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PRACTICAL ELECTRONICS

FEBRUARY 1983

85p

Into the REAL WORLD... Control Circuits

Plus - BATTERY to MAINS INVERTER and MICROFILE

PRACTICAL
ELECTRONICS

VOLUME 19 No. 2 FEBRUARY 1983

CONSTRUCTIONAL PROJECTS

GENERAL FEATURES

NEWS AND COMMENT

SPECIAL SUPPLEMENT

FRONT COVER: The green Phoenix connectors used on the front cover were kindly loaned by ERMA Ltd.

OUR MARCH ISSUE WILL BE ON SALE FRIDAY, FEBRUARY 11th, 1983
(for details of contents see page 4/6 of Micro-file)

WATFORD ELECTRONICS

33, CARDIFF ROAD, WATFORD, HERTS WD1 8ED, ENGLAND
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POLYESTER CAPACITORS: (Axial Lead) 400V: 1nF, 1n5, 2n2, 3n3, 4n7, 6n8 11p; 10n, 15n, 18n, 22n 12p; 33n, 47n, 68n 16p; 100n, 150n 20p; 220n 30p; 330n 42p; 470n 52p; 680n 60p; 1µF 68p; 2µ2, 4µ7 85p. 1000V: 1nF 17p; 10nF 30p; 15n 40p; 22n 36p; 33n 42p; 47n, 100n 50p.

POLYESTER RADIAL LEAD CAPACITORS: 250V: 10n, 20n, 15n, 22n, 27n 6p; 33n, 47n, 68n, 100n 7p; 150n, 220n 10p; 330n, 470n 13p; 680n 19p; 1µ 23p; 1µ5 40p; 2µ2 46p.

ELECTROLYTIC CAPACITORS (Values in µF). 500V: 10µF 52p; 47 78p; 63V: 0·47, 1·0, 1·5, 2·2, 3·3, 8p; 4·7 9p; 10 10p; 15, 22 12p; 33 16p; 47 12p; 68 16p; 100 19p; 220 26p; 1000 70p; 2200 99p; 50V: 68 20p; 100 17p; 220 24p; 40V: 4·8 16p; 22 9p; 33 12p; 330, 470 32p; 1000 48p; 2200 90p; 25V: 50p; 3300 76p; 4700 92p; 16V: 2·5, 40 8p; 47, 68, 100 9p; 125 12p; 220 13p; 330 16p; 470 20p; 680 34p; 1000 27p; 1500 31p; 2200 36p; 4700 79p.

TAG-END TYPE: 64V: 4700 245p; 3300 198p; 2200 139p; 50V: 3300 154p; 2200 110p; 40V: 4700 160p; 25V: 4700 98p; 10,000 320p; 15,000 345p.

POTENTIOMETERS: Carbon Track, 0·25W Log & Linear Values.
500Ω, 1K & 2K (LIN ONLY) Single 30p
5KΩ-2MΩ single gang 30p
5KΩ-2MΩ single gang D/P switch 78p
5KΩ-2MΩ dual gang stereo 88p

TANTALUM BEAD CAPACITORS:
35V: 0·1µ, 0·22, 0·33 15p; 0·47, 0·68, 1·0, 1·5 16p; 2·2, 3·3 18p; 4·7, 6·8 22p; 10 28p; 16V: 2·2, 3·3, 16p; 4·7, 6·8, 10 18p; 15 36p; 22 30p; 33, 47 40p; 100 75p; 220 88p; 10V: 15, 22 26p; 33, 47 35p; 100 55p.

SLIDER POTENTIOMETERS
0·25W log and linear values 60mm track
5KΩ-500KΩ Single gang 70p
10KΩ-500KΩ Dual gang 110p

SILVER MICA (pF)
2, 3·3, 4·7, 6·8, 8·2, 10, 1?, 18, 22, 27, 33, 39, 47, 50, 56, 68, 75, 82, 85, 100, 120, 150, 180 15p each
220, 250, 270, 330, 360, 390, 470, 600, 800 & 820pF 21p each
1000, 1200, 1800 30p each
3300, 4700 60p each

SIEMENS multilayer miniature capacitors.
250V: 1nF, 1n5, 2n2, 3n3, 4n7, 6n8, 8n2, 10n, 15n, 22n 7p; 18n, 27n, 33n, 47n 8p; 39n, 56n, 68n 9p.
100V: 100n, 120n, 10p; 150n 11p; 220n 13p; 330n 18p; 470n 23p; 680n 30p; 1µF 34p; 2µ2 50p.

PRESET POTENTIOMETERS
0·1W 50Ω-2·2M Mini Vert. & Horiz. 7p
0·25W 100Ω-3·3MΩ Horiz. larger 10p
0·25W 250Ω-4·7MΩ Vert. 10p

RESISTORS—Hi-stab, Miniature, 5%, Carbon.

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

CERAMIC Capacitors: 50V Range 1pF to 6800pF 4p; 10nF, 15n, 33n, 47nF 5p; 100nf/30V 5p.

POLYSTYRENE Caps:
10pF to 1nF 8p
1n5 to 12nF 10p

RESISTORS S.I.L. Package: 7 Commoned, 100Ω, 680Ω, 1K, 2K2, 4K7, 10K, 47K, 100K 24p.
8 Commoned: (9 pins) 150Ω, 180Ω, 270Ω, 330Ω, 1K, 2K2, 4K7, 10K, 22K, 47K, 100K 26p

TRANSISTORS

AC125/6	35
AC127/8	35
AC141/2	30
AC176	28
AC187/8	32
ACY17/18	70
ACY19/20	75
ACY21/22	75
AD142	120
AD149	79
AD161/2	42
AF118	95
AF139	40
AF239	55
BC107/8	10
BC107B	12
BC108B	12
BC108C	12
BC109	10
BC109B	12
BC109C	12
BC117/8	20
BC140/42	30
BC147/8	9
BC147B	10
BC148C	10
BC149	9
BC149C	12
BC153/4	27
BC157/8	10
BC159	11
BC167A	10
BC168C	10
BC169C	10
BC170	15
BC171/2	11
BC173	11
BC177/8	16
BC179/81	20
BC182/3	10
BC184	10
BC182L	10
BC183L	10
BC184L	10
BC186/7	26
BC212/3	10
BC212L	10
BC213L	10
BC214	10
BC214L	10
BC237/8	14
BC307B	14
BC308B	16
BC327/8	15
BC337/8	15
BC441	34
BC461	34
BC477/8	40
BC516/7	40
BC547/8	12
BC549C	14
BC556/7	15
BC558/9	15
BCY70	16
BCY71/2	20
BD124	115
BD131/2	48
BD133	60
BD135	45
BD136/7	40
BD138/9	40
BD140	40
BD245	45
BD378	70
BD434	58
BD695A	125
BD696A	125
BDY56	180
BDY60	160
BF167	29
BF177	25
BF178	30
BF179	35
BF180	38
BF194/5	12
BF196/7	12
BF198/9	18
BF200	30
BF224	25
BF244A	28
BF244B	29
BF256B	35
BF257/8	32
BF259	35
BF274	42
BF336	40
BF451	35
BF594/5	30
BFR39/40	23
BFR41/79	23
BFR80/81	25
BFR98	105
BFX29/84	28
BFX85/86	28
BFX87/88	28
BFY50/51	23
BFY52	23
BFY56	32
BFY64	35
BFY81	120
BFY90	80
BRY39	40
BSX20	20
BSX29	34
BSY95A	25
BU105	170
BU205	190
BU206	200
BU208	200
MD8001	250
MJ2955	70
MJE340	54
MJE370	100
MJE371	100
MJE520	95
MJE2955	99
MJE3055	70
MPF102	40
MPF103/4	30
MPF105	30
MPF106	40
MPSA05	25
MPSA06	25
MPSA12	32
MPSA55	30
MPSA56	30
MPSA70	30
MPSU02	58
MPSU05	55
MPSU06	65
MPSU52	65
MPSU55	60
MPSU56	60
OC23	170
OC28/36	220
OC41/42	75
OC44	75
OC70	40
OC71/72	40
OC76	50
OC81/82	50
OC83/84	40
OC170/1	50
OC200/2	50
TIP29A	32
TIP29C	38
TIP30A	35
TIP30C	37
TIP31A	38
TIP31C	37
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	73
TIP141	105
TIP142	105
TIP147	120
TIP2955	60
TIP3055	60
TIS43	32
TIS44	45
TIS88A	50
TIS90	30
TIS91/93	32
VK1010	30
VN10KM	55
VN46AF	78
VN66AF	80
VN88AF	94
VN89AF	96
ZTX107/8	11
ZTX109	12
ZTX212	28
ZTX300	13
ZTX301/2	16
ZTX303	25
ZTX304	17
ZTX314	25
ZTX320/26	30
ZTX451	23
ZTX341	30
ZTX500/1	14
ZTX502/3	18
ZTX504	25
ZTX531	25
ZTX550	25
2N696	30
2N697	23
2N698	40
2N699	48
2N706A	19
2N708	19
2N914/5	32
2N918	35
2N930	20
2N1131/2	24
2N1303/4/5	65
2N1307/8	65
2N1613	30
2N1671B	160
2N2160	295
2N2219A/20A	25
21A/22A	25
2N2369A	18
2N2646	45
2N2846	80
2N2904A/05A	21
06A/07A	26
2N2926G	10
2N3053	26
2N3054	58
2N3055	48
2N3442	140
2N3614	199
2N3615	199
2N3702/3	10
2N3704/5	10
2N3706/7	10
2N3708/9	10
2N3710	10
2N3771	179
2N3772	195
2N3773	210
2N3819	22
2N3820	38
2N3822/3	45
2N3866	90
2N3903/4	15
2N3905/5	15
2N4037	46
2N4069	45
2N4427	80
2N4859	78
2N4871	55
2N5135/6	20
2N5172	18
2N5179	45
2N5180	45
2N5191	75
2N5194	80
2N5305	24
2N5457	30
2N5458/9	30
2N5485	36
2N5777	45
2N6027	32
2N6109	60
2N6290	70
2SA636	250
2SA671	250
2SA715	60
2SC495/6	70
2SC1061	250
2SC1096	85
2SC1162	30
2SC1172	125
2SC1173	125
2SC1306	100
2SC1307	150
2SC1449	85
2SC1679	190
2SC1678	140
2SC1923	50
2SC1945	225
2SC1953	90
2SC1957	90
2SC1969	140
2SC2028	85
2SC2029	210
2SC2078	170
2SC2091	85
2SC2166	165
2SC2314	85
2SC2465	125
2SC2547	30
2SD234	75
2SK45	90
2SK288	225
2SJ83	225
2SJ85	225
3N128	112
3N140	112
40097	120
40100	215
40101	130
40250	95
40251	150
40311	60
40313	130
40315	90
40316	95
40317/20	80
40360	60
40361/62	70
40406/7	75
40408	75
40411	285
40412	90
40467	130
40468	85
40594	105
40595	110
40603	110
40673	70
40871/2	90

