60p
LM741	18p
LM747	70p
LM748	35p
LM1014	150p
LM1801	300p
LM1830	250p
LM1871	450p
LM1872	450p
LM1886	700p
LM1889	350p
LM2917	200p
LM3302	75p
LM3900	50p
LM3909	85p
LM3911	125p
LM3914	200p
LM3915	200p
LM3916	225p
LM13600	110p
M51513L	230p
M51516L	500p
MB3712	200p
MB3730	400p
MC1310P	150p
MC1413	75p
MC1445	250p
MC1458	36p
MC1493	100p
MC1495L	350p
MC1496	70p
MC3340P	120p
MC3401	50p
MC3403	75p
MF1D	250p
MK50240	900p
MK50398	700p
MK50938	635p
ML920	800p
MM57160	620p
MN6221A	600p
NE531	140p
NE544	150p
NE555	16p
NE556	45p
NE564	420p
NE565	120p
NE566	155p
NE567	140p
NE570	410p
NE571	400p
NE592	60p
NE5534P	110p
NE5534AP	120p
PLL02A	500p
RC4136	60p
RC4151	200p
S566B	225p
SAA1900	£16
SAD1024A	£9
SFF96364	800p
SL490	350p
SN76131	125p
SN76477	450p
SN76488	450p
SN76660	120p
SN87489	400p
SN76495	400p
SP8515	750p
TA7120	150p
TA7130	160p
TA7204	200p
TA7205	90p
TA7222	150p
TA7310	150p
TBA641BX1	£4
TBA800	80p
TBA810	100p
TBA820	80p
TBA920	200p
TBA950	225p
TC9109	900p
TCA210	350p
TCA220	350p
TCA270	350p
TCA940	175p
TCA965	120p
TDA1004A	£3
TDA1008	320p
TDA1010	200p
TDA1022	500p
TDA1024	120p
TDA1170	300p
TDA2002V	300p
TDA2003	325p
TDA2020	320p
TL064	100p
TL071/81	25p
TL072/82	45p
TL074	100p
TL083	75p
TL084	90p
TL094	200p
TL170	50p
TL430C	70p
TMS1601	1200p
UA1003-3	935p
UA2240	150p
UAA170	170p
ULN2003A	75p
ULN2004	75p
ULN2068	290p
ULN2802	200p
ULN2804	150p
UPC575	275p
UPC592H	200p
UPC1156H	£3
UPC1185H	£5
XR2206	300p
XR2207	375p
XR2211	575p
XR2216	675p
XR2240	120p
ZN414	80p
ZN419C	180p
ZN423E	130p
ZN424E	130p
ZN425E	350p
ZN426E	300p
ZN427E	590p
ZN428E	410p
ZN1034E	200p
ZN1040E	670p
ZNA234	850p

VOLTAGE REGULATORS

FIXED PLASTIC

1A	+ve		-ve	
5V	7805	40p	7905	45p
6V	7806	40p	7906	45p
8V	7808	40p	7908	45p
12V	7812	40p	7912	45p
15V	7815	40p	7915	45p
18V	7818	40p	7918	45p
24V	7824	40p	7924	45p
5V 100mA	78L05	30p	79L05	45p
6V 100mA	78L06	30p		
8V 100mA	78L08	30p		
12V 100mA	78L12	30p	79L12	60p
15V 100mA	78L15	30p	79L15	60p

OTHER REGULATORS

LM309K 1A 5V	140p	78HGKC	600p
LM317K T03	325p	78HO5KC	550p
LM317T	200p	78GUIC	200p
LM337T	225p	79GUIC	225p
LM323K 3A 5V	450p	79HGKC	700p
LM723N	30p	ICL 7660	200p
TL494	300p	LM305AH	250p
78S40	225p	78H12	600p
78P05	900p	SG3524	300p

OPTO-ELECTRONICS

2N5777	40p	TIL32	55p
OCP71	180p	TIL78	55p
ORP12	120p	TIL31A	120p
ORP60	120p	TIL81	90p
ORP61	120p	TIL100	75p

OPTO ISOLATORS

ILD74	130p	TIL111	70p
MCT26	100p	TIL112	70p
MCS2400	190p	TIL113	70p
MOC3020	150p	TIL116	70p
ILQ74	240p		

LEDS

0.125"		0.2"	
TIL209 Red	10p	TIL220 Red	10p
TIL211 Gr	12p	TIL222 Gr	12p
TIL212 Yel	15p	TIL228 Yel	15p
		Rectangular LEDs(R,G,Y)	30p
		TIL311	600p
		TIL312/3	110p
DL704	140p	TIL321/3	130p
DL707 Red	140p	TIL330	140p
FND357	120p	7750/60	200p
FND500	90p	Barograph	225p
FND507	90p		
MAN3640	200p		
MAN4640	200p		
NSB5881	570p		

DRIVERS

9368	250p
9370	300p

COMPUTER COMPONENTS

CPUs

1802CE	650p
2650A	£12
6502	350p
6502A	500p
6800	225p
6802	250p
6809	650p
68B09	£12
6809E	£12
8035	350p
8039	300p
8080A	250p
8085A	350p
8748	1800p
INS8060	£11
TMS9980	£20
TMS9995	£12
Z8	£24
Z80	250p
Z80A	320p
Z80B	£15
Z8088	£12

SUPPORT DEVICES

3242	800p
3245	450p
6520	280p
6522	350p
6522A	550p
6532	550p
6551	650p
6821	100p
68B21	220p
6829	£12.50
6840	375p
68B40	600p
6850	110p
68B50	220p
6852	250p
6854	700p
68B54	800p
6875	570p
8154	950p
8155	350p
8156	350p
8205	225p
8212	110p
8216	100p
8224	110p
8226	250p
8228	220p
8243	280p
8250	850p
8251	250p
8253	390p
8255	250p
8256	£36
8257	400p
8259	400p
8271	£36
8279	440p
8284	350p
8288	£11
8755	£16
9902	£3
TMS4500	£14
TMS9928	£30
Z80P10	250p
Z80AP10	280p
Z80CTC	250p
Z80ACTC	280p
Z80ADART	700p
Z80ADMA	£10
Z80SI 0/1/2	£9

MEMORIES

2101-4A	400p
2102-3L	120p
2107B	500p
2111A	300p
2112-A	300p
2114-2L	100p
2147	450p
4027-3	300p
4044-45	450p
4116-15	120p
4116-20	90p
4118-3	450p
4164-2	400p
4816AP-3	270p
5101	300p
5516	950p
6116-3	420p
6116LP-3	750p
6514-45	200p
6810	120p
7489	210p
74S189	225p
74S201	350p
74S289	175p
93415	600p
93425	600p

ROMs/PROMs

74S188	325p
74S287	350p
74S288	225p
74S387	325p
74S471	650p
74S473	850p
74S474	650p
74S570	650p
74S571	650p
74S573	950p

EPROMs

2516(+5v)	250p
2532	375p
2532-30	700p
2564	£12
2708	250p
2716(+5v)	250p
2716 (350nS)	500p
2732 (350nS)	£8
2716(350ns)	500p
2732(350ns)	750p
2764	£11
TMS2716	750p

CRT CONTROLLER

CRT6545	900p
CRT5027	£18
CRT5037	£18
EF9365	£45
EF9366	£45
MC6845	650p
MC6847	650p
SFF96364	£8
TMS9918	£60
TMS9927	£18
TMS9928	£20
TMS9929	£20

INTERFACE ICs

AD558CJ	775p
AD561J	£14
AD7581	1150p
AM25S10	350p
AM26LS2521	£2
AM26LS31	125p
AM26LS32	125p
D7002	480p
DAC80	£28
DM8131	275p
DP8304	250p
DS3691	400p
DS8830	140p
DS8831	140p
DS8832	250p
DS8833	225p
DS8836	150p
DS8838	225p
LF13201	450p
MC1488	55p
MC1489	55p
MC3418	950p
MC3446	300p
MC3480	850p
MC3486	500p
MC3487	300p
MC4024	325p
MC4044	325p
MC14411	675p
MC14412	750p
75107	90p
75110/12	160p
75114/15	160p
75121/22	140p
75150P	120p
75154	140p
75182	90p
75361	150p
75363	150p
75365	150p
75451/2	72p
75453/4	72p
75491/2	65p
8T26	120p
8T28	120p
8T95/96	90p
8T97/98	90p
81LS95/96	80p
81LS97/98	80p
9602	220p
9637AP	160p
ZN425E-8	350p
ZN426E-8	350p
ZN427E	£6
ZN428E-8	450p

DISC CONTROL ICs

FD1771	£20
FD1791	£22
FD1793	£22
FD1795	£28
FD1797	£28
FD8271	£36
WD1691	£15
WD2143	550p

CHARACTER GENERATORS

RO3-2513 U.C.	750p
L.C.	700p
DM86564	£12
MC66760	750p
SN74S262AN	£10

KEYBOARD ENCODER

AY5-2376	700p
74C922	500p
74C923N	500p

BAUD RATE GENERATORS

MC14411	700p
COM8116	800p
4702B	750p

UARTs

AY-3-1015P	300p
AY-5-1013P	300p
COM8017	300p
IM6402	450p
TR1602	300p

[illegible]

(TEX TOOL)

24 pin	600p
28 pin	800p
40 pin	£10

[illegible]

6MHz UHF	375p
8MHz UHF	450p

CRYSTALS

32.768KHz	100p
100KHz	250p
200KHz	280p
Freq in MHz	
1.0	290p
1.008	275p
1.5	450p
1.8432	210p
2.00	225p
2.45760	210p
2.5	250p
2.662	250p
3.276	150p
3.5795	100p
3.686	300p
4.00	150p
4.194	200p
4.43	110p
4.608	250p
4.915	250p
5.0	175p
5.068	£2
6.0	150p
6.144	150p
7.0	150p
7.168	175p
8.00	175p
8.86	175p
10.00	175p
10.5	250p
10.7	150p
12.00	150p
14.318	175p
14.756	250p
15.00	200p
16.00	200p
17.7	200p
18.00	200p
18.432	150p
19.968	150p
20.00	200p
24.00	£2
26.690	150p
27.145	200p
38.6667	175p
48.0	175p
55.5	400p
116	300p
145.80	250p

REAL TIME CLOCK

MK3805	£TBA
MM58174	700p
MSM5832	700p

TELETEXT DECODER

SAA5020	600p
SAA5030	900p
SAA5041	£16
SAA5050	900p

LOW PROFILE SOCKETS BY TI

8 pin	9p	18 pin	16p	24 pin	24p
14 pin	10p	20 pin	18p	28 pin	26p
16 pin	11p	22 pin	22p	40 pin	30p

WIRE WRAP SOCKETS BY TI

8 pin	25p	18 pin	50p	24 pin	70p
14 pin	35p	20 pin	60p	28 pin	80p
16 pin	40p	22 pin	65p	40 pin	100p

TRANSISTORS

AD161/2	45p
BC107/8	13p
BC109C	14p
BC117	20p
BC147/8	9p
BC149	10p
BC157/8	10p
BC159	11p
BC169C	12p
BC172	12p
BC177/8	17p
BC179	18p
BC182/3	10p
BC184	11p
BC187	30p
BC212/3	11p
BC214	12p
BC237	15p
BC327	16p
BC337	16p
BC338	15p
BC461	35p
BC477/8	30p
BC516/7	40p
BC547B	14p
BC548C	12p
BC549C	16p
BC557B	14p
BC559C	18p
BCY70	18p
BCY71	22p
BD131	75p
BO132	50p
BD135/6	40p
BD139	40p
BD140	40p
BD189	60p
BD232	60p
BD233	75p
BD235	85p
BD241	60p
BD242	60p
BD379	60p
BD380	60p
BD677	40p
BF244B	35p
BF256B	50p
BF257/8	32p
BF337	30p
BFR39	25p
BFR40/1	25p
BFR79	25p
BFR80/1	25p
BFR96	180p
BFX29	40p
BFX30	32p
BFX84/5	40p
BFX86/7	27p
BFX88	27p
BFY89	180p
BFY50	24p
BFY51/2	24p
BFY56	33p
BFY90	80p
BRY39	45p
BSX19/20	24p
BU104	225p
BU105	190p
BU108	250p
BU109	225p
BU126	150p
BU180A	120p
BU205	200p
BU208	200p
BU406	145p
BUX80	600p
BUY69C	350p
E310	50p
MJ802	400p
MJ2501	225p
MJ2955	90p
MJ3001	225p
MJ4502	400p
MJE340	60p
MJE2955	100p
MJE3055	70p
MPF102	40p
MPF103/4	30p
MPF105	30p
MPSA06	30p
MPSA12	50p
MPSA13	50p
MPSA20	50p
MPSA42	50p
MPSA43	50p
MPSA56	32p
MPSA70	50p
MPSA93	40p
MPSU06	63p
MPSU07	60p
MPSU45	90p
MPSU65	78p
TIP29A	35p
TIP29C	40p
TIP30A	35p
TIP30C	40p
TIP31A	40p
TIP31C	45p
TIP32A	45p
TIP32C	60p
TIP33A	70p
TIP33C	80p
TIP34A	90p
TIP34C	120p
TIP35A	120p
TIP35C	140p
TIP36A	140p
TIP36C	150p
TIP41A	50p
TIP41C	55p
TIP42A	60p
TIP42C	65p
TIP54	160p
TIP120	75p
TIP121	75p
TIP122	80p
TIP142	120p
TIP147	120p
TIP2955	78p
TIP4055	70p
TIS93	30p
ZTX108	12p
ZTX300	13p
ZTX452	45p
ZTX500	15p
ZTX502	16p
ZTX504	18p
ZTX652	55p
ZTX652	60p
ZTX752	70p
VN66AF	72p
VN10KM	60p
VN66	80p
2N697	25p
2N698	45p
2N706A	30p
2N708	30p
2N918	45p
2N930	18p
2N1131/2	38p
2N1613	25p
2N1711	25p
2N2102	70p
2N2160	350p
2N2219A	25p
2N2222A	25p
2N2369A	17p
2N2484	25p
2N2646	40p
2N2904/5	25p
2N2906A	25p
2N2907A	25p
2N2926	9p
2N3053	25p
2N3054	55p
2N3055	35p
2N3442	140p
2N3553	240p
2N3584	250p
2N3643/4	48p
2N3702/3	10p
2N3704/5	10p
2N3706/7	10p
2N3708	10p
2N3773	200p
2N3819	20p
2N3820	40p
2N3823	30p
2N3866	90p
2N3902	700p
2N3904	15p
2N4037	65p
2N4123/4	27p
2N4125/6	27p
2N4401/3	25p
2N4427	90p
2N4871	50p
2N5087	27p
2N5089	27p
2N5172	27p
2N5191	90p
2N5245	40p
2N5401	50p
2N5459	30p
2N5460	50p
2N5485	36p
2N5875	250p
2N6027	30p
2N6052	300p
2N6059	325p
2N6107	65p
2N6247	190p
2N6254	130p
2N6290	65p
2SC1306	100p
2SC1307	150p
2SC1957	90p
2SC1969	150p
2SC2028	80p
2SC2029	200p
2SC2078	160p
2SC2335	200p
2SC2612	200p
3N128	120p
3N140	120p
3N141	110p
3N201	110p
3N204	200p
40290	250p
40361/2	75p
40408	90p
40409	100p
40410	100p
40594	120p
40595	120p
40673	75p
40871/2	100p

DIODES

BY127	12p
BYX36300	20p
OA47	8p
OA90/91	9p
OA95	9p
OA200	9p
OA202	10p
1N914	4p
1N916	7p
1N4148	4p
1N4001/2	5p
1N4003/4	6p
1N4005	6p
1N4006/7	7p
1N5404/5	14p
1N5404/7	19p
IS920	9p

BRIDGE RECTIFIERS

1A 50V	19p
1A 100V	20p
1A 400V	25p
1A 600V	30p
2A 50V	30p
2A 100V	35p
2A 400V	45p
3A 200V	60p
3A 600V	72p
4A 100V	95p
4A 400V	100p
6A 50V	80p
6A 100V	100p
6A 400V	120p
10A 400V	200p
25A 400V	400p

[illegible]

3A 400V	60p
6A 400V	70p
6A 500V	88p
8A 400V	75p
8A 500V	95p
12A 400V	85p
12A 500V	105p
16A 400V	110p
16A 500V	130p
T2800D	130p

THYRISTORS

3A 400V	100p
8A 600V	120p
12A 400V	160p
16A 100V	180p
16A 400V	180p
C106D	45p
MCR101	38p
TIC44	27p
2N3525	130p
2N4444	180p
2N5060	30p
2N5064	35p

PCB MOUNTING RELAYS

6 or 12V DC Coil SPDT 2A 24V DC	160p
6 or 12V DC Coil DPDT 5A 24V DC 240V AC	200p
6 or 12V DC Coil SPDT 10A 24V DC 240V AC	225p

ZENERS

2.7V-33V 400mW	9p
1W	15p

TECHNOMATIC LTD

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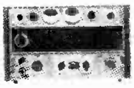
Detailed Price List on request.
Stock items are normally by return of post.



MARCONI SIGNAL GENERATORS

TF2002A/S (illustrated) 10kHz-72MHz. AM/FM. **£750**
TF2002. As above but AM only. **£450**
MARCONI TF1066B/1. AM/FM Generator. 10-470MHz. 0.2uV-200mV output. FM Deviation up to ±100kHz. **£550**
MARCONI TF995A/5. AM/FM Generator. Narrow deviation model 995 covering 1.5-220MHz. **£450.** TF995B/5 **£525.**
MARCONI TF1064B/5. AM/FM Signal generator covering in three ranges 68-108, 118-185 and 450-470MHz. FM fixed deviations of 3.5 & 10kHz. AM fixed 30%. **£225**

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Cat. No. 98A. Noise weighting filters for CCIR/ARM signal-to-noise ratio measurements. As new units. **£40** each (+£1 p&p).

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Miniature type (22mm diam.). Counting up to 15 turn "Helipots". Brand new with mounting instructions. Only **£2.50** each.

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We now have a stock of used but excellent condition, fully tested, variable (0-260V) transformers at the following ratings.
BERCO (enclosed) 2A .... **£12.50+£1.50 pp**
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ZENITH (enclosed) 8A .... **£26.00+£2.50 pp**
Also available, small quantity of Heavy Duty and 3 Phase Variacs. P.O.A.

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Switchable 1W & 10W FSD. Internal 3.5 & 8 Ohm load impedances. Housed in grey enamelled case 6×6×3". Large easy to read 3" sq. meter. Scope output provision. **£10** (+£1).
HEATHKIT Model AW-IU. Internal load switchable 3, 8, 15 & 600 Ohm. Meter scaled 0-50W (+dB scale). 5 Ranges from 5mW-50W FSD. Mains powered. **£25** (+£1).
MARCONI TF893A. 1mW-10W Full scale in 5 ranges. Impedances 2.5-20K Ohm in 48 steps. Direct calibration in Watts and dBm. **£85** (+£2).

GPO JACK SOCKET STRIPS. 20-WAY Type 320 (3-pole) **£2.50** ea. Type 520 (3-pole with switching contacts) **£4** ea. Please include 35p each for postage on these. GPO type 316 jack plugs for above **20p** ea. (10+ post free). Plus VAT please. Also recent stock of new, mint condition 720 Type, £6 each.

PHILIPS RF SIGNAL GENERATOR

As new condition Philips PM 5326. AM/FM RF Signal generator covering 0.1-125MHz. Integral 5 digit Frequency display. Mod AM & FM + Sweep facilities. 1 only available.

P. F. RALFE ELECTRONICS

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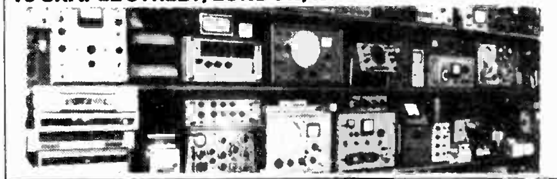
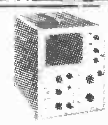


'ADVANCE' 'SCOPES – SPECIAL OFFER



A bulk purchase of Advance series 'scopes enables us to offer the following fully reconditioned, guaranteed units as follows.

OS2000 20MHz dual-beam. 10mV/cm. (2002Y & 2003X P.I.s) **£200.**
OS2100 30MHz dual-beam. 10mV/cm. (plug-in units as above) **£230.**
OS2200 25MHz dual-beam. 10mV/cm STORAGE. 2005X plug-in **£316.**

N.B. All these prices INCLUDE 15% VAT. Securicor despatch if required + £10 ea. We also have in stock various optional plug-in units such as Differential (50uV) Y-amp., Sweep-delay X-amp, etc. Please call for details. For full spec SAE please.

ADVANCE VM77D Millivoltmeters. 15Hz-4.5MHz. 1mV Full scale –300V AC **£55**
WOELKE ME104C. Wow & Flutter Meter **£95**
AVO Type 1 LCR Component Bridge.
WAYNE KERR AF Signal Generator Type S121 **£75**
AIRMEC Wave Analysers Models 853 and 248A.
CENTRONICS P1 Printer, one only. AND Type 663 Printer.
ROHDE & SCHWARZ SDR Signal Generator. 300MHz-1GHz.
HEWLETT PACKARD 608C Signal Generator. 10-480MHz AM.
MARCONI Component Bridge Model TF2700. (LC&R).
OKIDATA CORP Series 3300 Hard-Disc Drives.
TALLY Model 220 Line Printers.

BELL & HOWELL MICROFICHE VIEWERS

Type SR5. Screen size 9×5". Recent small quantity now avail. **£55**

DISC CARTRIDGES

BASF 12-Segment Single Hard Disc Cartridges. Brand new surplus stock.

SWEEPERS

TELONIC Sweep generator system type 2003. Fitted with Marker, attenuator, Detector plug-in units and Generator covering 800-1500MHz. **£325**

MUIRHEAD FACSIMILE UNITS

MUFAX 'COURIER' facsimile receiver type K441-CH and transmitters K400 AMCH in stock in excellent condition.

PLEASE NOTE. All the pre-owned equipment shown has been carefully tested in our workshop and reconditioned where necessary. It is sold in first-class operational condition and most items carry a three months' guarantee. For our mail order customers we have a money-back scheme. Repairs and servicing to all equipment at very reasonable rates. PLEASE ADD 15% VAT TO ALL PRICES.

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1. APT.10459/8. Stabilised Regulated supplies. New stock arrival hence LOWER PRICES. Available in preset output voltages between 6 and 30V DC (state requirements) ±4V approx. Three sizes available, 5A, 7½A & 10A. Prices **£20, £25 & £30** respectively (plus postage £2, £2.50 and £4).
2. Mullard Dual supplies. Pos/Neg 12V @ 1A & 0.4A. Dimensions 9×4×5". **£10** ea. (+£1 p&p).
3. Farnell Current limited. 13-17V DC @ 2A. **£15.** 27-32V DC @ 1A. **£15** (+£1 p&p).
4. Lambda LXS Series supplied 110V AC Input. 5V @ 14A. **£20** (+£2.50 p&p). Various other voltages available from stock in small quantity.
5. Coutant 5/6V @ 5A. Small size (7×5×3"). **£20** (+£1).
6. Variable 0-30V @ 1A. Volt-metered. **£30.**
7. Farnell 5V Switching. 60A. **£85.**

RF SIGNAL GENERATORS

ADVANCE Type E2. 100kHz-100MHz. Internal AM & Audio O/P. 1uV-100mV output. Price each **£50** inc. VAT.
TAYLOR Type 68A/M. 100kHz-240MHz. Internal Modulation. **£60** inc. VAT.
All of these units are in full working condition and carry our usual 90-Day Warranty. In both cases please add £2 each for carriage.

MILLI-VOLT MEASUREMENT, ANALOGUE

MARCONI TF2600. Twelve ranges 1mV-300V FSD. Wide-band to 10MHz.
MARCONI TF2603. Frequency range 50kHz-1.5GHz. High Sensitivity from 300uV.
MARCONI TF2604. Electronic Multi-meter. AC/DC 300mV Full scale to 300V (1kV DC). Resistance ranged. AC Frequency range 20Hz-1500MHz.

BRUEL & KJOER

Model 2006 Heterodyne Voltmeter. AM/FM/Voltage measurements to 240MHz.

CLAUDE LYONS 240V AC REGULATORS

Small quantity available of constant voltage mains regulators. Continuous current rating 5A. Model no. CVR-1200. Input 204-252V. Output adjustable 200-245V AC± 0.3%. 45-65Hz. Condition as new. (Dims– 11"×7"×6". Weight 20Kgs). **Price £95 ea. + Carriage £5.**

ROTRON INSTRUMENT COOLING FANS

Supplied in excellent condition, fully tested.
115V, 4.5×4.5×1.5" **£4.50.** 230V **£5.** 115V. 3×3×1.5" **£4** + postage ea. 35p.
Also brand new 230V at **£6** ea.

WW-10

PAN & TILT HEADS were used for CCTV Cameras heavy duty weight about 75 lbs will give 360° Pan & Tilt as two reversible 240v motors approx height 19" will adapt for Dish mount, ext soiled due to outdoor use, £65. VIDEO TAPE REC Philips type N1500 colour, RF in out, cassette type with circ £85. MAINS CONV. 24v DC I/P O/P 230v AC 50c/s 140 watts sine wave rotary type, £45. RADIOSONDE UNITS British Mk. II new cond. with chart & circ req 90/2v DC Tx on 27 Mc/s, £7.50. TEST SET. CT373 Audio bench T.S. AF Osc 17c/s to 170Kc, O/P var 300 Uv to 10v RMS into 600 ohm, Valve Voltmeter 30 Mill/V to 100v FSD in 7 ranges, Distortion meas set 20c to 20Kc, 3 ranges 10, 30 & 100% new condition with handbook & leads for 200/250v, £115. HIGH VOLTAGE TS 240 I/P O/P 15/20 or 25Kv in fitted wood case size 9×7×13" with leads, uses vibrator contact breaker, £27. MARCONI TF1102 ext AM modulators will handle sine, sq or video up to 300Mc/s with book, £25. FREQ CONV. I/P 240v O/P 115v 400c/s 1 phase sine wave 100 watts new solid state unit by Roband, £115. OSC AMP UNIT comprises 150 watt valve amp & var freq AF Osc 30c to 30Kc as O/P voltmeter and adjustable O/P impedance down to 16.7 ohm for 240v in table case, £115. TRIX A/C CABIN SPK UNITS size 17×3½×2½" as 4×3×3" 3 ohm spk units, £6.50. POWER UNITS 240v I/P provides O/P of 28v DC up to 15 amps semi reg load range 4/15a complete in case 7×7×16", £38. METERS Record circa scale 200/250v 50c size 4×4×3½" new, £15. Also freq meters 45/65c/s 230v 2½" dia, £11.50. Also misc panel meters mixed 4 for £6.50. COAX CABLE UR57 HD 75 ohm 10mm osd, £4.50 for 10mt, 30p mt over this new. RTTY TERM UNIT Redifon CSF unit 445/470kc reqs 25 Mill/V drive from 50 ohm, shift 400/1000c/s, standard 80-0-80 O/P reqs ext power unit with handbook good cond., £65. RECT. No. 7 110/200/250v or 12v DC I/P provides 80-0-80v at 30Ma, 12v etc can also be used to give 240v AC O/P from 12v DC I/P up to 40 watt in fitted wood case with circ, £8.50. H.F. Tx AMP UNITS ex A/C TX 2/18Mc/s 100 watts inc two 4X150s req ext drive & power with circ etc in case 8×8×12½", £27. CCTV System Philips medical system with high grade lens & Plumbicon tube, 19" mon cable, etc, with circs., £165. METER 0/100 amps DC with shunt 4½" £11.50. AERIALS Army 60 meter wire dipoles new £6.50. Also PYE 70/73Mc/s Ground plane aerials new 50 ohm £25 callers. MORSE KEYS min type for A510 new cond., £3.50. Misc items for callers. Parts from old Marc HF 5 Kw Tx, inc 4uf 6kv conds, parts from Marc, etc., Radar Speed meas equip.

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4164 200ns	3.99	3.56	3.42
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2114 450ns Low power	.95	.85	.80
4118 250ns	3.35	3.00	2.85
6116 150ns CMOS	3.55	3.20	2.95
2708 450ns	2.35	2.10	2.02
2716 450ns 5 volt	2.60	2.25	2.10
2716 450ns three rail	5.75	5.00	4.65
2732 450ns Intel type	3.50	3.15	3.00
2532 450ns Texas type	3.70	3.30	3.00

Z80A-CPU ....£3.95 780A-P10 ....£2.99 Z80A-CTC £2.99
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5 inch SSSD £17.00 5 inch SSDD £19.25 5 inch DSDD £21.00
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Supplier	Volt	Amps	O/H	Price
COUTANT	**240**			
ASC200	18	2A	5	22.00
ASA1000	5	10A	8	40.00
ASB200	12	2A	6	16.00
	6	5A	6	28.00
ATB200	15+15	2A	1	16.00
ICL035	10	2A	1	14.00
ASA500	6	5A	2	28.00
ASA1000	5	10A	12	44.00
ASA20018	16-24	2A	1	18.00
ASA5006	3-8	5A	2	26.00
OA2	15	0.1A	217	12.00
OA5	12	1A	3	14.00
IC200	5	2A	4	16.00
ED500	12	5A	1	24.00
SOL20/5	5	20A	1	80.00
LAMBDA				
LMCC28	30	3A	1	22.00
LOTX5152	12	0.5A	1	15.00
LJ51150V	5	20A	1	42.00
LOSY5	5	6A	2	28.00
LXSA5	5	4A	16	22.00
LM219263	22-32	1A	1	
LM219v	22-32	1.2A	1	24.00
FARNELL				
15/25	15	2A	56	18.00
15/25	6	15A	1	62.00
15/25	28	10A	2	52.00
A15	12-17	0.1A	8	12.00
15/25	15	2A	19	18.00
30/15	20	1A	26	15.00
A15			25	15.00
APTTSU	20	3A	2	24.00
73SC	5	3A	211	15.00
SSB MH	40	2A	1	
VOLSTAT	9-5	3.5A	2	21.00
ITT				
MR20AS51	5	20A	4	45.00
MR5AS51	5	5A	1	30.00
MQ10AS15	15	10A	2	48.00
MQ3BS301	30	3A	2	20.00
MR10AS4	4-5	10A	2	44.00
MQ5AS151	15	5A	2	24.00
PC250A15	+/-12-15	.25A	1	15.00
DIGIVUE			2	
AE00101	24	3.5A	5	64.00
BRANDENBURG				
374			20	30.00
375			2	30.00
376			4	30.00
GOULD				
MG24	24	15A	20	48.00

Supplier	Volt	Amps	O/H	Price
GRESHAM				
30/1	12	3.0A	3	31.00
GX15/2	15	2A	4	26.00
GX60/2C	60	2A	2	28.00
GX15/5B	15	5A	1	35.00
GX033	12	1A	1	
ELEC/ASSO				
10/0017	12	1A	2	
GOULD	**110**			
MG5	5	60A	27	95.00
MG24	24	8A	44	41.00
ADVANCE				
PMA35	15	5A	16	32.00
PMA34	30	10A		79.00
PMA17	7	3A	10	24.00
PMA46	50	1A	32	28.00
COUTANT				
KSG500	6	5A	1	27.00
ASA1000	5	10A	59	44.00
OA2		1A	4	
OA3	+/-12-15	.25A	11	18.00
ESM3	12-24	3A	4	21.00
EEMS7	12-24	7A	1	36.00
ESM15	12-24	15A	12	49.00
IC200	5	0.3A	4	16.00
LXSCC50V	5	16A	11	60.00
LMCC20	20	5A	.1	43.00
LAMBDA				
LXSC12R	12	6.5A	3	44.00
LCSC24	24	3.6A	19	26.00
LMD20	20	7.5A	2	36.00
LXDD152R	7.5	5A	3	43.00
LXDD152R	12-15	6.2A	9	48.00
LXB12R	12	3.8A	1	28.00
LXSD15R	15	14A	1	60.00
LMMCC5	5	10A	1	48.00
LXSA50VR	5	4A	14	27.00
FARNELL				
15/25	15	2A	3	18.00
5D15002T	5	150A	1	14.00
NCR/31505059	4	15A	1	38.00
GOULD/MG5	5	40A	47	80.00
ACO/SE50	5	100A	1	8.00
ITT/PM65A151	15	65A	12	8.00
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374	117		45	30.00
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376	117		5	30.00
388A	117		1	30.00
LAMBDA				
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LMD28	28	6A	1	40.00
LXSCC5R	5	16A	1	
LXSCC12R	12	10A	1	48.00
LXDC152R	12-15	2.5A	1	26.00

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By Micro Consultants Ltd, 50Ω cable drive op. Linearity 0.25%, max. 0.125% typ. Settling time; 2V step 70nS typ. 2MV step 50nS colour television transmission standard. Diff. gain 0.5% diff phase shift 0.5% types rad 802 and MC2208/8. Unused. Ex-maker's pack.