LINEAR IC's

555 CMOS	80
702	75
709C 8 pin	35
710	48
741	14
747C 14 pin	65
748C 8 pin	36
753 8 pin	185
810	159
9400CJ	350
AY-1-1320	225
AY-1-5050	99
AY-1-5051	160
AY-1-6720	210
AY-3-1270	675
AY-3-8910	375
AY-3-8912	625
AY-5-1230	450
AY-5-1317A	630
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	200
CA3090AQ	375
CA3123	165
CA3130	90
CA3140	40
CA3160	95
CA3161E	160
CA3162E	450
CA3189	200
CA3240	110
HA1366	175
HA1388	255
ICL7106	750
ICL7107	975
ICL7611	99
ICL7660	240
ICL8038CC	300
ICL8211	350
ICM7204	550
ICM7205	1150
ICM7207	475
ICM7215	1050
ICM7216A	1950
ICM7216B	1950
ICM7216C	1950
ICM7217A	790
ICM7224	785
ICM7240	300
ICM7555	80
ICM7556	150
LA3350	220
LA4031P	240
LA4032	295
LA4400	295
LA4422	275
LC7120	350
LC7130	340
LC7137	350
LF347	150
LF351	48
LF353	95
LF355	88
LF356	95
LF357	110
LF398	475
LM10	325
LM301A	24
LM307	45
LM308	95
LM311	70
LM318	150
LM319	215
LM324	30
LM334Z	90
LM335	128
LM339	47
LM348	64
LM349	115
LM358	90
LM377	175
LM379	480
LM380	75
LM381N	145
LM382	115
LM384	140
LM386	90
LM387	120
LM389	95
LM393	100
LM394CH	290
LM725CN	325
LM733	70
LM2917	195
LM3302	75
LM3900	50
LM3909	85
LM3911	125
LM3914	200
LM3915	200
LM3916	250
LM13600	110
LS7220	280
M253AA	1150
M51513L	230
M51515L	320
MB3712	220
MB3756	440
MC1303	88
MC1304P	260
MC1310P	150
MC1445	250
MC1458	35
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
MC3423P	80
MF10	350
MFC6040	75
MK50398	635
ML924	275
MSM5526	820
NE515	275
NE529	225
NE531	140
NE543	225
NE544	210
NE555	16
NE556D8	45
NE560	325
NE561	395
NE562B	410
NE564	420
NE565A	120
NE566	155
NE567	140
NE570	410
NE571	400
NE5532	145
NE5534	150
OM335	750
RC4136D	69
RC4558	45
S566B	225
SA83209	425
SAB3210	325
SAB3271	485
SAB4209	595
SG3402	295
SL490	350
SN76003N	350
SN76013N	350
SN76023N	350
SN76033	350
SN76227N	95
SN76477	420
SN76488	480
SN76660	120
SP0256AL2	£18
SPB629	299
TA7120	150
TA7204	195
TA7205	175
TA7222	150
TA7310	150
TAA661A	190
TAA700	275
TAA900	395
TAD100	159
TBA120S	70
TBA540	275
TBA550Q	330
TBA641-A12/BX1	290
TBA651	190
TBA800	80
TBA810S	95
TBA820	80
TBA920Q	200
TBA990	350
TCA270	350
TCA280A	220
TCA940	175
TCA965	120
TDA1004	290
TDA1008	310
TDA1010	198
TDA1022	499
TDA1024	115
TDA1034	350
TDA1490	325
TDA2002	325
TDA2004	495
TDA2006	300
TDA2020	320
TDA2030	295
TDB0797	420
TL061CP	40
TL062CP	60
TL064CN	98
TL071CP	24
TL072CP	45
TL074CN	100
TL081CP	24
TL082CP	45
TL083CP	75
TL084CP	90
TL091CP	55
TL170	50
UA2240	120
UA78540	230
UAA170	170
UAA180	170
UAA1003-3	935
ULN2003	75
ULN2004	75
ULN2068	290
ULN2802	200
ULN2804	150
ULN2283	100
UPC575	165
UPC1025H	265
UPC1182	270
UPC1156H	275
UPC1366	195
XR2206	300
XR2207	375
XR2211	575
XR2216	675
XR2266	360
ZN414	80
ZN419CE	190
ZN423E	138
ZN424E	130
ZN425E-8	345
ZN426E-8	300
ZN427E-8	590
ZN428E	410
ZN429E-8	210
ZN459	570
ZN1034E	200
ZN1040E	675
ZNA234E	850

COMPUTER IC's

1702	350
1802CP	650
2112-2	250
2114L-300n	90
2114L-200n	95
2147-3	425
2532-450n	350
2564	£12
2708	225
2716-5V	215
2732-450n	350
2764	999
3242	590
4027	190
4116-150	85
4116-200	80
4118-250	325
4164-200	450
4334-3 (CMOS 2114)	325
4816-100ns	225
4864-3 64K	450
5101	220
6116-150ns	390
6116L-120ns	550
6117-100n	490
6167-6	795
6502 CPU	325
6503	600
6504-250	550
6520	100
6522 VIA	300
6530 RRIOT	£11
6532 RIOT	570
6545 CRTC	899
6551 ACIA	650
6592 PC	£20
6800	£70
6802	250
6803	850
6804	160
6805	670
6808	520
6809	630
6810	115
6812	100
68B21	220
6821	100
6840	375
6843	£12
6845	685
6847	650
6850	110
6852	250
6854	599
6875	500
68000	£78
74C922	420
8080A	250
8085A	350
8088	£18
81LS95	80
81LS96	80
81LS97	80
81LS98	85
8118-10	225
8123	125
8155	350
8156	350
8202	£25
8205	225
8212	110
8214	425
8215-300	300
8216	100
8224	110
8226	250
8228	220
8243	270
8250	850
8251A	250
8253	400
8255	225
8256A	£35
8257A	400
8259	395
8271	£35
8279	385
8284	350
8288	£10
8T26A	99
8T27	150
8T28A	120
8T31	350
8T95N	90
8T97N	90
9364AP	550
9602	220
AM26LS31C	125
AM26LS32A	125
AY-3-1015	300
AY-5-1013	300
AY-5-1350	388
AY-5-2376	600
AY-5-3600	750
COM8017	275
COM8116	700
DM8131	275
DP83048N	250
DS3691N	320
DS8820	110
DS8830	110
DS8831	125
DS8832	
DS88LS120N	275
FD1761	£15
FD1771	£15
FD1791	£22
FD1793	£23
FD1795	£28
FD1797	£28
HD26501	75
HMG167-6	795
IM6402	380
INS8060N	1050
INS8154N	£9
MC1488	55
MC1489	55
MC14411	675
MC14412	775
MC3446	260
MC3447P	315
MK3886-2M	£7
MM5280D	695
MM5303	635
MM5307	1275
MM5387A	475
MM58174	770
RO-3-2513L	650
RO-3-2513U	600
SFF96364E	800
SP0256AL2	£18
TMS2716-3	725
TMS6011	365
TMS4164-15	475
TMS9928	£30
TMS9995	£12
ULN2003	75
UPD7002	440
Z80CPU 2·5	299
Z80ACPU4M	300
Z80CTC	250
Z80ACTC	260
Z80B	£11
Z80DART	495
Z80ADART	550
Z80ADMA	895
Z80DMA	675
Z80P10	260
Z80AP10	275
Z80S10-1	850
Z80AS10	980