SPECIAL OFFER PRICE £10.00

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3-0-3V 100mA	£1.06
5-0-5V 400mA	£1.25
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6-0-6V 250mA	£1.16
0/6-0/6 280mA	£2.00
8-0-8V 400mA	£1.25
9-0-9V 75mA	£1.14
9-0-9V 3A	£3.00
11V 2A, 22V 1A	£2.00
12-0-12 50mA	£1.18
12-0-12V 100mA	£1.48
12V 130mA	£0.80
12-0-12V 250mA	£1.94
12V 1A5	£1.25
13V+6.5V Sec 2 Amp	£2.00
0-12-0-12 96VA	£8.00
15V 100mA	£1.00
0/12-0/12 500+500mA	£2.96
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12-0-12V 1 Amp	£3.36
15-0-15V 1 Amp	£3.62
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17V 300mA	£1.50
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6-0-6V 1.5 Amp	£3.20
20-0-20 400mA	£1.80
22-0-22 50mA	£1.00
24V 100mA	£1.00
24V 250mA	£1.50
25V+6.2V Sec 1.6 Amp	£1.90
30,24,20,15,12,2 Amp	£7.96
9-0-9 2 Amp	£4.70
12V 2 Amp	£4.84
20-0-20V 2 Amp	£6.98
30-0-30V 2 Amp	£7.96
30V 250mA	£1.50
30-25-0-25-30 1A6	£6.00
0-2-4-6-8-10 5A	£6.00

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Switchcraft XLR Connectors always in stock. Discounts on quantity.

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170×100×50mm	£1.65
200×120×80mm	£3.55

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3 Phase 20 AM Filters 433V 50/60Hz Phase to Phase 250V AC 50/60Hz Phase to Neutral mfr. by Corcom Chicago Il., USA., **£15 each.**
Single Phase Filter 30 Amps 125V 60Hz by Potter **£5.00**
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All the above mentioned Filters are brand new. Carriage extra.

SPECIAL OFFER! 0.1% TOL resistors. The following values available. 2K, 3K, 10K, 30K, 1 Mega ohms. Welwyn or Filmet. Price **30p each.**

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10A 250V AC ILLUMINATED ROCKER SWITCH
Red, DP ST 26×30mm rectangular snap-in type. **£0.75**

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01-800 Rectangular snap-in series

2PCO Latching	£1.50
2PCO Momentary	£1.50
Indicator only	£0.50

Lenses available in red or white only.

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AB10 4×5.25×1.5in. (101.6×133.4×38.1mm)	£1.12
AB11 4×2.50×2in. (101.6×63.5×50.8mm)	£0.96
AB12 3×2×1in. (76.2×50.8×25.4mm)	£0.70
AB13 5×4×2in. (152.4×101.6×50.8mm)	£1.38
AB14 7×5×2in. (177.8×127.0×50.8mm)	£1.64
AB15 8×6×3in. (203.2×152.4×76.2mm)	£1.98
AB16 10×7×3in. (254.0×177.8×76.2mm)	£2.70
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79	1	2	**4.32**	1.40
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90	12	24	**23.20**	OA
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(AMPS)

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235	330, 330	0-9, 0-9	**2.41**	.90
207	500, 500	0-8-9, 0-8-9	**3.36**	1.20
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236	200, 200	0-15, 0-15	**2.41**	.90
239	50MA	12-0-12	**3.11**	.90
214	300, 300	0-20, 0-20	**3.39**	1.20
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206	1A, 1A	0-15-20, 0-15-20	**5.60**	1.60
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Pri 0-120V×2

2×30V tapped secs volts available 6, 8, 10, 12, 16, 18, 20, 24, 30, 36, 40, 48, 60V, or 24V-0-24V or 30V-0-30V

Ref.	60v	30v	£	P&P
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126	1	2	**7.15**	1.50
127	2	4	**9.20**	1.90
125	3	6	**13.31**	2.02
123	4	8	**15.15**	2.26
40	5	10	**19.16**	2.24
120	6	12	**21.86**	2.64
121	8	16	**30.72**	OA
122	10	20	**35.76**	OA
189	12	24	**41.22**	OA

(AMPS)

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Ref.	VA (Watts)	TAPS	£	P&P
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67	500	0-10-115-200-220-240V	**13.30**	2.24
84	1000	0-10-115-200-220-240V	**22.70**	2.80
93	1500	0-10-115-200-220-240V	**28.17**	OA
95	2000	0-10-115-200-220-240V	**42.14**	OA
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80	4000	0-10-115-200-220-240V	**93.01**	OA
57	5000	0-10-115-200-220-240V	**108.30**	OA

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Ref.	50v	25v	£	P&P
102	0.5	1	**4.13**	1.40
103	1	2	**5.03**	1.40
104	2	4	**8.69**	1.84
105	3	6	**10.36**	1.90
106	4	8	**14.10**	2.12
107	6	12	**18.01**	1.84
118	8	16	**24.52**	2.70
119	10	20	**30.23**	OA
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2000	**£60.47**	OA	95W

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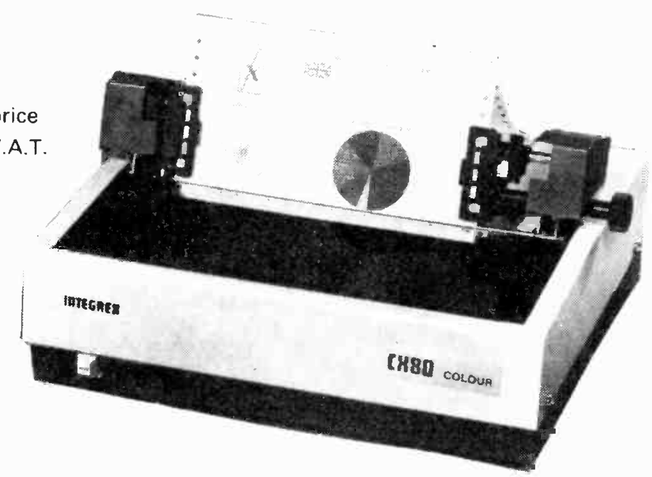

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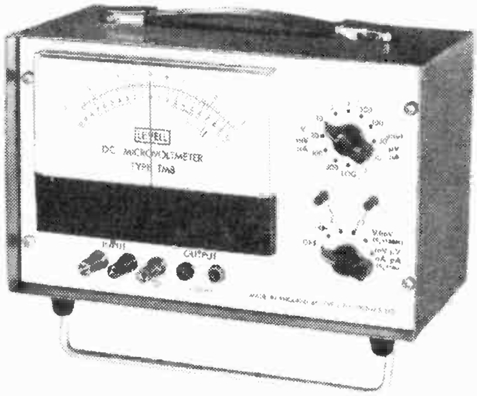

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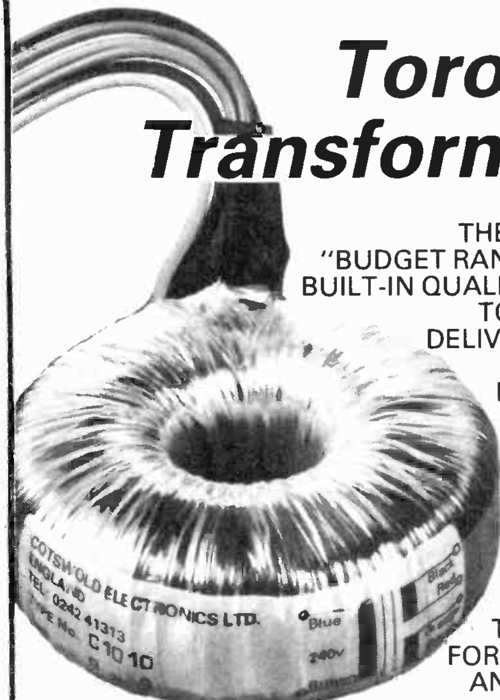

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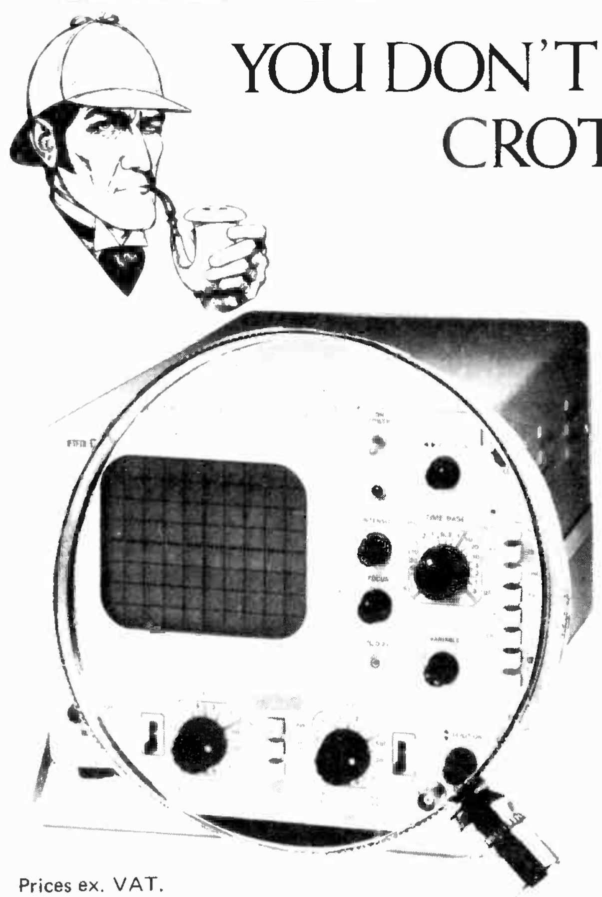

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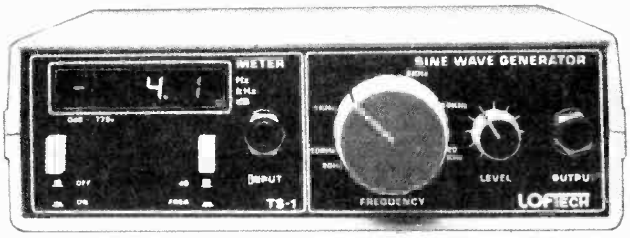

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AUTONNIC PUSH-BUTTON TUNER. 4 × Med. Wave, 1 × Long Wave plus manual control. Overall length 14cm, depth 5cm, height 33mm. Excellent unit for the manufacture of a competitive car radio. £15 for 10 + V.A.T.; £68 for 50 + V.A.T.; £125 for 100 + V.A.T.; £565 for 500 + V.A.T.; £1,020 for 1,000 + V.A.T.; £2,300 for 2,500 + V.A.T. Sample sent for £2 + £1 P. and P. (£3.45 inc. V.A.T.).

BRITISH-MADE TRANSFORMER. Input 240V at 50HZ, output 12V-0-12V, ½ amp. with built-in thermal overload output, p.c. mounting; £25 for 10 + V.A.T.; £115 for 50 + V.A.T.; £210 for 100 + V.A.T.; £950 for 500 + V.A.T.; £1,700 for 1,000 + V.A.T. Samples sent for £3 + 75p P. and P. (£4.31 inc. V.A.T.).

150-WATT HINCHLEY DROP-THROUGH TRANSFORMER. Input 220/240V. A.C., output 30-0-0 with 14V. tap width 96mm × 80mm × 54mm deep inc. winding, etc., 90mm; approx weight 2.7 kgs.; £75 for 10 + V.A.T.; £350 for 50 + V.A.T.; £620 for 100 + V.A.T.; £2,800 for 500 + V.A.T.; £5,100 for 1,000 + V.A.T. Sample sent for £9 + £2 P. and P. (£12.65 inc. V.A.T.).

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BSR	P170	Rim	Ceramic	£20
BSR	P232	Belt	Ceramic	£24
GARRARD	6200	Rim	Ceramic	£22
GARRARD	Delux	Belt	Magnetic	£40
BSR	P204	9 volt	Ceramic	£18
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BSR	Budget	Rim	Ceramic	£16
BSR	Delux	Rim	Ceramic	£18

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Post £2
Cut out for most BSR or Garrard decks. Silver grey finish, black trim. Size 16×13¾in. **£4**

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17⅞×13⅛×3¼in.	£5	18¼×12½×3in.	£5
17¼×9⅜×3½in.	£3	14⅜×12½×2⅞in.	£5
16½×15×4½in.	£5	16⅝×13×4in.	£5
17×12⅞×3½in.	£5	14½×13⅛×2¾in.	£5
22⅝×13⅞×3in.	£5	17¼×13¾×4⅛in.	£5
21½×14¼×2½in.	£5	21×13⅞×4⅛in.	£5
23¾×14×3⅞in.	£5	30¾×13⅜×3¼in.	£5

THE "INSTANT" BULK TAPE ERASER £9.50 Post 95p
Suitable for cassettes and all sizes of tape reels. AC mains 200/250V. Hand held size with switch and lead (120 volt to order). Will also demagnetise small tools and computer tapes.
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BATTERY ELIMINATOR MAINS to 9 VOLT D.C.
Stabilised output, 9 volt 400 m.a. U.K. made in plastic case with screw terminals. Safety overload cut out. Size 5×3¼×2½in. Transformer Rectifier Unit. Suitable Radios, Cassettes, models, **£4.50**. Post 50p.
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EMI 13½x8in. LOUDSPEAKERS
Model 450A, 10 watts R.M.S. with moving coil tweeter and two-way crossover; 3 ohm or 8 ohm. "Final Clearance".
SUITABLE BOOKSHELF CABINET £6.50. Size 18×11×6in. Post £1.50.
Sale Price £8 Post £1.50

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TOGGLE SWITCHES SP **40p.** DPST **50p.** DPDT **60p.**
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RESISTORS. 10Ω to 10M. ¼W, ½W, 1W, **2p**; 2W **10p**; Low ohm 1 watt 0.47 to 3.9 ohm **10p.**
HIGH STABILITY. ½w 2% 10 ohms to 1 meg. **10p.**
WIRE-WOUND RESISTORS 5 watt, 10 watt, 15 watt **20p.**
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BSR Stereo Ceramic SC7 Medium Output **£2.** SC12 **£3.**
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1P 12W; 2P 2W; 2P 6W; 3P 4W; 4P 2W; 4P 3W.
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2.5mm and 3.5mm **JACK SOCKETS 25p. Plugs 25p.**
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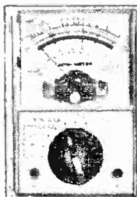

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DC volts 5.25, 250, 500.
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Resistance 0 to 600K ohms.
£6.50 Post 50p
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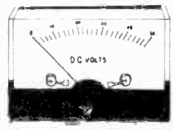
50μa, 100μa, 500μa, 1ma, 5ma, 50ma, 100ma, 500ma, 1 amp, 2 amp, 25 volt, VU 2¼×2×1¼. Stereo VU 3¼×1⅝×1in.
£4.50 Post 50p



RCS SOUND TO LIGHT CONTROL BOX
Complete ready to use with cabinet size 9×3×5in 3 channel, 1000 watt each. For home or disco Input 200mV to 100 watt. AC 200/250V. Post £1. **£27**
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Rope lights, 4 channel, 11ft with controller **£33.** PP £1.
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This kit is suitable for record players, guitars, tape playback, electronic instruments or small PA systems. Two versions available: Mono, **£14**; Stereo, **£20.** Specification 10W per channel; size 9½×3×2in. SAE details. Full instructions supplied. 240V AC mains. Post £1.