74C

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

74S Series

74S00	30
74S02	30
74S04	30
74S05	60
74S08	60
74S10	40
74S11	50
74S20	40
74S22	50
74S30	40
74S32	70
74S37	60
74S74	75
74S85	450
74S86	480
74S112	90
74S113	90
74S114	90
74S124	300
74S132	110
74S133	60
74S138	115
74S139	115
74S140	60
74S151	180
74S153	182
74S157	250
74S158	195
74S163	300
74S174	250
74S175	320
74S188	140
74S189	140
74S194	320
74S195	480
74S197	400
74S201	350
74S225	500
74S240	300
74S241	300
74S244	290
74S251	250
74S257	250
74S258	250
74S260	70
74S262	850
74S287	225
74S288	150
74S289	290
74S299	540
74S301	000
74S365	000
74S373	400
74S374	365
74S470	325
74S471	620
74S472	1150
74S474	400
74S475	800
74S571	620

75 Series

75107/8	95
75110	90
75150	125
75154	125
75182/3	99
75188/9	55
75322	140
75450	86
75451/2	52
75454	70
75491/2	85

TTL 7400

7400	11
7401	11
7402	11
7403	12
7404	13
74L04	85
7405	15
7406	20
7407	20
7408	14
7409	14
7410	14
7411	16
7412	18
7413	18
7414	20
7416	20
7417	20
7420	15
7421	20
7422	20
7423	20
7425	18
7426	18
7427	18
7428	25
7430	14
7432	20
7433	22
7437	25
7438	22
7440	15
7441	55
7442	32
7443	90
7444	90
7445	55
7446	60
7447	35
7448	40
7450	16
7451	16
7453	16
7454	16
7460	16
7470	30
7472	24
7473	24
7474	20
7475	25
7476	25
7480	40
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	28
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	19
74176	40
74177	45
74178	80
74179	80
74180	40
74181	115
74182	60
74184	90
74185	95
74186	470
74188	250
74190	48
74191	48
74192	48
74193	45
74194	40
74195	40
74196	48
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

74LS

LS00	11
LS01	11
LS02	11
LS03	12
LS04	12
LS05	13
LS08	12
LS09	12
LS10	13
LS11	13
LS12	12
LS13	20
LS14	26
LS15	13
LS20	13
LS21	12
LS22	12
LS26	14
LS27	12
LS28	14
LS30	12
LS32	13
LS33	14
LS37	14
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	16
LS114	22
LS122	36
LS123	38
LS124	90
LS125	24
LS126	25
LS132	35
LS133	30
LS136	24
LS138	25
LS139	28
LS145	70
LS147	100
LS148	70
LS151	40
LS153	40
LS154	80
LS155	30
LS156	36
LS157	27
LS158	30
LS160	32
LS161	37
LS162	37
LS163	37
LS164	43
LS165	50
LS166	52
LS168	85
LS170	70
LS173	55
LS174	50
LS175	40
LS181	90
LS183	180
LS190	36
LS191	36
LS192	36
LS193	37
LS194	33
LS195	33
LS196	45
LS197	45
LS221	55
LS240	55
LS241	55
LS242	55
LS243	55
LS244	55
LS245	70
LS247	50
LS248	55
LS249	55
LS251	32
LS253	32
LS257	30
LS258	35
LS259	55
LS260	22
LS261	100
LS266	18
LS273	54
LS275	125
LS279	30
LS280	90
LS283	40
LS290	53
LS293	40
LS295	75
LS298	80
LS299	150
LS320	200
LS323	160
LS324	168
LS325	295
LS326	240
LS327	240
LS347	95
LS348	90
LS352	62
LS353	62
LS362	750
LS363	140
LS364	140
LS365	28
LS366	32
LS367	28
LS368	35
LS373	60
LS374	55
LS375	50
LS377	85
LS378	80
LS379	110
LS384	395
LS385	250
LS390	46
LS393	42
LS395	95
LS399	150
LS445	100
LS471	620
LS490	200
LS540	100
LS541	80
LS640	180
LS641	180
LS645	180
LS668	125
LS669	120
LS670	100
LS673	550

CMOS

4000	10
4001	10
4002	12
4006	50
4007	14
4008	32
4009	24
4010	24
4011	10
4012	16
4013	20
4014	46
4015	40
4016	20
4017	32
4018	45
4019	25
4020	42
4021	40
4022	40
4023	13
4024	32
4025	13
4026	80
4027	20
4028	39
4029	45
4030	15
4031	125
4032	80
4033	125
4034	140
4035	45
4036	275
4037	115
4038	110
4039	290
4040	40
4041	40
4042	40
4043	40
4044	40
4045	105
4046	46
4047	40
4048	40
4049	25
4050	25
4051	45
4052	60
4053	50
4054	85
4055	85
4056	85
4057	1915
4059	435
4060	45
4061	1195
4062	995
4063	85
4066	24
4067	245
4068	14
4069	13
4070	13
4071	13
4072	13
4073	15
4075	13
4076	60
4077	13
4078	15
4081	13
4082	13
4085	50
4086	60
4089	125
4093	20
4094	70
4095	95
4096	70
4097	190
4098	75
4099	75
4160	96
4161	99
4162	99
4163	99
4174	99
4175	105
4194	105
4408	790
4409	790
4410	725
4411	690
4412	790
4415	480
4419	280
4422	770
4433	770
4435	850
4440	999
4450	350
4451	350
4490	350
4500	675
4501	28
4502	60
4503	36
4504	75
4505	185
4506	35
4507	35
4508	130
4510	46
4511	46
4512	42
4513	199
4514	125
4515	125
4516	65
4517	275
4518	40
4519	30
4520	70
4521	130
4522	125
4526	60
4527	50
4528	50
4529	150
4530	90
4531	130
4532	50
4534	455
4536	275
4538	70
4539	90
4541	140
4543	70
4544	150
4548	40
4549	375
4553	245
4554	190
4555	35
4556	35
4557	320
4558	120
4559	395
4560	160
4561	104
4562	495
4566	165
4568	250
4569	175
4572	36
4580	460
4581	250
4582	99
4583	99
4584	48
4585	99
4597	330
4599	290
40097	45
40098	42
40100	215
40101	130
40102	140
40103	175
40104	95
40105	115
40106	75
40107	60
40108	450
40109	100
40110	300
40114	240
40163	50
40174	45
40175	50
40192	95
40193	95
40194	90
40195	80
40244	195
40245	195
40373	240
40374	245
45106	585

SPEAKERS
8Ω, 0.3W, 2"; 2.25", 2.5", 3" 80p
0.3W, 2.5" 40Ω; 64Ω or 80Ω 80p

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
1N5408	19
1S44	9
1S921	9
6A/100V	40
6A/400V	50
6A/800V	65

Noise Diode
Z5J 195

SCR's Thyristors

0.8A-100V	32
5A/300V	38
5A/400V	40
5A/600V	48
8A/300V	60
8A/600V	95
12A/100V	78
12A/400V	95
12A/800V	188
BT106	150
BT116	180
C106D	38
TIC44	24
TIC45	29
TIC47	35
2N5062	32
2N5064	38
2N4444	130

DIAC
ST2 25

BRIDGE RECTIFIERS
(plastic case)

1A/50V	18
1A/100V	20
1A/400V	25
1A/600V	34
2A/50V	30
2A/200V	40
2A/400V	46
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	50

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

VARICAPS

MVAM2	165
BA102	30
BB105B	40
BB106	40

TRIACS

3A/100V	48
3A/400V	56
3A/800V	85
8A/100V	60
8A/400V	69
8A/800V	115
12A/100V	78
12A/400V	82
12A/800V	135
16A/100V	103
16A/400V	105
16A/800V	220
25A/400V	185
25A/800V	295
25A/1000V	480
30A/400V	525
T2800D	120