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350-0-350V 250mA, 6.3V 6A CT	£12.00	£2
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250V 60mA, 6V 2A	£4.75	£1
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Tapped outputs available

	Price	Post
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2 amp. 6, 8, 10, 12, 16, 18, 20, 24, 30, 36, 40, 48, 60	£10.50	£2
3 amp. 6, 8, 10, 12, 16, 18, 20, 24, 30, 36, 40, 48, 60	£12.50	£2
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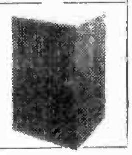
6V. ½ amp.	£2.00	£1	15-0-15V. 2 amps	£4.50	£1
6-0-6V. 1½ amp.	£3.50	£1	20V 1 amp	£4.00	£1
9V. 250ma.	£1.50	£1	20-0-20V 1 amp	£4.50	£1
9V. 3 amp	£3.50	£1	20-40-60V 1 amp	£4.50	£2
9-0-9V. 50ma	£1.50	£1	25-0-25V 2 amps	£5.50	£1
9-0-9V. 1 amp	£3.50	£1	28V 1 amp Twice	£6.00	£2
10-0-10V. 2 amps	£4.00	£1	30V 1½ amp	£4.50	£1
10-30-40V. 2 amps	£4.50	£1	30V 5 amp and 17-0-17 2a	£5.50	£2
12V. 100ma	£1.50	£1	35V 2 amps	£4.50	£1
12V. 750 ma	£2.50	£1	TOROIDAL 30-0-30V 4a and 20-0 20V ½a	£10.00	£2
12V 3 amps	£4.50	£1			
12-0-12V. 2 amps	£4.50	£1			
CHARGER TRANS		Post	**RECTIFIERS**		Post
6-12 volt 3a	£4.50	+ £2	6-12 volt 2a	£1.10	+ 80p
6-12 volt 4a	£6.50	+ £2	6-12 volt 4a	£2.00	+ 80p

OPUS COMPACT SPEAKERS £22 pair
Post £2
TEAK VENEERED CABINET
11×8½×7in, 15 watts
50 to 14,000 cps. 4 ohm or 8 ohm
OPUS TWO 15×10½×7¾in 25 watt 2-way system **£39 pair.** Post £3



LOW VOLTAGE ELECTROLYTICS Wire ends **10p**
1 mf, 2 mf, 4 mf, 8 mf, 10 mf, 16 mf, 25 mf, 30 mf, 50 mf, 100 mf, 250 mf. All 15 volts. 22 mf/6v/10v; 25 mf/6v/10v; 47 mf/10v; 50 mf/6v; 68 mf/6v/10v/16v/25v; 100 mf/10v; 150 mf/6v/10v; 200 mf/10v/16v; 220mf/4v/10v/16v; 330 mf/4v/10v; 500 mf/6v; 680 mf/6v/10v; 1000 mf/2.5v/4v/10v; 1500 mf/6v/10v/16v; 2200 mf/6v/10v; 3300 mf/6v; 4700 mf/4v.
500mF 12V **15p**; 25V **20p**; 50V **30p.** 1200mF 76V **80p.**
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2000mF 6V **25p**; 30V **42p**; 40V **60p**; 1500mF 100V **£1.20.**
2200mF 63V **90p.** 2500mF 50V **70p**; 3000mF 50V **65p**;
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1mF 250V **25p**; 1.5mF 100V **25p**; 2.2mF 250V **30p**; 3.3mF 100V **40p**; 4.7mF 100V **40p**; 10mF 63V **40p**; 32mF 50V **25p**; 47mF 50V **40p.**

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2/500V	45p	32+32+16/350V	90p	8+8/500V	£1
8/450V	45p	100+100/275V	65p	8+16/450V	75p
16/350V	45p	150+200/275V	70p	16+16/350V	80p
32/500V	95p	220/450V	95p	32+32/350V	85p
32/350V	50p	32+32+32/325V	75p	32+32/500V	£1.80
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.001, .002, .003, .005, .01, .02, .03, .05 mfd 400V **5p.**
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50pF Single gang **95p. GEARED TWIN GANGS** 25pF **95p.** 365+365+25+25pF **£1.**

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Size 11×9×⅛in. Operating voltage 240V, 250W approx. Suitable for Heating Pads, Food Warmers, Convector Heaters, Propagation, etc. Must be clamped between two sheets of metal or ceramic, etc.
ONLY **60p** EACH (FOUR FOR **£2**) ALL POST PAID.

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high power full range quality loudspeakers. British made. Ideal for Hi-Fi, music P.A. or discotheques. These loudspeakers are recommended where high power handling is required with quality results.

MODEL	INCHES	OHMS	WATTS	TYPE	PRICE	POST
MAJOR	12	4-8-16	30	HI-FI	£16	£2
SUPERB	12	8-16	30	HI-FI	£26	£2
AUDITORIUM	12	8-16	45	HI-FI	£24	£2
AUDITORIUM	15	8-16	60	HI-FI	£37	£2
GROUP 45	12	4-8-16	45	PA	£16	£2
GROUP 75	12	4-8-16	75	PA	£20	£2
GROUP 100	12	8-16	100	Guitar	£26	£2
DISCO 100	12	8-16	100	Disco	£26	£2
GROUP 100	15	8-16	100	Guitar	£35	£2
DISCO 100	15	8-16	100	Disco	£35	£2

BAKER AMPLIFIERS BRITISH MADE

NEW PA150 MICROPHONE PA AMPLIFIER £129
4 channel 8 inputs, dual impedance, 50K-600 ohm 4 channel mixing, volume, treble, bass. Presence controls, Master volume control, echo/send/return socket. Slave sockets. Post £3.

BAKER 150 Watt AMPLIFIER 4 Inputs £99
For Discotheque, Vocal, Public Address. Three speaker outlets for 4, 8 or 16 ohms. Four high gain inputs, 20 mv, 50K ohm. Individual volume controls "Four channel" mixing. 150 watts 8 ohms R.M.S. Music Power. Slave output 500 M.V. 25K.ohm. Response 25 Hz – 20kHz ± 3dB. Integral Hi-Fi preamp separate Bass & Treble. Size – 16"×8"×5½". Wt – 14lb: Master volume control. British made. 12 months' guarantee. 240v A.C. mains or 120V to order. All transistor and solid state. Post £2.
MONO SLAVE £80. 100 Volt Line Model £114. Post £2.
New Stereo Slave 150 + 150 watt 300 watt Mono £125. Post £4.

BAKER 50 WATT AMPLIFIER
£69 Post £2

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RCS offers MOBILE PA AMPLIFIERS. Outputs 4-8-16 ohms
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Mic 1; Mic 2; Phono; aux. outputs 4 or 8 or 16 and 100v line
60-watt RMS, Mobile 24 volt DC & 240-volt AC mains, inputs 50K. 3 mics + 1 music. Outputs 4-8-16 ohm + 100 volts line **£95** PP £2

Battery only Portable PA Amplifier 10w max. Includes mike and speaker, OK for meetings, crowd control, stalls, fetes, traders, parties, etc. Batteries included (6 of U2) **£27.50** post £2.

R.C.S. 100 watt R.M.S. VALVE AMPLIFIER
4 Channel mixing. Master treble, bass and volume controls. 5 Speaker outlets, suits 4, 8, 16 ohm. Disco group. **£125.** Carr. & ins. £15.
60 WATT VALVE AMPLIFIER, 3 mixer inputs, 4-8-16 ohm, 100 volt line. 5 controls **£59,** post £4

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MAKE	MODEL	SIZE	WATTS	OHMS	PRICE	POST
WHARFEDALE	TWEETER	4in	30	8	£7.50	£1
GOODMANS	TWEETER	3½in	25	8	£4	£1
AUDAX	TWEETER	4in	30	8	£6.50	£1
AUDAX	MID-RANGE	4in	50	8	£7.50	£1
SEAS	MID-RANGE	4½in	100	8	£12.50	£1
AUDAX	WOOFER	5½	25	8	£10	£1
GOODMANS	HIFAX	7½×4¼	100	4/8/16	£27	£2
GOODMANS	WOOFER	8in	25	4/8	£6.50	£1
GOODMANS	HB	8in	60	8	£12.50	£1
WHARFEDALE	WOOFER	8in	30	8	£9.50	£2
AUDAX	WOOFER	10in	50	8	£16	£2
GOODMANS	HPG	12in	120	8/15	£29.50	£2
GOODMANS	GR12	12in	90	8/15	£27.50	£2
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15 ohm, 2¼in, 3½in, 5×3in, 6×4in, **£2.50.**6½in 10W **£5.** 8in **£4.**
25 ohm, 3in, **£2**; 5×3in, 6×4in, 7×4in, **£2.50. 120 ohm,** 3¼in dia. £1.
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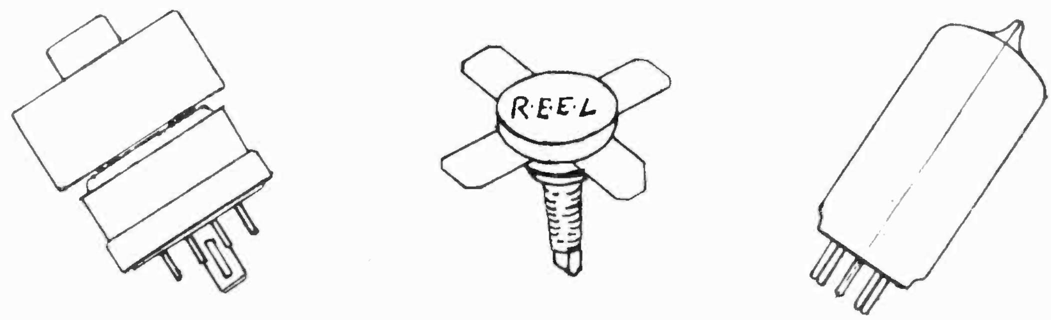

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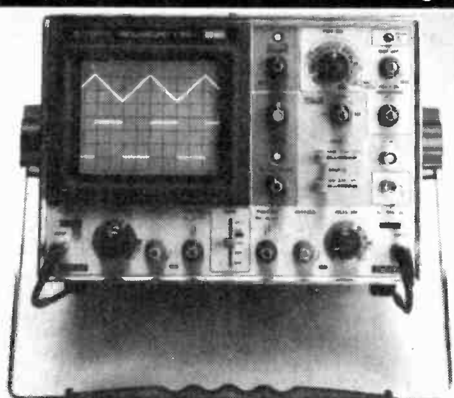

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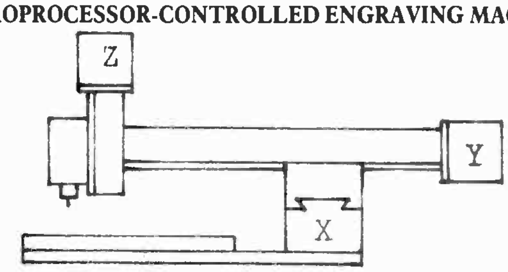

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71	2	1	**4.25**	1.00
18	4	2	**4.91**	1.20
85	5	2.5	**6.78**	1.20
70	6	3	**7.69**	1.20
108	8	4	**8.98**	1.30
72	10	5	**9.82**	1.50
116	12	6	**10.89**	1.50
17	16	8	**12.97**	1.50
115	20	10	**17.46**	1.60
187	30	15	**21.69**	1.70
226	60	30	**44.45**	2.00

30 VOLT RANGE

Ref.	Amps	£	£
112	0.5	**3.19**	1.00
79	1.0	**4.32**	1.00
3	2.0	**6.99**	1.20
20	3.0	**8.10**	1.30
21	4.0	**9.67**	1.40
51	5.0	**11.95**	1.40
117	6.0	**13.52**	1.50
88	8.0	**18.10**	1.80
89	10.0	**20.88**	1.90
90	12.0	**23.20**	4.00
91	15.0	**26.60**	4.00
92	20.0	**35.64**	4.00

50 VOLT RANGE

Ref.	Amps	£	£
102	0.5	**4.13**	1.10
103	1.0	**5.03**	1.10
104	2.0	**8.69**	1.30
105	3.0	**10.36**	1.50
106	4.0	**14.10**	1.60
107	6.0	**18.01**	1.70
118	8.0	**24.52**	2.00
119	10.0	**30.23**	4.00
109	12.0	**36.18**	4.00

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Ref.	Amps	£	£
124	0.5	**4.70**	1.20
126	1.0	**7.15**	1.20
127	2.0	**9.20**	1.40
125	3.0	**13.31**	1.50
123	4.0	**15.15**	1.70
40	5.0	**19.16**	1.70
120	6.0	**21.86**	2.00
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Brand new monitors, 14" screen, RGB input bandwidth 10meg sync level .75V-5V P to P 625 lines 50 or 60 frames per sec, power consumption 70 watts. Ideal for use with the BBC computer. Special offer price **£145** + VAT.

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Usual price approx. £88
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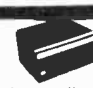
COMPUTER 'CAB'



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.
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Keep your hot parts COOL and RELIABLE with our range of **BRAND NEW** professional cooling fans.
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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

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7100 Single sided £225.00 + Carr. **7200 Double sided £295.00** + Carr.
Optional accessories: Full technical manual £20.00 alone. £10.50 with drive. Refund of difference on drive purchase. DC and AC power connector and cable kit £8.45. 50 way IDC connector £5.50. 50 way ribbon cable £3.20 per metre.

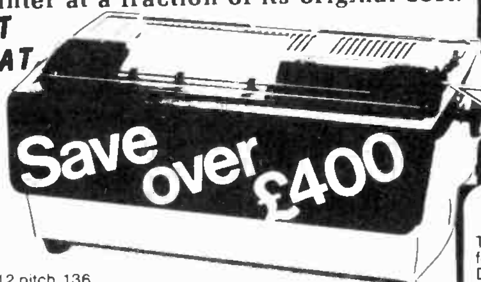
VIDEO MONITORS

MOTOROLA 9" open chassis monitor. Standard 240 v AC with composite 75 ohm video input, bandwidth in excess of 18 mhz. Monitors are ex equipment and although unguaranteed they are all tested prior to despatch, and have no visible burns on the screens. Dim approx. 9" x 9" x 9". Supplied complete with mains and input lead. Ideal ZX81 etc. or giving the tele back to the family!! Black and white phosphor. **£35.00** + £9.00 Carr.
12" CASED. Made by the British KGM Co. Designed for continuous use as a data display station, unit is totally housed in an attractive brushed aluminium case with ON-OFF, BRIGHTNESS and CONTRAST controls mounted to one side. Much attention was given to construction and reliability of this unit with features such as, internal transformer isolated regulated DC supply, all components mounted on two fibre glass PCB boards – which hinge out for ease of service, many internal controls for linearity etc. The monitor accepts standard 75 ohm composite video signal via SO239 socket on rear panel. Bandwidth of the unit is estimated around 20 Mhz and will display most high def graphics and 132 x 24 lines. Units are secondhand and may have screen burns. However where burns exist they are only apparent when monitor is switched off. Although unguaranteed all monitors are tested prior to despatch. Dimensions approx. 14" high x 14" wide by 11" deep. Supplied complete with circuit. 240 volt AC operation. ***ONLY £45.00 PLUS £9.50 CARR.***
14" COLOUR superb chassis monitor made by a subsidiary of the HITACHI Co. Inputs are TTL RGB with separate sync. and will plug direct into the BBC micro etc. Exceptional bandwidth with good 80 col. definition. Brand new and guaranteed. Complete with full data & circuit. 240 v AC working. Dim. 14" x 13" x 13". ***ONLY £199.00 PLUS £9.50 CARR.***

SUPER DEAL? NO — SUPER STEAL!!

The FABULOUS 25CPS TEC Starwriter Daisy wheel printer at a fraction of its original cost.