SOLDERCON PINS
100 70p
500 350p

OPTO ELECTRONICS
LEDS including Clips

TIL209 Red 3mm	10
TIL211 Green 3mm	14
TIL212 Yellow	14
TIL220 .2" Red	12
0.2" Yel, Grn, Amber	14
Rectangular LEDs with two part clip. R, G & Y	29
Rectangl. Stackable LEDS	18
Triangular LEDs R&G	18
0.2" Flashing LED Red	56
0.2" Bi colour LEDs Red/Green	65
Green/Yellow	80
0.2" Tri colour LEDs Red/Green/Yellow	85
0.2" Red High Bright	59
LD271 Infra Red (emit)	46
TIL32 Infra Red (emit)	52
SFH205 (detector)	118
TIL78 (detector)	54
TIL38	45
TIL81	82
TIL100	90

7 Segment Displays

TIL321 .5" C.An	115
TIL322 .5" C.th	115
DL704 .3" C.Cth	99
DL707 .3" C.Anod	99
.8" Orange C.A.	250
FND357 or 500	120
.3" Green C.A.	140
±1.3" Red or Green	150
Bargraph 10 seg. Red	225
Bargraph NSM3914	500

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

DALO ETCH RESIST
Pen plus spare tip 90p

COPPER CLAD BOARDS

	Single-sided	Double-sided	SRBP 9.5"x8.5"
Fibre Glass 6"x6"	90p	110p	95p
6"x12"	150p	195p	

VEROBOARDS 0.1"

	Clad	Plain
$2\frac{1}{2}$x$3\frac{3}{4}$"	80p	—
$2\frac{1}{2}$x5"	91p	—
$3\frac{3}{4}$x$3\frac{3}{4}$"	91p	—
$3\frac{3}{4}$x5"	105p	87p
$3\frac{3}{4}$x17"	380p	232p
$4\frac{3}{4}$x18"	470p	—
Pkt. of 100 pins	50p	
Spot Face Cutter	135p	
Pin Insertion Tool	178p	

'VQ' Board	180
'DIP' Board	374
Vero Strip	144
S100 Board	£14

PROTO-DECs

Veroblock	405
S-Dec	350
Eurobreadboard	520
Bimboard 1	695
Superstrip SS2	£13

VERO WIRING PEN and Spool 350p
Spare Wire (Spool) 75p; Combs 6p ea.
Wire Wrapping Stakes 100 250p

0.5" LIQUID CRYSTAL DISPLAYS

$3\frac{1}{2}$ digit	495
4 digit	530
6 digit	625
BPX25	195
BPW21	295
BPX65	270
IL74	45
ILD74	99
ILQ74	185
TIL111	75
OCP71	120
ORP12	78
ORP61	85
2N5777	45
4N33	135

OPTO SWITCH
Reflective TIL139 170
Slotted similar to RS 186

ALUM. BOXES

3x2x1"	65
4x2$\frac{1}{2}$x2"	85
4x2$\frac{1}{4}$x2$\frac{1}{2}$"	103
4x4x2$\frac{1}{2}$"	120
5x4x2	105
5x2$\frac{1}{2}$x1$\frac{1}{2}$"	90
5x2$\frac{1}{2}$x2$\frac{1}{2}$"	130
5x4x1$\frac{1}{2}$"	99
5x4x2$\frac{1}{2}$"	120
6x4x2"	120
6x4x3"	150
7x5x3"	180
8x6x3"	210
10x4$\frac{1}{2}$x3"	240
10x7x3"	275
12x5x3"	260
12x8x3"	295

VOLTAGE REGULATORS
1A T0220 Plastic Casing

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

100mA T092 Plastic Casing

5V	78L05	30p	79L05	60p
6V	78L62	30p		—
8V	78L82	30p		—
12V	78L12	30p	79L12	60p
15V	78L15	30p	79L15	60p

LM300H	170	LM305H	140
LM304H	160	LM309K	135
78H05 5V/5A	550	LM317K	320
78H12 12V/5A	580	LM317P	99
78HG+5 to +24V 5A	599	LM323K	500
79HG −2.25V to −24V 5A	685	LM337T	175
		LM723	35
		TBA625B	75

SWITCHES

SLIDE 250V
1A DPDT 14
1A DPDT C/OFF 15
$\frac{1}{2}$A DP on/on/on 40

TOGGLE 2A 250V
SPST 33
DPDT 44
4 pole on off 54

PUSH BUTTON
Spring loaded
Latching or Momentary 6A
SPDT c/over 99
DPDT c/over 145

MINIATURE
Non Locking
Push to make 15p
Push break 25p

SUB-MIN TOGGLE 2 amp
SP changeover 60
SPST on off 54
SPDT c/off 85
SPDT Biased 105
DPDT 6 tags 75
DPDT C/OFF 88
DPDT on/on/on 185
DPDT Biased 145
3 pole c/over 205

ROCKER: 5A, 250V, SPST 28p
ROCKER: 10A 250V SPDT 38p
ROCKER: With neon lights red when on. 10A 250V, DPST 85p
ROCKER: (White) 10A/250V DPDT 72p
ROTARY: Make your own Multiway Switch. Shafting Assembly accommodates up to 6 wafers. 90p
Break before make Wafers. Silver contacts. 1 pole/12 way; 2 pole/6 way; 3 pole/4 way; 4 pole/3 way; 6 pole/2 way 65p
Mains DPST Switch to fit 45p
Screen & Spacers 6p
ROTARY: (Adjustable Stop Type) 1 pole/2 to 12 way, 2p/2 to 6 way, 3 pole/2 to 4 way, 4 pole/2 to 3 way 45p
ROTARY: Mains 250V AC, 4 Amp 56p
DIL SWITCHES: (SPST) 4 way 65p; 6 way 80p; 8 way 87p; 10 way 135p; (SPDT) 4 way 190p.
THUMBWHEEL Mini front mounting
Decade Switch Module 220p
B.C.D. Switch Module 275p
Mounting Cheeks (pair) 75p
PROXIMITY Switch with magnet 125p

DIL SOCKETS

	Low profile	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

ZIF DIL SOCKET

16 way	475p
24 way	575p
28 way	850p
40 way	975p

DIL PLUGS (Headers)

Pins	Solder	IDC
14	38p	95p
16	42p	100p
24	88p	138p
40	195p	218p

RIBBON CABLE
(price per foot)

Ways	Grey	Color
10	12p	22p
16	25p	40p
20	25p	40p
26	35p	52p
34	48p	60p
40	55p	70p
60	75p	115p

ULTIMUM

WATFORD'S most versatile MICRO EXPANSION SYSTEM. Interfaces with: APPLE, ATOM, DRAGON, PET, RESEARCH MACHINE, SPECTRUM, SUPERBOARD, VIDEO GENIE, ZX81, etc. As published in P.E. starting from Nov., 1982.
Send SAE for details.

IDC CONNECTORS (Speed block type)

2 rows	PCB PLUG with latch Strt. Pins	Angle Pins	Female Header Socket	Female Card-Edge Connector
				120p
10 way	90p	99p	85p	—
16 way	130p	150p	110p	195p
20 way	145p	166p	125p	240p
26 way	175p	200p	150p	320p
34 way	205p	236p	169p	340p
40 way	220p	250p	190p	420p
50 way	235p	270p	200p	470p

EURO CONNECTORS

	FEMALE SOCKETS Strt.	Angle	MALE PLUGS Strt.	Angle
DIN 41617 31 way	170p	—	—	175p
DIN 41612 2x32 way	285p	325p	220p	295p
DIN 41612 2-3x32 way	300p	340p	240p	300p
DIN 41612 3x32 way	360p	385p	280p	400p

'D' CONNECTORS:
Miniature

Pins	9 way	15 way	25 way	37 way
MALE				
Solder	80p	110p	160p	240p
Angle	150p	210p	250p	355p
Strait	170p	160p	220p	310p
FEMALE				
Solder	105p	160p	200p	338p
Angle	165p	215p	290p	440p
Strait	175p	200p	300p	420p
COVERS Top & Side Entry	95p	90p	100p	110p

IDC 25 way Plg. 385p, Skt. 450p

SIL Sockets 0.1"
20 way 65p
32 way 95p

EDGE CONNECTORS

	1"	.156"
2x10 way	—	135p
2x15 way	—	140p
2x18 way	180p	145p
2x22 way	199p	200p
2x23 way	170p	190p
2x25 way	225p	220p
2x28 way	185p	—
2x30 way	245p	—
2x36 way	295p	—
2x40 way	315p	—
2x43 way	395p	—
2x75 way	550p	—

TRANSFORMERS (mains Prim. 220-240V)
3-0-3V, 6-0-6V 100mA; 9-0-9V 75mA; 12-0-12V 75mA; 15-0-15V 75mA 98p
6VA: 2x6V-.5A; 2x9V-.4A; 2x12V-0.3A; 2x15V-.25A 220p
12VA: 2x4V5-1.3A; 2x6V-1.2A; 2x12V-.5A; 2x15V-.4A 295p (35p p&p)
24VA: 6V-1.5A 6V-1.5A; 9V-1.2A 9V-1.2A; 12V-1A 12V-1A; 15-.8A 15-.8A; 20V-.6A 20V-.6A 330p (60p p&p)
50VA: 2x6V-4A; 2x9V-2.5A; 2x12V-2A; 2x15V-1.5A; 2x20V-1.2A; 2x25V-2A; 2x30V-0.8A 485p (60p p&p)
100VA: 2x12V-4A; 2x15V-3A; 2x20V-2.5A; 2x30V-1.5A; 2x40V-1.25A; 2x50V-1A 920p (60p p&p)

JUMPER LEADS Ribbon Cable Assembly
DIL Plug (Headers)
Single Ended Lead, 24" long

Length	14pin	16pin	24 pin	40 pin
24"	145p	165p	240p	380p
Double Ended Leads				
6"	185p	205p	300p	485p
12"	198p	215p	315p	490p
24"	210p	235p	345p	540p
36"	230p	250p	375p	595p

IDC FEMALE RECEPTACLE Jumper Leads 24"

	20pin	26pin	34pin	40pin
1 end	160p	200p	260p	300p
2 ends	290p	370p	480p	525p

COMPUTER CORNER

- **SEIKOSHA GP100A** – Unihammer Printer, normal & double width characters, dot resolution graphics 10" Tractor feed, parallel interface standard. **FREE** 500 Sheets **£175**
- **SEIKOSHA GP 250X** **£240**
- **DRAGON** Microcomputer. **£173**
- **JUPITER ACE** Microcomputer **£78**
- **SOFTY–2.** The complete Microprocessor development system. New powerful instructions. Accepts any 24 pin 5V single rail EPROM. Supplied fully built & tested. **£169**
- **WEMON.** Watford's 4K Ultimate Monitor IC for Superboard & UK101. **£10**
- **VIDEO MONITORS.** Fully cased. Smoked anti-glare display filter. Bandwidth 12MHz. Res. 750 lines. I/P 75Ω or high. 240V/50Hz. 9" – B&W **£89;** Green **£95;** Amber **£98.** 12" – Green **£114;** Amber **£118.**
- **ZENITH 12" Hi-RES,** Green Monitor 40/80 column select switch **£80**
- **TEX EPROM ERASER.** Erases up to 32 ICs in 15-30 min. **£33**
- **TEX EPROM ERASER** with the Solid-State 30 minute Electronic Timer. **£43**
- **Spare** 'UV lamp bulbs **£9**
- **POWER SUPPLY** Regulated, Variable from +5V to +15V @ 4A. Fully Cased **£39**
- **MULTIRAIL PSU KIT.** Output: +5V/5A; +12V; +25V; −5V; −12V @ 1A. **£40**
- Attractive Beige/Brown **ABS CASE** for Superboard/UK101 or Home Brew **£29**
- **4 x 4 matrix keypad** (reed switch assembly) **£4**
- **C12 COMPUTER Grade BASF Cassettes** in Library Cases **40p**
- **STACK-PACK.** Unique 10 section stackable Drawers rack including 10 x C12 Computer grade Cassettes (BASF Tape). **550p**
- **$8\frac{1}{2}$" & $9\frac{1}{2}$" Fan fold paper** (1000 sheets) **£7**
- **Teleprinter Roll** (no VAT) **£3.50**

(P&P on some of the above items is extra)

Call in at our shop for demonstration of any of the above items. Be satisfied before you buy.

● SPECIAL OFFER ●

	1+	25+
2732	350p	330p
2764	699p	599p
4116-150ns	85p	80p
4816-100ns	225p	205p
6116-150ns	390p	360p
6522	300p	270p

★ PRINTERS ★

- **MX80FT/3** 10" Tractor and Friction Feed. 9x9 matrix, 80 column, 80 CPS, Bi-directional, Centronix Interf., BR110-9600 Hi-res, bit image graphics, subscript & superscript, Italics, Underlining plus **FREE** 500 Sheets paper.
  ONLY £324 (carr. £7)
- **MX100 FT/3** 15", 100 CPS, 136 column, plus all the MX80 features. **£425**
- **NEC PC-8023BE-C,** 100CPS bi-directional, logic seeking, 80 column, 7x9 Dot matrix, super/subscript, underlining, true decenders Tractor/Friction, Hi-Res, 2K Buffer, Proportional Spacing, at a Special Price. Plus **FREE** 500 sheets paper.
  ONLY £320 (carr. £7)

ANTEX Soldering Irons

C15W	450
CX17W	475
CCN15W	490
X25W	500
Spare bits	65
Elements	210
Iron stands	165
Heat Shunt	30

Access

Just phone your order through, we do the rest. 0923-50234

ASTEC UHF MODULATORS
6MHz 280p
8MHz Wide Modulators 425p

ULTRASONIC TRANSDUCERS
40KHz Transmitter & Receiver 325p/pair

CRYSTALS

32.768KHz	100
100KHz	235
200KHz	268
455KHz	370
1MHz	275
1.008M	275
1.28MHz	392
1.5MHz	420
1.6MHz	395
1.8MHz	395
1.8432M	200
2.0MHz	225
2.4576M	200
2.5MHz	225
2.56250M	220
3.2768M	150
3.57954M	98
3.6864M	300
4.0MHz	150
4.032MHz	290
4.194304M	200
4.433619M	100
4.608MHz	200
4.80MHz	200
5.0MHz	160
5.185MHz	300
5.24288M	390
6.0MHz	140
6.144MHz	150
6.5536MHz	200
7.0MHz	150
7.168MHz	250
7.68MHz	200
8.0MHz	150
8.08333M	395
8.867237M	175
9.00MHz	200
9.375MHz	350
10.0MHz	175
10.5MHz	250
10.7MHz	150
10.24MHz	200
12.0MHz	175
12.528MHz	300
14.31818M	170
14.7456M	175
14.765MHz	250
15.0MHz	200
16.0MHz	200
18.0MHz	180
18.432M	150
19.968MHz	150
20.0MHz	200
24.0MHz	170
24.930MHz	325
29.695MHz	150
26.670MHz	325
27.125MHz	295
27.145M	190
27.648MHz	300
38.66667M	175
48.0MHz	175
55.5MHz	400
100MHz	350
116.0MHz	300
145.8MHz	225

AMPHENOL CONNECTORS

	Solder type Plugs	Sockets	IDC Plug
24 way IEEE	475p	500p	480p
36 way Centronix	525p	550p	485p

BBC MICRO UPGRADE KITS

Upgrade your BBC Micro with our upgrade kit and save yourself £ s s s . . .

- 16K MEMORY (8x4816-100ns) BBC1 **£18.00**
- Printer User I/O Port BBC2 **£8.20**
- Complete Printer Cable 36" **£12.00**
- Disc Interface Kit BBC3 **£41.00**
- Compatible Disc Drives see below
- Analogue I/O Kit BBC4 **£6.75**
- Serial I/O Kit BBC5 **£7.50**
- Expansion Bus Kit BBC6 **£6.50**
- Complete Upgrade Kit from Model A to B **£45**
- COLOUR MONITOR - MICROVITEC 1431. 14" RGB Input. For BBC. Lead included.
- Complete range of Connectors, Cables, Quality Software, Accessories, Books, etc. for BBC available. Send SAE for detail list.

FLOPPY DISC DRIVES

- TEAC FD-50A $5\frac{1}{4}$" 40 track SSSD Uncased 100K **£125**
- TEAC FD-50A $5\frac{1}{4}$" 40 track SSSD in cabinet with own PSU 100K **£180**
- TEAC FD-50A $5\frac{1}{4}$" 40 track Two Drives SSSD in cabinet with PSU 200K **£350**
- TEAC FD-50E $5\frac{1}{4}$" 80 track S/S in cabinet with own PSU 200K **£250**
- TEAC FD-50E Two $5\frac{1}{4}$ S/S 80 track Drives, cased with PSU. 400K **£475**
- SIEMENS FDD100-5 Fully cased drive for APPLE (incl. Cable) **£235**
- APPLE II DOS Int. Card for above drive. Gold plated Edge connection **£42**
- DRIVE Connecting Cable. Single **£8;** Dble **£12.**
- 10 Verbatim $5\frac{1}{4}$" Diskettes S.D. **£20;** DD **£30**

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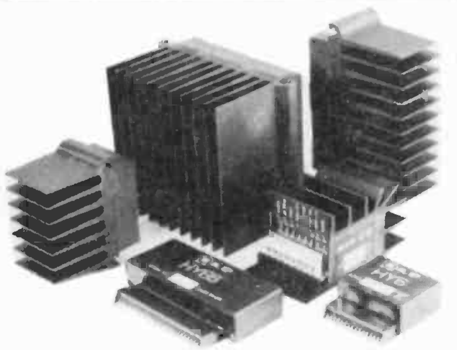
Tel. (0923) 40588 Telex. 8956095

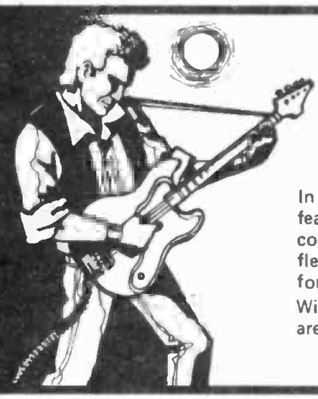
GET BIG POWER

ILP Modular Amplifiers

the third generation



Due to continous improvements in components and design ILP now launch the largest and most advanced generation of modules ever.