BRAND NEW AT ONLY £499 + VAT



Made to the very highest spec. the **TEC Starwriter FP1500-25** features a heavy duty die cast chassis and DIABLO type print mechanism giving superb registration and print quality. Micro-processor electronics offer full DIABLE/QUME compatibility plus Bi directional printing, 10 or 12 pitch, 136 or 163 chars per line, full width 381 mm friction or single sheet paper, – order now or call sales office for more information and print sample. Please specify RS232 or CENTRONICS interface. Supplied complete with **FREE** dust cover and daisy wheel.
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FROM £195 + CAR. + VAT
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Options: Floor stand ***£12.50*** + VAT
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The amazing SOFTY 2. The complete "toolkit" for the open heart software surgeon. Copies, Displays, Emulates ROM, RAM and EPROMS of the 2516, 2532 variety. Many other features include keyboard, UHF modulator. Cassette interface etc. Functions exceed capabilities of units costing 7 times the price! Only ***£169.00*** pp £1.95 *Data sheet on request*

RECHARGEABLE BATTERIES

CYCLON type D001 sealed lead acid maintenance free 2v 2.5 ah. will deliver over 300 amps on short circuit!! Brand new at only ***£2.95***

D.C. POWER SUPPLY SPECIALS

Experimentors PSU Ex-GPO unit all silicon electronics. Outputs give +5v @ 2 amps. +12v @ 800 ma. -12v @ 800 ma. +24v @ 350 ma. 5v @ 50 ma. floating. Dim 160 x 120 x 350 mm. All outputs fully regulated and short circuit proof. Removed from working equipment, but untested. Complete with circuit. Transformer guaranteed. Only ***£14.50*** + £2.50 pp.
CUSTOM POWER CO55 5v @ 3 amp. Very compact unit dim. approx 60 x 90 x 190 mm. Semi open chassis, full crowbar overvoltage protection. Tested Ex Equipment. ***£11.95*** + pp £1.25
MINI SYSTEM PSU Ex equipment unit ideal for the small micro. Outputs give 5v @ 3 amps. +12v @ 1 amp and -12v @ 300 ma. Crowbar overvoltage protection and current limit. Fully tested. Dim 70 x 165 x 320 mm. Complete with Circuit only ***£12.95*** + £2.00 pp.
PERIPHERAL SYSTEM SUPPLY. Fully cased unit supplied in a Brand new or little used condition. Outputs give 5v @ 11 amps. "+" 15-17v @ 8 amps. "–" 15-17v @ 8 amps and "+" 24v @ 4 amps. All outputs are crowbar protected and the 5 volt output is fully regulated. Fan cooled. Supplied tested, with circuit ***£55.00*** + £8.50 carr.
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MODEM 2B/C Fully fledged, up to 300 baud async, ANSWER & CALL modes, auto answer, auto switching, ideal networks etc. Just 2 wire connection to comms line. **£85.00**
MODEM 20-1 Compact unit for use with PRESTEL or full duplex 2 wire link. 75 baud transmit – 1200 baud receive. Auto answer. **£130.00**
MODEM 20-2 same as 20-1 but 75 baud receive 1200 baud transmit. **£130.00**
MODEM 20-3 Made for data rates up to 1200 baud in full duplex mode over 4 wire circuit or half duplex mode over 2 wires. **£130.00**
Carriage. 13A £4.50. 2B/C & 20 £9.50.
For more details contact sales office.

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 play plus we always include something from our ads. for unbeatable value!! Sold by weight.

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All prices quoted are for U.K. Mainland, paid cash with order in Pounds Stirling PLUS VAT. Minimum order value ***£2.00***, Minimum Credit Card order ***£10.00***. Minimum BONA FIDE account orders from Government depts., Schools, Universities and established companies ***£20.00*** Where post and packing not indicated please ADD 60p + 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.

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DAF91	0.45
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DH63	1.20
DH77	0.90
DH79	0.56
DH149	2.00
DK91	0.90
DK92	1.20
DK96	2.50
DL35	1.00
DL63	1.00
DL70	2.50
DL73	2.50
DL91	1.50
DL92	0.60
DL93	1.10
DL96	2.50
DLS10	8.00
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DM70	1.10
DM160	2.75
DY51	1.00
DY80	1.20
DY86/87	0.55
DY802	0.60
E1T	9.00
E55L	21.50
E80CC	7.00
E80CF	10.00
E80F	9.50
E80L	9.50
E81CC	3.50
E81L	12.00
E82CC	3.50
E83CC	3.50
E83F	3.50
E86C	9.50
E88C	6.00
E88CC	2.60
E90CC	5.00
E90F	7.95
E91H	4.50
E92CC	2.25
E99F	6.99
E130L	14.50
E180CC	6.50
E182CC	9.00
E180F	6.50
E186F	8.50
E280F	19.50
E283CC	10.00
E288CC	13.50
E810F	16.00
E1148	1.00
EA50	1.00
EA76	1.95
EA79	1.95
EAA91	0.60
EABC80	0.68
EAC91	2.50
EAF42	1.20
EAF801	1.40
EB34	1.50
EB41	3.00
EB91	0.52
EBC33	2.50
EBC41	1.95
EBC81	0.85
EBC90	0.75
EBC91	0.75
EBF33	2.50
EBF80	0.50
EBF83	0.50
EBF85	0.95
EBF89	0.70
EBF93	0.95
EBL1	1.50
EBL21	2.00
EBL31	3.95
EC52	0.75
EC80	4.25
EC81	4.50
EC86	1.00
EC88	1.00
EC90	0.70
EC91	7.00
EC92	1.25
EC93	0.80
EC95	7.00
EC97	1.10
EC8010	6.00
ECC32	3.00
ECC33	3.50
ECC35	3.50
ECC40	3.00
ECC81	0.85
ECC81 Mullard	1.10
ECC82	0.55
ECC82 Philips	1.10
ECC83	0.65
ECC83 Mullard	1.35
ECC83 Philips	1.10
ECC84	0.50
ECC85	0.60
ECC86	1.45
ECC88	0.75
ECC91	2.00
ECC180	0.72
ECC189	0.78
ECC801S	3.50
ECC803S	3.50
ECC804	0.60
ECC807	1.95
ECC808	2.95
ECC2000	12.00
ECF80	0.72
ECF82	0.60
ECF86	1.70
ECF200	1.85
ECF202	1.85
ECF801	0.85
ECF804	6.00
ECF805	2.50
ECF806	10.25
ECH3	2.50
ECH4	3.00
ECH35	1.60
ECH42	1.00
ECH81	0.58
ECH83	0.78
ECH84	0.69
ECH2000	1.50
ECL80	0.60
ECL82	0.65
ECL83	2.50
ECL84	0.74
ECL85	0.69
ECL86	0.74
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ED5100	3.50
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EF39	1.00
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EF42	3.50
EF50	1.50
EF55	2.25
EF71	1.50
EF72	1.20
EF73	1.00
EF80	0.55
EF83	3.50
EF85	0.50
EF86	0.95
EF86 Mullard	1.50
EF89	0.85
EF91	1.25
EF92	2.50
EF93	0.85
EF94	0.55
EF95	1.00
EF97	0.90
EF98	0.90
EF183	0.65
EF184	0.65
EF731	1.80
EF732	1.80
EF800	11.00
EF804S	9.85
EF805S	9.85
EF806S	9.85
EF812	0.65
EFL200	1.50
EH90	0.72
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EL32	0.95
EL33	4.00
EL34	1.95
EL34 Mullard	2.95
EL36	1.50
EL37	9.00
EL38	6.00
EL41	2.25
EL42	2.00
EL81	3.95
EL82	0.58
EL84	0.69
EL85	4.50
EL86	0.85
EL90	1.25
EL91	6.00
EL95	0.70
EL183E	3.50
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EL360	7.95
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EM34	7.50
EM35	1.50
EM80	0.70
EM81	0.70
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EM85	1.10
EM87	1.10
EN10	8.00
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GZ31	1.00
GZ32	1.00
GZ33	4.50
GZ34	2.15
GZ37	4.50
HAA91	1.00
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HBC91	0.80
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HF94	0.60
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HL41DD	3.50
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HL90	0.70
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KT41	4.00
KT44	4.00
KT45	4.00
KT61	3.50
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KT66 USA	6.00
KT66 GEC	9.95
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M8162	5.50
M8163	3.85
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M8195	3.00
M8196	3.25
M8204	2.00
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PC97	1.10
PC800	1.10
PC900	0.75
PCC84	0.40
PCC85	0.54
PCC88	0.70
PCC89	0.70
PCC189	0.70
PCC805	0.70
PCC806	0.80
PCE82	0.80
PCF80	0.65
PCF82	0.60
PCF84	0.65
PCF86	1.20
PCF87	0.40
PCF200	1.35
PCF201	1.35
PCF800	0.40
PCF801	1.35
PCF802	0.60
PCF805	1.48
PCF806	1.00
PCF808	1.25
PCH200	1.10
PCL82	0.80
PCL83	2.50
PCL84	0.75
PCL85	0.80
PCL86	0.65
PCL200	1.60
PCL800	0.80
PCL805	0.80
PD500	3.50
PD510	3.65
PEN4DD	2.00
PEN25	2.00
PEN4ODD	2.50
PEN45	3.00
PEN45DD	3.00
PEN46	2.00
PFL200	1.25
PL21	2.50
PL33	1.25
PL36	0.95
PL38	1.50
PL81	0.72
PL81A	0.72
PL82	0.60
PL83	0.52
PL84	0.80
PL88	1.00
PL95	1.20
PL302	1.00
PL345	12.50
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PL504	0.95
PL508	1.95
PL509	4.85
PL519	4.95
PL802	4.50
PL820	2.95
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PY81	0.70
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PY83	0.70
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QS72/20	1.50
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QS1206	1.05
QS1207	0.90
QS1208	0.90
QS1209	2.00
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QS1211	1.50
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QS1213	5.00
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U191	0.70
U192	1.00
U193	0.65
U251	1.00
U291	0.60
U301	0.55
U801	0.75
UABC80	0.65
UAF42	1.00
UBF80	0.60
UBC41	1.75
UBC81	1.50
UBF89	0.60
UBL21	1.75
UC92	1.20
UCC84	0.70
UCC85	0.60
UCF80	1.00
UCH21	1.20
UCH42	1.35
UCH81	0.65
UCL82	0.80
UF41	1.15
UF42	1.15
UF80	0.80
UF89	1.50
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6BG6G	1.25
6BH6	1.20
6BH8	1.50
6BJ6	1.20
6BK4	4.00
6BK7A	1.95
6BM8	0.58
6BN4	1.65
6BN6	1.65
6BN7	4.50
6BN8	2.75
6BQ5	0.69
6BQ7A	0.72
6BL8	0.65
6BR5	0.70
6BR7	4.15
6BR8	2.15
6BR8A	2.15
6BS7	4.50
6BS8	2.50
6BW4	1.50
6BW6	5.35
6BW7	1.50
6BW8	4.00
6BX6	0.48
6BX7GT	3.50
6BZ6	2.00
6BZ7	2.95
6BZ8	0.95
6C4	0.80
6C6	0.50
6C8G	1.50
6C11	2.50
6C15	2.50
6C18	2.50
6CA4	0.60
6CA7	4.50
6CB6	1.50
6CD6GA	4.50
6CF6	1.50
6CH6	10.35
6CL6	3.50
6CL8A	2.00
6CM5	1.60
6CS6	0.75
6CW4	7.25
6CY5	1.00
6DC6	2.00
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6DQ5	2.30
6DR7	2.00
6EA8	2.50
6EB8	1.75
6EU8	1.75
6EW6	1.50
6F1	2.00
6F6G	2.00
6F12	1.50
6F13	3.00
6F14	1.00
6F17	2.75
6F18	1.50
6F19	0.48
6F21	2.50
6F22	0.70
6F23	0.60
6F24	1.25
6F25	1.25
6F28	1.25
6F33	17.00
6FG5	1.95
6GH8A	0.80
6GK5	1.50
6GK6	2.00
6GV7	2.50
6H3N	1.10
6H6	1.35
6H6GT	1.20
6J4	1.10
6J5	1.95
6J5G	0.75
6J6	0.55
6JB6A	3.95
6JE6C	3.50
6JS6A	3.50
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6K7G	0.70
6KD6	4.50
6L1	2.50
6L19	3.95
6L6GC	2.50
6L6GT	1.15
6L7G	0.75
6LD20	0.60
6LF6	2.95
6LQ6	2.95
6N7GT	1.50
6P15	0.80
6P25	3.00
6P28	2.00
6Q7	1.20
6S7	1.10
6SA7GT	1.00
6SC7	1.50
6SG7	1.20
6SH7	1.20
6SJ7GT	1.20
6SK7	0.80
6SK7GT	1.20
6SL7GT	0.72
6SN7GT	0.69
6SQ7	0.80
6SS7	1.95
6U4GT	1.75
6U5G	1.50
6U8	0.80
6U8A	1.50
6V6GT	0.80
6X2N	1.00
6X4	0.96
6X5GT	0.50
6X5GTY	1.00
6X8A	2.25
7A7	2.00
7AD7	1.75
7B7	1.40
7C5	3.00
7C6	2.50
7H7	2.00
7Q7	2.00
7S7	3.00
7Y4	1.95
10C1	5.50
10C2	0.70
10D2	1.25
10F1	0.75
10GK6	1.95
10P14	2.50
10P18	0.78
10LD11	1.00
10LD12	0.65
11E2	16.50
11E3	55.00
12AE6	0.85
12AG8	1.50
12AL5	1.00
12AT6	0.59
12AT7	0.85
12AT7WA	2.50
12AU6	1.50
12AU7	0.55
12AV6	0.80
12AX4GT	1.00
12AX7	0.65
12AX7WA	2.50
12AYZ	4.00
12AZ7A	1.95
12B4A	3.50
12BA6	0.90
12BE6	1.05
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12SA7GT	1.00
12SH7	1.00
12SK7	1.00
12SJ7	0.60
12SN7GT	1.85
12U7	1.50
13D3	3.20
13D7	3.20
13E1	115.00
14S7	1.00
15E	1.00
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19H4	23.95
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20L1	0.95
20P1	0.55
20P3	0.60
20P4	1.05
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30C1	0.70
30C15	0.40
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30C18	1.48
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30FL2	1.10
30FL12	0.95
30FL13	1.10
30FL14	1.25
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30L15	0.60
30L17	0.60
30P4MR	1.00
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30P18	0.60
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2050	8.95
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5642	8.50
5651	3.20
5654	1.95
5670	3.50
5675	23.50
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5718	6.50
5725	2.50
5726	2.50
5727	2.50
5749	2.50
5750	2.00
5751	3.50
5763	3.50
5814A	3.25
5840	3.50
5842	6.50
5879	3.90
5881A	4.60
5894	39.50
5899	4.50
5963	2.00
5965	2.25
5993	8.00
6005	1.95
6012	6.00
6021	3.95
6057	2.50
6059	3.75
6060	1.50
6062	4.50
6063	2.00
6064	3.25
6067	1.95
6072	4.20
6080	5.75
6080WA	8.50
6096	2.85
6132	10.00
6136	2.50
6146A	4.99
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11 Watt	1R-10K	0.20
	15K-22K	0.24
17 Watt	1R-10K	0.26
	15K-22K	0.28

WW-2

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B7G Skirted	0.30
B8G	0.70
B9A	0.20
B9A Skirted	0.30
B10B	0.16
B13B	0.50
8 Pin DIL	0.10
14 Pin DIL	0.12
14 Pin DIL/Q	0.30
16 Pin DIL	0.15
OCTAL	0.35
CANS	0.27
B9A PCB	0.15
B5	0.75
B9G	0.38

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15V 16V 18V 20V 22V 24V 27V 30V
33V 36V 39V 47V 51V 56V 68V 75V

BZY88 0.07
2V7 3V 3V3 3V6 3V9 4V3 4V7 5V1
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12V 13V 15V 18V 20V 24V 27V 30V