WE'RE INSTRUMENTAL IN MAKING A LOT OF POWER

In keeping with ILP's tradition of entirely self-contained modules featuring, integral heatsinks, no external components and only 5 connections required, the range has been optimized for efficiency, flexibility, reliability, easy usage, outstanding performance, value for money.

With over 10 years experience in audio amplifier technology ILP are recognised as world leaders.

BIPOLAR MODULES

Module Number	Output Power Watts rms	Load Impedance Ω	DISTORTION T.H.D. Typ at 1KHz	DISTORTION I.M.D. 60Hz/7KHz 4:1	Supply Voltage Typ	Size mm	WT gms	Price inc. VAT
HY30	15	4-8	0.015%	<0.006%	± 18	76 x 68 x 40	240	£8.40
HY60	30	4-8	0.015%	<0.006%	± 25	76 x 68 x 40	240	£9.55
HY6060	30 + 30	4-8	0.015%	<0.006%	± 25	120 x 78 x 40	420	£18.69
HY124	60	4	0.01%	<0.006%	± 26	120 x 78 x 40	410	£20.75
HY128	60	8	0.01%	<0.006%	± 35	120 x 78 x 40	410	£20.75
HY244	120	4	0.01%	<0.006%	± 35	120 x 78 x 50	520	£25.47
HY248	120	8	0.01%	<0.006%	± 50	120 x 78 x 50	520	£25.47
HY364	180	4	0.01%	<0.006%	± 45	120 x 78 x 100	1030	£38.41
HY368	180	8	0.01%	<0.006%	± 60	120 x 78 x 100	1030	£38.41

Protection Full load line. Slew Rate 15v/µs. Risetime: 5µs. S/N ratio 100db.
Frequency response (−3dB) 15Hz – 50KHz. Input sensitivity: 500mV rms.
Input Impedance 100K Ω. Damping factor 100Hz >400.

PRE-AMP SYSTEMS

Module Number	Module	Functions	Current Required	Price inc. VAT
HY6	Mono pre amp	Mic/Mag. Cartridge/Tuner/Tape/Aux + Vol/Bass/Treble	10mA	£7.60
HY66	Stereo pre amp	Mic/Mag. Cartridge/Tuner/Tape/Aux + Vol/Bass/Treble/Balance	20mA	£14.32
HY73	Guitar pre amp	Two Guitar (Bass Lead) and Mic + separate Volume Bass Treble + Mix	20mA	£15.36
HY78	Stereo pre amp	As HY66 less tone controls	20mA	£14.20

Most pre-amp modules can be driven by the PSU driving the main power amp. A separate PSU 30 is available purely for pre amp modules if required for £5.47 (inc. VAT). Pre-amp and mixing modules in 18 different variations. Please send for details.

Mounting Boards

For ease of construction we recommend the B6 for modules HY6–HY13 £1.05 (inc. VAT) and the B66 for modules HY66–HY78 £1.29 (inc. VAT).

MOSFET MODULES

Module Number	Output Power Watts rms	Load Impedance Ω	DISTORTION T.H.D. Typ at 1KHz	DISTORTION I.M.D. 60Hz/7KHz 4:1	Supply Voltage Typ	Size mm	WT gms	Price inc. VAT
MOS 128	60	4-8	<0.005%	<0.006%	± 45	120 x 78 x 40	420	£30.41
MOS 248	120	4-8	<0.005%	<0.006%	± 55	120 x 78 x 80	850	£39.86
MOS 364	180	4	<0.005%	<0.006%	± 55	120 x 78 x 100	1025	£45.54

Protection: Able to cope with complex loads without the need for very special protection circuitry (fuses will suffice).
Slew rate: 20v/µs. Rise time: 3µs. S/N ratio: 100db
Frequency response (−3dB): 15Hz – 100KHz. Input sensitivity: 500mV rms
Input impedance: 100K Ω. Damping factor: 100Hz > 400.

'NEW to ILP' In Car Entertainments

C15

Mono Power Booster Amplifier to increase the output of your existing car radio or cassette player to a nominal 15 watts rms.

Very easy to use.

Robust construction. **£9.14 (inc. VAT)**

Mounts anywhere in car.

Automatic switch on.

Output power maximum 22w peak into 4Ω
Frequency response (−3dB) 15Hz to 30KHz, T.H.D. 0.1% at 10w 1KHz
S/N ratio (DIN AUDIO) 80dB, Load Impedance 3Ω
Input Sensitivity and impedance (selectable) 700mV rms into 15K Ω 3V rms into 8Ω
Size 95 x 48 x 50mm, Weight 256 gms.

C1515

Stereo version of C15. **£17.19 (inc. VAT)**

Size 95 x 40 x 80. Weight 410 gms.

POWER SUPPLY UNITS (Incorporating our own toroidal transformers)

Model Number	For Use With	Price inc. VAT
PSU 21X	1 or 2 HY30	£11.93
PSU 41X	1 or 2 HY60, 1 x HY6060, 1 x HY124	£13.83
PSU 42X	1 x HY128	£15.90
PSU 43X	1 x MOS128	£16.70
PSU 51X	2 x HY128, 1 x HY244	£17.07

Model Number	For Use With	Price inc. VAT
PSU 52X	2 x HY124	£17.07
PSU 53X	2 x MOS128	£17.86
PSU 54X	1 x HY248	£17.86
PSU 55X	1 x MOS248	£19.52
PSU 71X	2 x HY244	£21.75

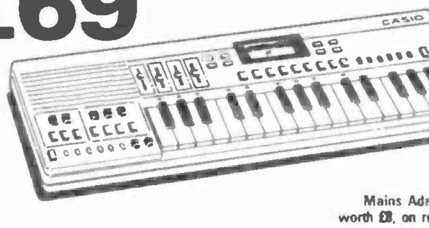
Model Number	For Use With	Price inc. VAT
PSU 72X	2 x HY248	£22.54
PSU 73X	1 x HY364	£22.54
PSU 74X	1 x HY368	£24.20
PSU 75X	2 x MOS248, 1 x MOS368	£24.20

Please note: X in part no. indicates primary voltage. Please insert "0" in place of X for 110V, "1" in place of X for 220V, and "2" in place of X for 240V.

You liked the VL-Tone You will love the PT-30!

MORE CASIO MAGIC

£69



FREE
Mains Adaptor & Songbook worth £8, on request with order

This incredibly sophisticated portable musical instrument has a computer brain that can turn you into a talented musician overnight.
The **AUTOMATIC HARMONIZATION** feature analyses notes which have been programmed and supplies appropriate chords for accompaniment. Three different choices are available to suit your taste and any chord, or chords can be manually changed if desired.
The 31 key monophonic keyboard has a comprehensive chord section with built-in Bass patterns. The PT-30 comes with 8 preset instrument voices and 12 rhythms plus 6 arpeggio patterns. There is also a transpose function and a liquid crystal display showing notes and chords.
The **508 STEP MEMORY** can be sub-divided to give up to 8 separate memories. These separate memories can be repeatedly played and/or linked to other memories in any order. Both notes and chords can be stored in this way. The contents of the memories can be stored onto cassette tape via the optional TA-1 interface, for re-loading at a later date. There is also a ONE KEY PLAY feature, similar to the VL-Tone products.

OTHER NEW CASIOTONES

MT-65 49 key, 8 note polyphonic portable keyboard with 20 preset voices. Simulated reverb/vibrato/delayed vibrato/sustain. Variable modulation (cross tone modulation). Twelve rhythms with a choice of 4 bass, 4 chord, and 4 arpeggio patterns. Bass can be played manually if desired. £149
CT-405 full size version of the MT-65, with transpose function. £275

SEND FOR FULL DETAILS OF THESE AND OTHER NEW MODELS

The most versatile watch ever created?

TE-2500 DICTIONARY WATCH

£39.95

Dictionary mode.
1,711 words in both English and Spanish.

5-Language translation mode.
36 basic sentences for daily conversation in English, Japanese, Spanish, French and German.
Backward and forward search buttons, with rapid search facility.

World time mode.
Displays all 24 time zones.
Daily alarm, hourly chimes, calendar and professional 1/10 second stopwatch. There are 6 programmable alarm messages and 2 alarm sound options.

TR-6000 TRANSLATOR CALCULATOR
6,000 words and phrases £29.95

This English-Spanish Spanish-English translator is a must for next year's holiday and, naturally, the alpha-numeric keyboard doubles as a calculator to help you work out your pesetas.

Delivery normally by return, subject to availability. Price includes VAT and Post and Packing. Send cheques, P.O., or phone your ACCESS/VISA card number to:-

TEMPUS

Dept PE, 38, Burleigh Street, Cambridge CB1 1DG. Tel: 0223 312866.

TERRIFIC VALUE!!!

We have a big store to clear. 100 tons of stock must go. 10 kilo parcel of unused parts. Minimum 1,000 items includes panel meters, timers, thermal trips, relays, switches, motors, drills, taps and dies, tools, thermostats, coils, condensers, resistors, etc. etc. Individually would cost you a fortune!
YOURS FOR ONLY £11.50 plus £3.00 post.

IONISER KIT

Refresh your home, office, shop, work room, etc. with a negative ION generator. Makes you feel better and work harder — complete mains operated kit, case included £11.95 plus £2.00 postage.

CAR STARTER/CHARGER KIT

This kit has no doubt saved many motorists from embarrasment in an emergency you can start car off mains or bring your battery up to full charge in a couple of hours. The kit comprises: 250w mains transformer, two 10 amp bridge rectifiers, start/charge switch and full instructions. You can assemble this in an evening, box it up or leave it on a shelf in the garage, whichever suits you best.
Price: **ONLY £12.50 + £3.00 post.**

3 — 30V VARIABLE VOLTAGE POWER SUPPLY UNIT

With 1 amp DC output, for use on the bench, students, Inventors, service engineers, etc. Automatic short circuit and overload protection. In case with a volt meter on the front panel. Complete kit £13.80.

ZX81 OWNERS

Make yourself a full size keyboard! Key switches complete with plain caps. 6 for **£1.15.**

COMPUTER PRINTER FOR ONLY £4.95

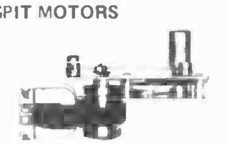
Japanese made Epson 310 — has a self starting, brishless drive motor. Complete with electronics — uses plain paper. Brand new with data. **ONLY £4.95 plus £1.25 Post.**

Cash, P.O. or cheque with order. Orders under £10.00, add 60p. Access & B/card orders by phone to Haywards Heath (0444) 454563. Delivery by return.

REVERSIBLE MOTOR WITH CONTROL GEAR

Made by the famous Framco Company this is a very robust motor, size approximately 7½" long, 3½" dia. 3/8" shaft. Tremendously powerful motor, almost impossible to stop. Ideal for operating stage curtains, sliding doors, ventilators, etc., even garage doors if adequately counter-balanced. We offer the motor complete with control gear as follows:
• 1 Framco motor with gear box. • 1 manual reversing and on/off switch. • 1 push to start switch. • 1 x 100w auto transformer. • 2 limit stop switches. • 1 circuit diagram of connections. £19.50 plus postage £2.50.

SPIT MOTORS



Powerful mains operated induction motors with gear box attached. The final shaft is a ½" rod with square hole, so you have alternative coupling methods — final speed is approx. 5 revs/min. **PRICE £5.50.** Similar motors with final speeds of 80, 100, 160 & 200 r.p.m. same price.

8 POWERFUL BATTERY MOTORS (all different)

Suitable for models, meccanos, drills, remote control planes, boats, etc. £2.95.

12 VOLT MOTOR BY SMITHS

Made for use in cars, these are series wound and they become more powerful as load increases. Size 3½" long by 3" dia. These have a good length of ¼" spindle — price £3.45. Ditto, but double ended £4.25.

EXTRA POWERFUL 12 VOLT MOTOR

Made to work battery lawnmower, this probably develops up to ¼ h.p., so it could be used to power a go-kart or to drive a compressor, etc. etc. £6.90 + £1.50 post. (This is easily reversible with our reversible switch — Price £1.15).

J.BULL(Electrical)Ltd.

Established 30 YEARS

(Dept PE), 34 - 36 AMERICA LANE, HAYWARDS HEATH, SUSSEX RH16 3QU.

TRANSFORMERS + VAT

EX-STOCK. Continuous Rating UK Postage. Overseas extra. Overseas Enquiries Welcomed

12V OR 24V OR 12-0-12V

Ref.	12V	24V	Price	P&P
213	1.0	0.5	£3.19	£1.20
71	2	1	£4.25	£1.20
18	4	2	£4.91	£1.60
85	5	2.5	£6.78	£1.50
70	6	3	£7.69	£1.40
108	8	4	£8.98	£1.64
72	10	5	£9.82	£1.80
116	12	6	£10.89	£1.90
17	16	8	£12.97	£2.12
115	20	10	£17.46	£2.44
187	30	15	£21.69	£2.64
226	60	30	£44.45	O.A.

50 VOLT RANGE (Split Sec) Pri 120/240V (2×25V tapped secs) Voltages available 5, 7, 8, 10, 13, 15, 17, 20, 33, 40 or 20V-0-20V or 25-0-25V.

Ref.	50V	25V	Price	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	£2.34
118	8	16	£24.52	£2.70
119	10	20	£30.23	O.A.
109	12	24	£36.15	O.A.

INVERTERS
12V DC to 240V AC cased 100W £46.00. 250W £101.00. 500W £180.00. 1kW (24V I/P) £240.00.

AVO METERS + VAT 15%

AVO 8 MK5. Latest Model	£122.10
AVO 71 LCD	£49.30
AVO 73 LCD	£68.90
AVO MM5 Minor	£43.60
DA117 Auto Range LCD	£157.00
AVO DA116 LCD Digital	£131.50
AVO DA211 LCD Digital	£58.50
AVO DA212 LCD Digital	£81.90
Battery MEGGER BM7/500V	£71.60
Wee MEGGER hand crank	£101.50

2 Taped 30v secs

60V RANGE

Amp	Price	P&P
1	£7.15	£1.50
2	£9.20	£1.90
3	£13.31	£2.02
4	£15.15	£2.26
5	£19.16	£2.24
6	£21.86	£2.64
8	£30.72	O.A.

30V RANGE (2×15V tapped secs) 3, 4, 5, 6, 8, 9, 10, 12, 15, 18, 20, 24, 30V or 12V-0-12V or 15V-0-15V.

Ref.	30V	15V	Price	P&P
112	0.5	1	£3.19	£1.20
79	1	2	£4.32	£1.40
3	2	4	£6.99	£1.60
20	3	6	£8.10	£1.85
21	4	8	£9.67	£1.90
51	5	10	£11.95	£2.00
117	6	12	£13.52	£2.02
88	8	16	£18.10	£2.26
89	10	20	£20.88	£2.24
90	12	24	£23.20	O.A.
91	15	30	£26.60	£3.00
92	20	40	£35.64	£4.83

MAINS ISOLATORS
SECS. 0-CT-120V twice.

Ref.	VA	Price	P&P
*07	20	£5.30	£1.50
149	60	£8.63	£1.60
150	100	£10.06	£1.84
151	200	£13.69	£2.12
152	250	£16.31	£2.64
154	500	£25.02	£2.90
155	750	£35.91	O.A.
156	1000	£45.89	O.A.
157	1500	£60.02	O.A.
158	2000	£72.43	O.A.
159	3000	£101.12	O.A.
	6000	£207.92	

TELEPHONES:—

Desk	Type	Model
746		£10.00
Wall Phone		£15.83
Push	Button	Trim-phone £24.35

+ £1.00 p&p + VAT 15%

Mains Eliminator in 13A moulded plug 3, 4.5, 6, 7.5, 9, 12V DC 300mA £5.10 £1.00+VAT 15%

BRIDGES

100V 25A	£1.80
100V 35A	£2.00
100V 2A	£0.52
200V 4A	£0.75
400V 1A	£0.25
400V 4A	£0.98
400V 6A	£1.44
500V 12A	£2.85

+P&P 20p+VAT 15%

400/440 to 240V ISOLATORS

VA	Price	+p&p
60	£8.11	£1.50
250	£16.07	£2.60
350	£19.88	£3.10
500	£24.77	£3.40
1000	£50.53	O.A.
2000	£74.79	O.A.
3000	£104.86	O.A.
6000	£207.92	O.A.

AUTOS (Step Up/Down)
105, 115, 190, 200, 210, 230, 240, for step up or down.

Ref	(Watts)	Price	P&P
113*	15	£2.39	£1.20
64	80	£4.85	£1.40
4	150	£6.48	£1.60
67	500	£13.30	£2.24
84	1000	£22.70	£2.80
493	1500	£28.17	O.A.
94	2000	£42.14	O.A.
73	3000	£71.64	O.A.
480	4000	£93.01	O.A.
57	5000	£108.30	O.A.

*0, 115, 220, 240.