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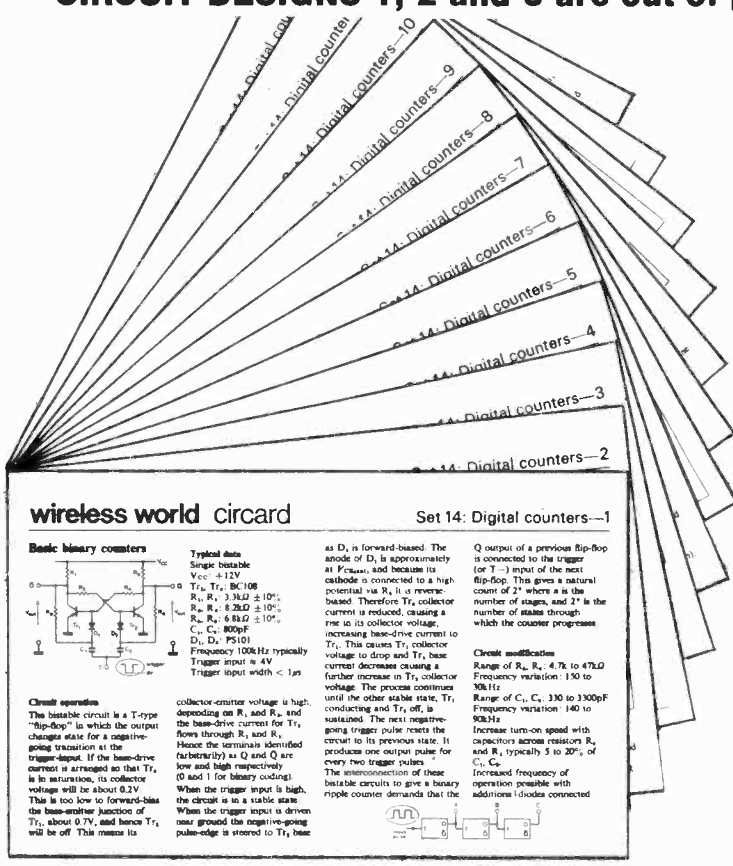

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74LS32	13
74LS37	14
74LS38	14
74LS42	28
74LS47	36
74LS51	14
74LS73	18
74LS74	16
74LS75	16
74LS76	15
74LS85	40
74LS86	16
74LS90	22
74LS92	30
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74LS107	20
74LS112	20
74LS123	34
74LS125	24
74LS126	25
74LS132	34
74LS136	23
74LS137	90
74LS138	25
74LS139	27
74LS145	70
74LS148	75
74LS151	40
74LS153	40
74LS155	30
74LS156	36
74LS157	27
74LS161	36
74LS163	36
74LS164	30
74LS165	50
74LS166	60
74LS173	55
74LS174	45
74LS175	40
74LS191	36
74LS193	40
74LS195	39
74LS196	48
74LS197	60
74LS221	48
74LS240	55
74LS241	55
74LS242	55
74LS243	55
74LS244	55
74LS245	70
74LS251	30
74LS253	30
74LS257	30
74LS259	55
74LS266	20
74LS273	55
74LS279	30
74LS299	150
74LS367	30
74LS368	26
74LS373	60
74LS374	55
74LS378	60
74LS393	45

7400

Type	Price
7400	11
7401	11
7402	11
7403	12
7404	13
7405	15
7406	20
7407	20
7408	14
7409	14
7410	14
7413	18
7414	20
7420	15
7430	14
7440	14
7442	32
7443	60
7444	60
7447	36
7448	40
7450	14
7451	14
7453	14
7454	14
7460	14
7470	24
7472	24
7473	26
7474	20
7475	25
7476	25
7480	36
7482	65
7483	38
7485	60
7486	18
7489	159
7490	20
7491	35
7492	25
7493	25
7494	35
7495	35
7496	34
74100	80
74104	45
74107	20
74121	24
74123	34
74125	29
74126	33
74141	52
74151	30
74154	50
74155	39
74156	35
74157	30
74190	45
74191	45
74192	45
74193	45
74393	78

CMOS

Type	Price
4000	10
4001	10
4002	12
4006	50
4007	14
4008	32
4009	24
4010	24
4011	11
4012	15
4013	20
4014	46
4015	40
4016	20
4017	32
4018	45
4019	25
4020	42
4021	40
4022	39
4023	14
4024	32
4025	13
4026	80
4027	20
4028	39
4029	45
4030	15
4041	40
4042	40
4043	40
4044	40
4046	46
4049	23
4050	23
4060	45
4069	13
4070	13
4071	13
4072	13
4081	13
4082	13
4093	20
4510	45
4511	45
4514	110
4516	53
4518	40
4520	50
4543	75
4583	90

Many other types in stock — see current price list.

All above prices are NET and shown in pence.

ANALOGUE

Type	Price
709C5	49
709C14	44
723C14	36
741C5	57
741C8	16
741S	56
741C14	47
741S	56
741C14	65
748C8	35
1458C5	62
1458C14	40
7106	450N
7107	500N
555	18N
7555	80
556	45
CA3046	70
CA3080E	70N
CA3130E	90
CA3140E	45
LM301AN	25
LM308N	60
LM317K	295
LM324N	32
LM348N	65
LM380N	66
LM380N6	80
LM381N	145
LM382N	115
LM3900N	50
LM3914N	200
LM3915N	200
NE555V	23
NE556A	45
NE567N	104
RC4151NB	80
S041E	290
S041P	121
S042E	364
S042P	138
S89	11.23
S178A	16.60
S187	13.28
S556B	214
S576A	235
S576B	235
S576C	235
S576D	225
S1469	468
SAB0600	425
SAB3209	497
SAB3210	311
SAB3211	168
SAB3271	329
SAB4209	497
SAB8256C	35.40
SDA2007	965
SDA2008	676
SDA3205	724
SDA3206	406
SAD1024	900
SAJ131	238
SAJ141	278
SAJ205	810
SAS231W	260
SAS251	142
SAS580	196
SAS590	196
SDA5680A	15.55
TAA761	104
TAA761A	49
TAA765A	62
TAA861	103
TAA865A	59
TAA2761A	72
TAA4761A	113
TAA4765A	120
TAB1041K	187
TBA120AS	62
TBA120U	72
TBA800	75
TBA105	75
TBA820	75
TBB1458	62
TBB1458B	40
TCA105	120
TCA105B	108
TCA105G	140
TCA250A	185
TCA205K	200
TCA335A	66
TCA345A	109
TCA345W	177
TCA671	131
TCA780	211
TCA871	114
TCA955	228
TCA965	136
TCA965K	120
TCA971	92
TCA991	80
TCA991K	100
TDA2002	120
TDA2003	126
TDA2030	150
TDA4050B	144
TDA4290	169
TDA4600	184
TDA4700A	546
TDA4718A	436
TFA1001W	252
TL071CP	25N
TL072CP	45N
TL074CN	100N
TL081CP	25N
UAA170	165
UAA170L	152
UAA180	165
UAA190	141
XR2206	300N
ZN414	80N
ZN424P	99
ZN425E	350

CRYSTALS

(in MHz)

MHz	Price	MHz	Price
0.032768	102	4.433	128
0.100000	453	4.915	157
1.000	453	5.000	157
1.8432	320	5.026	128
2.000	268	6.000	157
2.4576	268	6.144	157
3.2768	188	6.5536	128
3.579	128	8.000	1.88
4.000	102	8.867	128
4.194	128	10.000	157
		18.432	188

ZENNER DIODES

400mV/2.7-35V **7p**; 1.3W/303 100V **15p**; 20W/7.5-75V **£1.98**

REGULATORS

7805, 7806, 7808, 7812, 7815, 7818, 7824 **each 40p**. 78L05, 78L12, 78L15, 78L24 **each 32p**. 7905, 7906, 7908, 7912, 7915, 7918, 7924, 79L05, 79L12, 79L15, 79L24 **each 50p**.

CONNECTORS

DIN AUDIO

Pins	plug	skt
2	8p	8p
3	17p	8p
4	17p	14p
5 (180°)	17p	11p
5 (240°)	18p	8p
6	20p	20p
7	20p	30p

PARALLEL TYPE

	Plug	Skt
16 way	1.10	1.30
20 way	1.25	1.45
26 way	1.50	1.70
34 way	1.65	1.95
40 way	1.85	2.10

Plugs have retainers. Sockets have strain relief

JACK PLUGS, SKTS

MONO 25"			
chrome P1	53p	34p	42p
plastic P2	32p	14p	20p
STEREO 25"			
chrome P3	81p		52p
plastic P4	60p	15p	20p
Mono 3.5mm	18p		14p
Stereo	23p		42p

IC SOCKETS

pins	each	25 for
8	6	1.20N
14	8	1.60N
16	9	1.80N
18	11	2.20N
20	12	2.40N
22	14	2.80N
24	15	3.00N
28	18	3.60N
40	25	5.00N

D – SERIES

9	64p	96p	92p
15	88p	140p	96p
25	128p	206p	110p
37	176p	296p	122p

IDC Connectors

DIL

14 way	103p
16 way	117p
24 way	170p
40 way	265p

RECHARGEABLE CELLS

AA **109p**, C **249p**; D(4AH) **410p**; PP3 (7.2V) **449p**; (8.4V) **540p**

CHARGERS

PP3-NC75 **£5.59N**; NC756 **£5.59N** (any 2 pairs AA, C or D) NC1230 **£9.92N**

RF CHOKES 8T Series

1, 1.5, 2.2 etc. to 33μH **ea. 30p**. 47, 68, 100 etc. to 680μH **ea. 33p**. 1000, 1500 etc. to 4700μH **ea. 35p**.

CAPACITORS

Polystyrene, Siemens
5% Tolerance 160V
5, 7, 10, 12, 15, 18, 22, 27, 33, 39pF **15p**; 47, 56, 68, 82, 100, 120, 150, 180, 220, 270, 330, 390, 470, 560, 680, 820pF, 1n, 1n2, 1n5, 1n8, 2n2, 2n7, 3n3, 3n9, 4n7, **10p**; 5n6, 6n8, 8n2, 10n, **13p**
Ceramic Very small 1.8, 2.2, 2.7 etc, up to 1n **5p each**. 1n5, 2n2, 3n3, 4n7, 6n8, **5p**; 10n, 22n, **6p**; 33n, 47, **7p**; 100n, **8p**
Polyester, Siemens Layer Type 7.5mm lead spacing 100V
1n, 1n5, 2n2, 3n3m **6p**; 4n7, 6n8, 8n2, 10n 12n, 15n, 18n, 22n, 33n, 47n, **7p** 56n, 68n, **7p**; 82n, 100n, **9p** 120n, 150n, **15p**; 180n, 220n, **12p**; 270n, 330n, 330n, 390n, 470n, **15p**; 560n, 680n, **24p**; 10mm spacing 1uF **25p**; 15mm spacing 2u2 **35p**; 22.5mm, spacing 1uF 400V **50p**; 3.33uF 100V **69p**; In depth stocks

ELECTROLYTICS

Value	Price
1/63	9
2.2/25	13
2.2/63	9
4.7/63	9
4.7/100	14
6.8/40	9
10/6	13
10/25	9
10/40	11
10/63	12
10/100	15
22/10	9
22/25	11
22/40	12
22/63	15
22/100	16
47/3	3
47/10	11
47/25	12
47/40	15
47/63	15
47/100	18
100/3	3
100/10	12
100/16	12
100/25	12
100/40	15
100/63	20
100/100	27
220/10	16
220/16	16
220/25	16
220/40	20
220/28	28
220/100	42
470/10	19
470/16	19
470/25	19
470/40	27
470/63	45
470/100	73
1000/10	19
1000/16	26
1000/25	36
1000/40	44
1000/63	76
2200/6	09
2200/16	44
2200/25	
2200/40	73
4700/16	72
4700/25	90

TANTALUM BEADS

Value	Price
0.1/35	13
0.22/35	13
0.47/35	13
1.0/35	13
2.2/16	13
2.2/35	16
4.7/16	16
4.7/35	18
6.8/16	16
6.8/25	24
10/6.3	16
10/16	18
10/25	18
22/6.3	18
22/16	30
22/25	30
33/6.3	24
33/10	30
47/6.3	30
100/10	66

For full ranges of very many other types please see Cat 82 and/or current price list.

BOXES

High quality Black ABS plastic or die-cast plain or stove grey.

L	W	D	ABS		Plain		Stove Gr	
50	50	25	—		5001P	90p	5001	123p
100	60	25	2002	96p	5002P	117p	5002	154p
113	63	31	2003	109p	5003P	143p	5003	184p
121	66	40	2004	115p	5004P	162p	5004	210p
152	82	50	2005	134p	5005P	216p	5005	268p
192	113	61	2006	235p	5006P	314p	5006	401p

VERO RANGE plastic boxes

L	W	D	Type	Price
72	47	25	21024	54p
120	50	35	21390	87p
180	110	55	21391	160p

G RANGE professional Instrument Cases

134	90	44	21089	£7.68
224	140	64	21090	£11.62
302	170	84	21091	£15.78

VEROBOX CASES

to give a completely professional finish to a much valued project.
ABS, light grey top; dark grey bottom + 2 anodised panels

L	D	H	TYPE	PRICE
205	140	40	21034	£4.52
205	140	75	21035	£5.02
205	140	110	21036	£6.54
180	120	39	21037	£4.11
180	120	65	21038	£4.40
180	120	90	21039	£4.69
155	85	39	21040	£3.31
155	85	60	21041	£3.31
155	85	80	21042	£4.30
125	65	30	21047	£2.48
125	65	39	21048	£3.15
125	65	50	21049	£3.56

METERS

Large range of types in stock; also probes, leads, accessories, etc.
PANEL MOUNTING in 50, 100, 500μA; 1, 5, 10, 50, 100, 500mA, 1A either model.

MU Range 50 × 45mm **£2.68**

T Range 60 × 45mm **£5.95**

MULTIMETERS

NH56A NEW — 20KΩ/V AC/DC/-RES/dB in 23 ranges: 130 × 88 × 37mm **£11.20N**

YN360TR 20KΩ/V: AC/DC/R/dB/Transistor Test: in 21 ranges: 145 × 96 × 45mm **£16.45N**

SEMICONDUCTORS

Type	Price
1N914	03
1N914B	10
1N916	02N
1N4007	06
1N4148	03
1N5402	14
1N5407	18
2N697	23
2N706	18
2N930	20
2N1132	23
2N1302	110
2N1303	58
2N1304	62
2N1305	62
2N1306	90
2N1307	67
2N1308	147
2N1309	99
2N1599	100
2N1613	25
2N1711	25
2N1893	32
2N2218A	31
2N2219A	25
2N2222A	25
2N2369A	21
2N2484	25
2N2646	45
2N2904	26
2N2904A	25
2N2905A	25
2N3053	23
2N3054	56
2N3055	48
2N3405	64
2N3663	15
2N3702 11	08
2N3771	180
2N3794	21
2N3819	22
2N3820	40
3823	60
2N3904	15
2N3906	15
2N4036	46
2N4058-62	09
2N4124	25
2N4126	25
2N4284	30
2N4286	18
2N4289	23
2N4291	24
2N4292	21
2N4991	62
2N5062	32
2N5192	110
2N5195	106
2N5457	32
2N5458	32
2N5459	36
2N6050	380
2N6057	375
6F40	152
16F40	165
40HF40	225
40361	DIS
40362	65
40406	71
40408	95
40412	108
40430	100
40594	123
40595	123
40636	147
40673	145
A9903	16
AA113	13
AA116	9
AA117	13
AA118	9
AA119	9
AC126	25
AC127	25
AC128	25
AC151R	55
AC153K	20
AC176	25
ACY17	155
ACY18	120
ACY19	99
ACY20	90
ACY21	85
ACY39	170
ACY41	10
AD136	150
AD142	90
AD149	88
AD161	35
AD162	35
AF114	37
AF115	37
AF116	57
AF117	64
AF124 AF125	37
AF126	37
AF127	37
AF200	10
AF239	114
AF279	30
AFY12	204N
AFY16	327N
AFY180	310N
AFY18E	615N
AFY42	461N
AU106	240
AU111	(use
AU116)	
AUY22	10.95
BO140	25N
BO146	30N
BO226	45N
B1906	38
BA379	25
BAS40-03	36
BAS70-03	41
BAT14-036	11.75
BB409	33
BC107A,B	16
BC108A,B,C	16
BC109B,C	18
BC121W	30N
BC122Y	100
BC125	20
BC125	20
BC140	25
BC141	30
BC147A	10
BC149	10
BC154	25
BC160	25
BC161	30
BC167A	09
BC167B	09
BC168A	09
BC168B	09
BC169B	09
BC169C	09
BC177B	16
BC178B	16
BC179B	18
BC182	09
BC182L	09
BC183	09
BC183L	09
BC184	09
BC184L	09
BC202Y	120
BC212	09
BC212L	09
BC213	09
BC213L	09
BC214	09
BC214L	09
BC238C	09
BC239C	09
BC258B	09
BC267B	16
BC300	32
BC301	24
BC303	30
BC327	16
BC328	11
BC337	14
BC338	11
BC413	09
BC414	09
BC477	24
BC546	10
BC547	09
BC548	09
BC549	09
BC550	10
BC556	10
BC557	09
BC558	09
BC559	09
BC560	10
BC879	38
BC880	43
BCY31A	157
BCY58	18
BCY70	18
BCY71	18
BCY72	18
BD130	45N
BD131	48
BD132	48
BD135	27
BD136	27
BD139	30
BD140	32
BD644	42N
BD679	62
BD680	64
BF115	35
BF167	25
BF173	25
BF177	25
BF178	25
BF244B	40
BF254	14
BF255	14
BF420	31
BF421	34
BF457	35
BF458	35
BF459	35
BF597	12N
BFR34A	84
BFR39-41	23
BFR79-81	23
BFT65	119
BFT66	192
BFX29	24
BFX84	24
BFX85	24
BFX87	28
BFX88	26
BFY50	24
BFY51	24
BFY52	24
BFY90	143
BR34	70
BR64	110
BRY39	45
BSX20	22
BSX26	22
BSX63	769N
BT106	147
BT108	136
BU105	170
BU124	85
BU208	180
BUX26	350N
BUX28	545
BUX81	744
BUX85	249
BUZ10A	478
BUZ15	12.27
BUZ20	523
BUZ23	787
BUZ24	12.50
BUZ32	625
BUZ33	844
BUZ41A	637
BUZ44A	9.67
BUZ45	12.76
BUZ48	18.94
BUZ50A	763
BUZ54A	21.43
BUZ80	739
BUZ83	11.29
BUZ83A	11.95
BUZ84A	12.75
BY164	48
C106D1	45
C106	460N4
CU340	490N4
C407	17
C0546	126N1
C762	40
C1406	77
04 clip	for
C1406	and
E2506	10
D1046	88
E1110	76
E1210	76
E2506	154
EB383	20
MJ2955	90
MJE340	55
MJE2955	95
MJE3055	70
MPF102	40
MPS6531	40
MPS6534	42
MPSA12	36
MPSA63	38
NAS206S5	81
OA47	12
OA90	10
OA91	10
OA95	DIS
OA202	14
OC28	75
OC29	75
OC35	75
OC36	90
OC84	25
PM7A2	373
PN70	10
PN72	05
Q4006LT	104
Q4010LT	115
Q4025H	450
T2700D	189
T2800D	104
TAG3-400	100
TAG209 400	85
TAG209 600	130
TIC106D	48
TIC106M	55
TIC126D	64
TIC206D	54
TIC226D	61
TIC236D	96
TIC246D	105
TIP31A	36
TIP32A	36
TIP41A	45
TIP41C	60
TIP42A	45
TIP42C	60
TIP150	75
TIP2955	55
TIP3055	55
TIS43	50
U763	50
VN10KM	55
VN46AF	93
VN66AF	105
VN88AF	123
W02	25

PANEL LAMPS

LED chrome, red **54**
LED yellow or green **70** (high efficiency)
Filament in red, amber, green or clear
6V 60 mA **48**
14V 40 mA **54**
LED's
5mm red **10**
yellow **19**
green **16**
Mountings, B65 **3**

5V filament
3015F 8 mA **255**
3015F 15 mA **255**

KNOBS

Black plastic
K1 skirted with spot **16**
K2 as K1, 35mm **21**
K3 pointer **15**
K7 19mm knurled **23**
K8 as K7 + skirt **23**

DISPLAYS

7-segment
Common anode
MAN72A red **75**
MAN82A yellow **110**
MAN52A green **110**
Common cathode
MAN74A red **85**
MAN84A yellow **110**
MAN54A green **110**

THERMISTORS

K164
Disk type, 5mm dia. Resistance at 20°C; 6R8, 10, 22, 47, 100, 220, 470, 1K, 2K2, 4K7, 10K, 22K, 47K, 100K each **18p**

POTENTIOMETERS

Carbon Rotary (P20) 100ohms – 4M7 lin, 220ohms – 2M2 log. **32p each** w.switch **87p**. Dual gang (JP20) 4K7 – 1M2 lin, or log **95p** w switch **£1.50**

SLIDERS
58mm, low cost 10K 1M log only **29p**. Std 58mm mono 4K7 – 1M lin. or log **74p**. Stereo matched **£1.25**. Graduated bezels **36p each**.
PRESET
Min. 10mm dia. Hrix. or Vert. 100ohms – 1M **13p**
Preset Cermet rectilinear type 89P 100ohm – 1m **£1.06 each**
Preset Cermet 10mm dia. Horiz. or Vert. 100ohm **29p**
Plesseyu MPW T moulded carbon 47ohms – 2M2 **59p each**.

SOLDERING IRONS

Also large stocks of bits, desoldering devices, accessories, etc
ANTEX C 240V **£4.60N**; X.25-240V **£4.70N**, CSBP **£5.45N**; XSB **£5.56N**; ST4 Stand **£1.70N**
ORYX 50 watt temp. controlled **£15.50N**
SOLDER 500gm/18SWG **£7.60N**; Desolder braid 1.5m **54p**

SWITCHES

Type CK – 1P/12 way, 2P/6 way, 3P/4 way, 4P/3 way **48p**; Min Toggles S7101 SPDT **57p**; S7201 DPDT **80p**; S7301 3PDT **£1.64**; S7203 DPDT **96p**; Push Button min. 8531 make/8533 break **62p**; 8225 DPDT **£1.34**.
DUAL IN LINE ERG colour coded 0.3" × 0.1" format. On/Off single throw 2P SDS2 **54p**; 4P SDS4 **95**; 6P SDS6 **£1.38**; 8P SDS8 **£1.87**; 10P SDSO **£2.10**. *Low cost* D.I.L. 4P DNS04 **65p**; DNS08 **£1.00**

LATEST EV PRICE LIST FREE

includes many new additions to items in our catalogue
CATALOGUE incl 70p refundable voucher, 70p post free, making it an invaluable buying guide with price list.
Large s.a.e. brings price list FREE

RESISTORS

1/4, 1/3, 1/2, 3/4 watt – **all 2p each**, 10 of one value **15p**
2% Mullard metal film 5.1 ohms – 300K **5p each**, 10 of one value **40p**
5% wire wound 3W or 7W, most E12 values 1.2ohms to 8K2 **9p each** 10 for **70pN**

CREDIT CARD ORDERS

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A COMPETITION OPEN TO ALL WIRELESS WORLD READERS WITH £8000 IN CASH PRIZES

Design an Electronic Device to help the Disabled

Could you design a piece of equipment to help a disabled person? If so, you would — in addition to undertaking this worthy task — be eligible to win a substantial cash prize.

Our competition is open to individuals or groups resident in the UK. You register your entry using the form below, sending it to the Editor to arrive at his office not later than June 30th 1983. The designs themselves must be submitted to his office by 1st October 1983.

Entries, which will be judged by a group of eminent engineers and doctors, must consist of the following: - a statement of the design objectives; an overall description of the device; detailed circuit descriptions and diagrams; a model of the device or a model of a unique aspect of the design sufficient to demonstrate its feasibility.

The finalists will be invited to London to talk over their entries with the judges and be awarded their prizes. The prizes are:

1st prize £2,500
2nd prize £1,500

and the 4 runners up will be awarded prizes each of £1,000

To make sure you have the maximum time to undertake your design, return your entry form now!

"DESIGN AN ELECTRONIC DEVICE TO HELP THE DISABLED"
LIST OF RULES

1. The competition is open to U.K. residents only.
2. Entrants can be individuals or groups.
3. All participants must register their interest in entering the competition on the form provided which must be returned to the Wireless World Editorial Department by the 30th June 1983.
4. All entrants agree to give Wireless World first serial publication rights to an article describing the entry.
5. All entrants indemnify Wireless World from any liability in respect of injury to people or damage to property arising from the use of the design.
6. All submitted designs must be the original work of the entrant or entrants and must not infringe the rights of third parties in anyway.
7. All submissions should consist of:
   a) **A statement of design objectives**
   b) **An overall description of the device**
   c) **Detailed circuit descriptions and diagrams**
   d) **A model of the device or the unique aspect of the design sufficient to demonstrate its feasibility.**
8. The design will be judged on:
   a) **Originality and benefit to the handicapped**
   b) **Potential for production**
   c) **Elegance of engineering design**
   d) **Electronics content**
   e) **Design reliability**
   f) **Simplicity of operation**
   g) **Freedom from excessive maintenance**
   h) **Safety.**
9. Software only solutions are not accepted.
10. The judges' decision is final.
11. All designs must be submitted to the Wireless World Editor by the 1st October 1983.
12. Shortlisted entrants must be prepared to travel to a venue in London sometime during November and December 1983 to demonstrate their design. All costs will be paid by the journal.
13. Employees of Business Press International are not allowed to enter this competition.

wireless world
COMPETITION ENTRY FORM

"Design an electronic device to help the disabled"

Name of competitor ____________________

Address ____________________

____

Telephone (home) ____________________

(business) ____________________

I intend to enter the competition and to abide by the rules as laid down in the April 1983 issue of Wireless World

I understand that, in order to quaify, my entry must in the hand of the judges by 1st October 1983.

Signature ____________________

Date ____________________

Please send this form, as soon as possible, to

The Editor, WIRELESS WORLD
Room L302, Quadrant House, The Quadrant
Sutton, Surrey SM2 5AS.

Receipt of the form will be acknowledged

HART

LINSLEY-HOOD 300 SERIES AMPLIFIERS

These latest designs from the drawing board of John Linsley-Hood, engineered to the very highest standard, represent the very best that is available on the kit market today. The delicacy and transparency of the tone quality enable these amplifiers to outperform on a side-by-side comparison, the bulk of amplifiers in the commercial market-place and even exceed the high standard set by his earlier 75-watt design.
Three versions are offered, a 30 watt with Darlington output transistors, and a 35- and 45-watt, both with Mosfet output devices. All are of identical outside appearance which is designed to match and stack with our Linsley-Hood cassette recorder 2.
As with all Hart kits the constructor's interests have been looked after in a unique way by reducing the conventional (and boring) wiring almost to the point of extinction.
Any of these kits represents a most cost-effective route to the very highest sound quality with the extra bonus of the enjoyment of building a sophisticated piece of equipment.
30-watt Darlington amplifier, fully integrated with tone controls and magnetic pick-up facility. Total cost of all parts is **£81.12**. Special offer price for complete kits is **£65**.
35-watt Mosfet amplifier. Total cost of parts **£98.41**. Special offer for complete kits **£79.50**.
45-watt Mosfet amplifier. Total cost of parts **£104.95**. Special offer price for complete kits **£83.50**.

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Reprints of MOSFET article 25p. No V.A.T. Post free.

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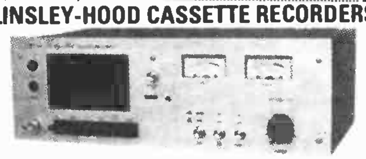
Snazzy matching slimline tuner and amplifier in beautiful wooden cabinets. These Ted Rule designs are for the enthusiast. Tuner covers LW, MW, SW, FM and TV sound! Digital frequency readout with clock and timer features. FM has 6 section front end and switchable bandwidth for exceptional fringe area performance. Amplifier has Toroidal transformer. Mosfet output stages, 50 watts per channel and got a cracking review in Practical Wireless.

Tuner. Complete Kit £123
Amplifier. Complete Kit £98

LINSLEY-HOOD CASSETTE RECORDERS



We have done two kits to this design, one using the original car cassette mechanism and the newer version using a very high quality front loading deck. This new deck has an excellent W & F performance and fitted with our latest Sendust Alloy Super Head gives an incredible frequency range (with good tape you can see 23KHz on ours!).

Linsley-Hood Cassette Recorder 1 .... £75.00
Linsley-Hood Cassette Recorder 2 .... £94.90
Reprints of "WW" Articles .... 70p. No VAT

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COMPLETE STEREO CASSETTE DECK

Brand-new high-quality stereo cassette unit with built-in record and play electronics. Ideal for use with any hi-fi system or music centre. Only a single 9-volt DC supply is required to power the whole unit.

Microphone and line inputs are provided on both channels and the line output will feed into any normal hi-fi amplifier. Erase and bias is provided by an ultrasonic oscillator, automatically switching to the correct level when a chrome or ferric cassette is put in place. Overall size 180mm × 130mm × 73mm. Complete with 3-digit counter.

We value this deck at about £30. **OUR VERY SPECIAL PRICE INCLUDING VAT AND POSTAGE – THIS IS ALL YOU PAY – ONLY £18.34 (while stocks last).**

FEED YOUR MICRO BYTES WITH OUR SOLENOID CONTROLLED CASSETTE DECK

Front loading deck with full solenoid control of all functions including optional read in fast wind modes. 12 volt operation. Fitted 3-digit memory counter and Hall IC Motion Sensor. Standard erase and stereo R/P Heads. Cheapest price ever for all these features. Only **£38.90** plus VAT. Full technical specification included.

LINSLEY-HOOD 100 WATT POWER AMPLIFIER

Our complete kit for this brilliant new design is the same size as our Linsley-Hood Cassette Recorder 2. Kit includes all parts for two power amplifiers with large heatsink area, huge power supply and speaker protection circuit. Total cost of all parts is **£114.46** but our special introductory price for all parts bought together is only **£105.50**.

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Do your tapes lack treble? A worn head could be the problem. Fitting one of our replacement heads could restore performance to better than new! Standard mountings make fitting easy and our TC1 Test Cassette helps you set the azimuth spot-on. We are the actual importers which means you get the benefit of lower prices for prime parts. Compare us with other suppliers and see! The following is a list of our most popular heads, all are suitable for use on Dolby machines and are ex-stock.

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HS16 Sendust Alloy Super Head. The best head we can find. Longer life than Permalloy, higher output than Ferrite, fantastic frequency response **£8.20**
HQ551 4-Track Head for auto-reverse or quadrophonic use. Full specification record and playback head **£7.40**
Please consult our list for technical data on these and other Special Purpose Heads.

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(For reel-to-reel decks)

These circuits are just the thing for converting that old valve tape deck into a useful transistorised recorder. Total system is a full three head recorder with separate record and replay sections for simultaneous off tape monitoring. We also stock the heads. This kit is well engineered but does not have the detailed instructions that we give with our more recent designs. We would not therefore recommend if to beginners. Reprints of the original three articles 45p. Post free. No VAT.

HART TRIPLE-PURPOSE TEST CASSETTE TC1

One inexpensive test cassette enables you to set up VU level, head azimuth and tape speed. Invaluable when fitting new heads. Only **£3.80** plus VAT and 50p postage.

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Brand New Governed 12v DC Tape Drive Motor Type MMI-6A2LK.
As used in SF925 and many other decks. 40mm Dia x 35mm Long, Shaft 10.5mm long x 2mm Dia. 6 x 2.5mm Mounting Holes on 26mm PCD on shaft end face. Anti-clockwise rotation at rated speed of 2200 RPM. Free run current 25mA. **£4.85 each.**

Lenco CRV/FFR.
We have a small quantity of spare motors for these decks at £6 each complete with drive pulley. Spare belts for FFR or CRV **90p (Large), 30p (Small).**

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Personal callers are always very welcome but please note that we are closed all day Saturday

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180R	1k8	18k	180k
200R	2k	20k	200k
220R	2k2	22k	220k
240R	2k4	24k	240k
270R	2k7	27k	270k
300R	3k	30k	–
330R	3k3	33k	330k
360R	3k6	36k	–
390R	3k9	39k	–
430R	4k3	43k	–
470R	4k7	47k	470k
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Senior Development Engineer to take design of real time microprocessor systems for video picture processing all the way from specification through to de-bugged delivary to client covering hardware (P.C.B. layout and prototype construction included) and software (high level and Assembler). Must be highly qualified with experience of microprocessors, vast memories, and L-S-I techniques, while knowledge of broadcasting video and display techniques would be useful.
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Commissioning and Test Engineers for a wide range of signal processing and digital video standards converters. Must have video and digital test experience and at least O.N.C.
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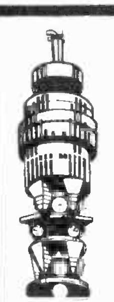

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Require an assistant to the technical director to plan and install and occasionally service sophisticated sound and lighting installations worldwide.

Candidates should have creative ability, commonsense and at least one year's industrial experience as well as an electronics degree. Extensive travel is involved and we expect the ideal candidate will be aged approximately 25 and single.

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RF communication and telephone systems experience is essential. Qualified applicants only. Good future. Salary will depend on experience starting with £7,500 as negotiable salary minimum.

Please reply in writing giving details of qualifications and career to date, to Box 2022.

Electronics Engineers
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Marconi Space and Defence Systems, Military Communications Division, are rapidly expanding their Portsmouth operations. New buildings are being erected in response to important new contracts. Now additional experienced staff qualified to Degree/HND/HNC level are required to lead or operate within teams in the following areas:

- PV Crypto • Crypto • Advanced Systems
- Naval Systems • Baseband

The precise grades and experience required vary according to the individual project. The following skills, however, are particularly relevant:

- Analogue/digital hardware design
- Software development and preparation
- Software/hardware development and integration
- Design engineers for LSI based project
- Innovative digital design

Our salary scales match the high standards of qualifications, experience and ability demanded. We offer a comprehensive range of benefits together with relocation assistance if required.

Phone Portsmouth 674019 for further information and an application form. Alternatively, you can write to Jack Burnie, Marconi Space and Defence Systems Limited, Browns Lane, The Airport, Portsmouth, Hants., quoting ref: BL 21

(All posts open to men and women)

Marconi
Space & Defence Systems

2018

BRITISH ANTARCTIC SURVEY

Radio Officer (Marine)

A vacancy exists for a Radio Officer (Marine) to serve initially aboard the Antarctic Research Vessel RRS John Biscoe. The successful applicant will be required to commence duties on 1 June. Voyages are normally seven months long and the vessel will sail from the United Kingdom on 21st June.

RRS John Biscoe's primary role is to support shipborne marine biology and associated oceanography in the southern ocean. She has a secondary responsibility to resupply Antarctic land stations as well as to support scientific parties in the field.

Candidates should possess valid certificates of proficiency recognised by the Department of Trade and have served the necessary sea time to work a single-handed station.

Salary: In the scale £7,773, £8,291, £8,398, £8,640 . . . to £10,917 per annum. In addition an allowance of £1,200 is payable for periods of service spent south of Montevideo.

For further details and an application form please write stating full qualifications and experience to:
The Establishment Officer, British Antarctic Survey, High Cross, Madingley Road, Cambridge CB3 0ET.

Please quote Ref: BAS 75

Closing date: 30 March, 1983

NATURAL ENVIRONMENT RESEARCH COUNCIL

(2035)

Channel 4
Engineering

VIDEOTAPE EDITOR—Ref EG/7

A Videotape Editor who is experienced in the operation of time code editing systems is required to work in our editing suite. Applicants must be able to demonstrate a detailed working knowledge of broadcast videotape editing.

JUNIOR TECHNICIAN—Ref EG/8

An opportunity exists for an individual who has an electronic/operational background, to make a start in the television engineering department of Channel 4. Applicants should either possess a qualification in electronics or mechanical engineering, or experience in a broadcasting engineering department.

Write enclosing a full C.V. and quoting the relevant reference number to The Personnel Department, Channel 4 Television, 60 Charlotte Street, London W1P 2AX by 25th March 1983.

Channel 4 is an equal opportunity employer; applications are welcome from candidates regardless of marital status, race, nationality, ethnic or national origins, or sex, and from registered disabled persons.

2030

CHANNEL FOUR TELEVISION

LOUGHBOROUGH UNIVERSITY OF TECHNOLOGY

WORKSHOP TECHNICIAN

Applications are invited for this new post in the Department of Computer Studies. The successful candidate should have HNC, HND, or equivalent and 6-10 years' experience in the field of microprocessors, electronics or digital systems in the first instance.

Salary on Grade 6 scale £6532-£7802 (under review). The appointment is for three years.

Requests for further particulars and application forms to Dr C. H. Machin, Department of Computer Studies, University of Technology, LOUGHBOROUGH Leics LE11 3TU.

(2025)

Book Editor

The Radio Society of Great Britain requires a second book editor to work on new and existing publications in its expanding range.

Applicants should have at least two years' relevant book or magazine experience and a knowledge of radio and electronics. They should be able to assume responsibilities for all aspects of book production from manuscript to bound copies, while working under minimum supervision.

The position is a good opportunity to take up a creative and responsible role in a small but highly successful publisher. It offers a competitive salary and excellent working conditions.

2038

Please write with full CV to David Evans, General Manager, Radio Society of Great Britain, Alma House, Cranborne Road, Potters Bar, Herts EN6 3JW, marking your envelope "Confidential".

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Plan and procure test equipment and control a team of test equipment engineers. To £12,670 — Hants.

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4) Test Engineer
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DEPARTMENT OF PHYSIOLOGY

ASSISTANT EXPERIMENTAL OFFICER (ELECTRONIC INSTRUMENTATION)

The department, which has an active neuroscience-based research programme, requires a person with design experience to work in collaboration with the academic staff in the development and maintenance of equipment for research laboratories. Degree in electronics an advantage. This post offers a challenging opportunity for those interested in developing the latest electronic technology in a biomedical environment.

Salary range: OR IB £5,550-£9,370 p.a. Duties to commence as soon as possible.

Applications (2 copies), together with the names and addresses of two referees, should be forwarded to the Vice-Principal (Administration) and Registrar, University College, PO Box 78, Cardiff CF1 1XL, from whom further particulars may be obtained. Closing date 15th April, 1983. Ref: 2532.
(2021)

ELECTRONICS ENGINEERS FOR BROADCAST TELEVISION

Ampex Corporation is the leading world manufacturer of professional video/audio recording equipment and a wide range of associated broadcast products, including computer controlled editing systems, cameras, digital effects and vision switchers.

We are looking for:

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To join our innovative project team involved in the design, installation and commissioning of TELEVISION STUDIO AND OUTSIDE BROADCAST VEHICLE PROJECTS.

The Broadcast Systems Group based in Reading supplies complete studio and mobile systems to broadcast installations worldwide.

The appointments involve occasional overseas travel for on-site commissioning.

Key requirements are:

★ Thorough knowledge of video and audio principles – HNC/Degree Electronics preferred
★ Experience in broadcast television industry
★ Previous knowledge of TV Systems would be an advantage

FIELD SERVICE ENGINEERS

(based in UK or Italy)

Electronics engineers to work on the installation and maintenance of television studio equipment at customer sites throughout Europe, Africa and the Middle East.

Key requirements are:

★ Thorough knowledge of electronic engineering – HNC/Degree Electronics preferred
★ 3 years' experience in a television studio/production environment with specific experience of either videotape or studio equipment, e.g. cameras, switchers, etc.
★ Availability to travel throughout Europe, Africa and the Middle East, together with ability to work on own initiative while away from base.

Attractive salaries and other benefits, including pension, life assurance and permanent health scheme, Bupacare option, product training, overseas allowances and relocation expenses as appropriate.

AMPEX

Please 'phone or write
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(2028)

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We are a small highly successful manufacturing company specialising in RF communications, digital and low frequency analogue equipment.

We require young highly motivated engineers wishing to develop their experience. The ideal candidate must have complete confidence in his ability.

- Starting salary £10K + (neg).
- 37½-hour week. Overtime available.
- Pay reviews every 6 months.
- Pleasant working environment.
- Location near City of London.

Contact Keith Penny on (01) 250 0894
(1983)

SCOTTISH OFFICE
DIRECTORATE OF TELECOMMUNICATIONS

WIRELESS TECHNICIAN

(£5,972-£8,058)

Applications are invited for two posts of Wireless Technician in the Central Services Department of the Scottish Office. The posts are based in East Kilbride and Edinburgh.

Candidates must have a sound theoretical and practical knowledge of Radio Engineering and Radio Communications equipment both fixed and mobile, in the frequency range HF to 2 GHz. They must also be able to use test equipment and simple machine tools. A sound basic knowledge of digital techniques would be an advantage. They should have a minimum of 3 years' appropriate experience and should hold an Ordinary National Certificate in Electronic or Electrical Engineering *or* a City and Guilds of London Institute Certificate in an appropriate subject *or* a qualification of higher or equivalent standard. Some assistance may be given with relocation expenses.

A valid UK driving licence is essential.

Application forms and further information are obtainable from Scottish Office Personnel Division, Room 110, 16 Waterloo Place, Edinburgh EH1 3DN (quote ref PM(PTS)2/1/83 (031 556 8400 Ext 4317 or 5028)).

Closing date for receipt of completed application forms is 11 April, 1983.
(2039)

Appointments

Senior Engineer - Vision Control

HTV

We are looking for a Senior Engineer to lead the Vision Control section at The Television Centre, Mold, which is part of the impressive Theatre Clwyd complex, where we are currently completing the installation of a second studio.

Experience in broadcast television is an essential requirement, and familiarity with Link 110 and 120 cameras would be a distinct advantage.

Salary, including supplements, is £11,884 per annum, and assistance towards the cost of relocating to this very attractive part of Wales may be available.

Suitably qualified candidates should write for an application form, enclosing a self-addressed envelope and quoting reference WW/146 to The Personnel Manager, HTV Limited, The Television Centre, Cardiff CF1 9XL.

2032

WE ARE AN EQUAL OPPORTUNITIES EMPLOYER.

POLYTECHNIC OF CENTRAL LONDON
School of Engineering & Science

ELECTRONICS TECHNICIAN
GRADE 5

Technician required to join a group working in communication and computer fields. Familiarity with computer/hardware/software, logic and digital techniques is desirable. Experience in workshop practice (electrical and mechanical) is essential.

Qualification: ONC or equivalent and/or appropriate industrial experience. Salary on scale £7,229-£8,237 inclusive of London Allowance.

Application form and further details from the Establishment Office, PCL, 309 Regent Street, London W1R 8AL. Tel. 01-580 2020 ext. 212. Closing date: 14 DAYS FROM APPEARANCE OF LAST ADVERTISEMENT. (2037)

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Network Supervisor

Channel 4 Television requires a Network Supervisor at their transmission centre in Charlotte Street.
The successful applicant should be fully conversant with all aspects of television technical operations, and will have occupied a position of responsibility within a broadcast television environment.
He/she is the senior technical operations staff member on shift who will deputise for management in their absence.
Excellent salary and promotion prospects.

Please write giving details of past experience, age and salary to The Personnel Department, (Ref EG/6), Channel 4 Television, 60 Charlotte Street, London W1P 2AX by 25th March 1983.

Channel 4 is an equal opportunity employer; applications are welcome from candidates regardless of marital status, race, nationality, ethnic or national origins, or sex, and from registered disabled persons.

2031

CHANNEL FOUR TELEVISION

BRITISH ANTARCTIC SURVEY

Radio Technician/ Operators

Radio Technician/Operators who have experience in maintenance and operation of HF and satellite communications are required to work single-handed at stations in the Antarctic.

Because of the isolated situation of Antarctica the ability to work on their own initiative is absolutely essential. Applicants should appreciate that they will be solely responsible for all aspects of communications. Ability to operate to MRGC standard with some knowledge of maritime procedures is also necessary. Appropriate training on specific equipment will be given if required.

The period of employment will be from 4 July, 1983, until Spring 1986 which entails working in Antarctica for two consecutive winters.

Applications are invited from single men (to work mainly overseas) who are physically fit and aged between 22 and 35.

Salary: from £5,709 per annum, plus annual increments. Also Antarctic allowance of £586 per annum. Accommodation provided whilst overseas. Clothing, messing and canteen are provided free on bases and free messing on voyage.

For details and an application form please write to:

The Establishment Officer
British Antarctic Survey
High Cross, Madingly Road, Cambridge CB3 0ET

Please quote ref BAS 74

Closing date 13th April, 1983

NATURAL ENVIRONMENT RESEARCH COUNCIL (2040)

NORWEB-MID LANCASHIRE AREA

THIRD ENGINEER (TELECOMMUNICATIONS) AREA ENGINEERING DEPARTMENT

There is a vacancy for a Third Engineer (Telecommunications) in the Area Engineering Department, Hartingdon Road, Preston.

Applicants should hold an appropriate degree, HNC, or full Technological Certificate, and should have had basic experience which will allow the person appointed to make a significant contribution to the installation, commissioning and future maintenance of a comprehensive microprocessor-based telecontrolled system. Experience will be gained in the wide variety of telecommunications equipment presently in use in the ESI.

Salary, £7,044-£10,675 p.a. plus £292 p.a. responsibility payment.

Applications obtainable from: **The Manager, Mid-Lancashire Area, Norweb, Hartington Road, Preston, Lancashire PR1 8LE by 8th April, 1983.**

(2033)

GOODHEAD PUBLICATIONS LIMITED

require an

EDITOR

for its monthly magazine, Amateur Radio

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(2019)

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Telephone: 01-723 6919 or 01-723 9408

(2043)

County Surveyor's

M1 Strengthening phase 1, 1983/4

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Companies wishing to be considered should apply to:

The County Surveyor, County Hall, Cauldwell Street, Bedford MK42 9AP. Tel: Bedford 63222 extension 34

(2034)

Bedfordshire
COUNTY COUNCIL

SENIOR VT ENGINEER

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2026

STV
Scottish Television,
Cowcaddens,
Glasgow G2 3PR.

Electronics Research
at the University of Essex

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Further information and application form available from: Dr J. K. Fidler, Chairman, Department of Electrical Engineering Science (ref Jan/2), University of Essex, Wivenhoe Park, Colchester CO4 3SQ. (2027)

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(2044)

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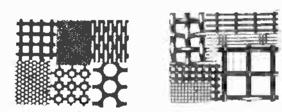

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(2045)

Dolby

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Medical Physics Technician

Grade IV

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(2046)

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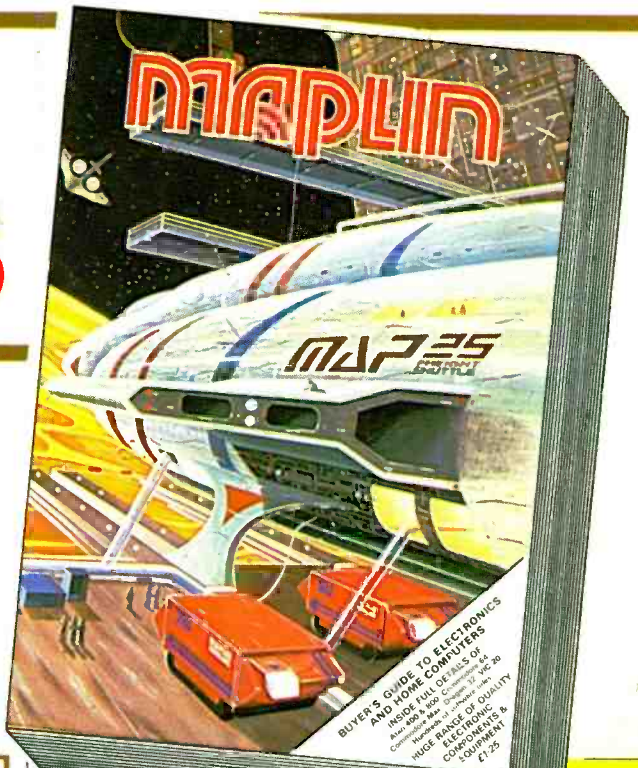

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