CASED AUTOS
0-220-240V 240V in 115V USA Socket outlet

VA	Ref	Price	P&P
20	56W	£7.21	£1.25
75	64W	£9.35	£1.50
150	4W	£12.10	£1.84
250	69W	£14.73	£1.60
500	67W	£22.14	£2.24
1000	84W	£33.74	£2.80
2000	95W	£60.47	O.A.

CUSTOM POWER SUPPLIES NOW AVAILABLE

Barrie Electronics Ltd.

3, THE MINORIES, LONDON EC3N 1BJ
TELEPHONE: 01-488 3316/7/8
NEAREST TUBE STATIONS: ALDGATE & LIVERPOOL ST.

BI-PAK BARGAINS

TRIACS — PLASTIC

4 AMP — 400v — T0202 — TAG 136G

1 OFF	10 OFF	50 OFF	100 OFF
40p	£3.75	£17.50	£30.00

8 AMP 400v — T0220 — TAG 425

60p	£5.75	£27.50	£50.00

SLIDER POTENTIOMETERS — ALL AT 50p PER PAK

Plastic 40mm Travel Mono

SX63 5 x 470 ohms Lin	SX67 5 x 47k Lin
SX64 5 x 1k Lin	SX68 5 x 47k Log
SX65 5 x 22k Lin	SX69 5 x 100 Lin
SX66 5 x 22k Log	SX70 5 x 1 meg Lin

SX40 250 Silicon Diodes—Switching like IN4148 DO 35. All good—uncoded. Worth double our price 45v 75mA £1.25

SX41 250 Silicon Diodes—General Purpose, like OA200/202 BAX13/16 Uncoded. 30-100v 200mA DO 7 £1.25

SX44 10 5A SCR's T064 3 x 50v 3 x 100v 2 x 200v 2 x 400v. Super value less than ½ price £1

SX45 10 5A SCR's T066 2 x 50v 2 x 100v 4 x 200v 2 x 400v All coded Brand new, a give away at £1

MINIATURE TOOLS FOR HOBBYISTS

Miniature round nose side cutters — insulated handles 4½inch length. Order No:Y043.

Miniature long nose pliers — Insulated handles 5½inch length. Order No:Y044.

Miniature bend nose pliers — insulated handles 5½inch length. Order No:Y045.

Miniature end nippers — insulated handles 4½inch length. Order No:Y048.

Miniature snipe nose pliers with side cutter and serrated jaws — insulated handles 5inch length. Order No:Y042.

All with insulated handles

ALL AT 1.25 each

FLEXEY DRIVER

A flexible shaft screwdriver for those awkward to get at screws. Overall length 8½inch. Order No:FS-1 Flat blade 4mm FS-2 Cross point no 1 £1.78 each.

GRIP DRIVER

6inch long screwdriver with spring loaded grip on end to hold screws in position while reaching into those difficult places. Order No:SD-1 Flat blade 4mm SD-2 Cross point no.0. 65p each

INEXPENSIVE TOOLS OF IMMENSE VALUE

Combined wire stripper, cutter, crimper incl. 25 asst. terminals for crimping. Order No:WS2. Our low price £1.20 each.

BA NUT DRIVER SET

Set of 5 BA spanner shafts plus universal handle in roll-up wallet. Sizes 0BA 2-4-6-8BA Order no: T192

£2.75 set

NEON SCREWDRIVER

7½in blade order no NS1 £0.65p each

5½in blade order no NS2 £0.60p each

Guarantee

Satisfaction or your money back has always been BI-PAK's GUARANTEE and it still is. All these Sale items are in stock, in quantity and we will despatch the same day as your order is received

EXPERIMENTOR BOXES — ALUMINIUM — PLASTIC

ALUMINIUM BOXES

Made with Bright Aluminium folded construction with deep lid and screws

SIZE " L	W	H	Order No.	Price
5¼	2¼	1½	159	83p
4	2¼	1½	161	83p
4	2½	2	163	83p
3	2	1	164	57p
8	6	3	166	£1.68
6	4	2	167	£1.12

Plastic Boxes

Coloured Black. Close fitting. Flanged Lid, fixing screws into brass bushes.

SIZE " L	W	H	Order No	Price
4	2	1	141	£1.00
4¾	2½	1½	143	£1.30
6	3¼	2	144	£1.80
Plastic as above but with aluminium top panel				
4	2¾	1	146	£1.40
Plastic sloping front				
5½	4¼	2⅝ slope to 1½	148	£2.14

All measurements for boxes are shown in inches. L = Length. W = Width. H = Height

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The lowest price ever.

The more you buy the cheaper they come!

Pin	10 off	50 off	100 off
8 pin	85p	£3.50	£6.00
14 pin	90p	£3.75	£6.50
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VOLTAGE REGULATORS T0220

Positive +	Negative +
7805 — 50p	7905 — 55p
7812 — 50p	7912 — 55p
7815 — 50p	7915 — 55p
7824 — 50p	7924 — 55p

BI-PAK'S OPTO 83 SPECIAL

A selection of Large & Small size LED's in Red Green, Yellow and Clear, plus shaped devices of different types. 7 Segment displays, photo transistors, emitters and detectors.

Types like MEL11, FPT100 etc. Plus Cadmium Cell ORP12 and germ. photo transistor OCP71. TOTAL OF 25 pieces.

O/NO SX57A

Valued - Normal Retail £12.00

Our Price **£5.00**

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100 A Collection of Transistors, Diodes, Rectifiers, Bridges, SCR's, Triacs, IC's both Logic and Linear plus Opto's all of which are current everyday usable devices.

Guaranteed Value over £10 at Normal Retail Price

yours for only **£4·00** Data etc. in every pak Order No. SX56

MW398 NI-CAD CHARGER

Universal Ni-Cad battery charger. All plastic case with lift up lid. Charge/Test switch. LED indicators at each of the five charging points

Charges —	Power —
PP3 (9V)	220-240V AC
U12 (1.5V penlite)	Dims —
U11 (1.5V "C")	210 x 100 x 50mm
U2 (1.5V "D")	£6.95

POWER SUPPLY OUR PRICE £3.25

Power supply fits directly into 13 amp socket. Fused for safety. Polarity reversing socket. Voltage switch. Lead with multi plug. Input — 240V AC 50HZ Output - 3 4.5 6 7.5 9 & 12V DC Rating - 300 ma MW88

1 Amp SILICON RECTIFIERS

Glass Type similar IN4000 SERIES IN4001-IN4004 50 — 500v — uncod..d — you select for VLTS. ALL perfect devices — NO duds Min 50v. 50 for £1.00 — worth double ORDER NO SX76

Silicon General Purpose NPN Transitors TO-18 Case Lock fit leads — coded CV7644 Similar to BC147 — BC107 — ZT89 ALL NEW! VCE 70v IC500mA Hfe 75-250

	50 off	100 off	500 off	1000 off
PRICE	£2.00	£3.80	£17.50	£30.00

Order as CV7644

Silicon General Purpose PNP Transistors TO-5 Case Lock fit leads coded CV9507 similar 2N2905A to BFX30 VC 60 IC 600mA Min Hfe 50 ALL NEW!

	50 off	100 off	500 off	1000 off
PRICE	£2.50	£4.00	£19.00	£35.00

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Silicon NPN'L' TypeTransitors

TO-92 Plastic centre collector Like BC182L — 183L — 184L VCBO 45 VCEO 30 IC200mA Hfe 100-400

ALL perfect devices — uncoded ORDER AS SX183L

50 off	100 off	500 off	1000 off
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Brand New — Uncoded — Pelect Devices

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3 x 7 segment displays Basic Circuit 0-2V± instructions provided to extend voltage & current ranges. Operating voltage 9/12v. Typ. Power Consumption 50mA O/NO:SX99 Once only price **£9.95**

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Comprising 4 × 1½ amp rectifiers mounted on PCB.

VRM — 150 vlts

IFM — 1.5 Amps

Size: 1 inch square

10 off £1.00

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100 off £7.50

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MULTITESTERS

1,000 opv Including test leads & Battery. AC volts:- 0-15-150-500-1,000. DC volts:- 0-15-150-500-1,000. DC currents - 0-1ma-150ma. Resistance - 0-2.5 K ohms 100 K ohms. Dims:- 90 x 61 x 30mm.

O/No.1322.OUR PRICE £6.50 ONLY

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O/No. 1315. OUR PRICE ONLY £24.75

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National INS8080AN 40 Pin DIL N. Channel Silicon GATE MOS TECHNOLOGY As used in Nationals N8080 Micro Computer Family. Instruction Cycle Time 2 uS. Supplied with functional Block Diagram. BRAND NEW — NOT seconds or reclaims. 100% perfect ORDER NO SX8080 **only**

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40 Pin IC Socket to fit SX8080 ORDER NO 1609 Offer price **30p**

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Variable from 2-30 volts and 0-2 Amps. Kit includes — 1 — VPS30 Module, 1 — 25 volt 2 amp transformer, 1 — 0-50v 2" Panel Meter, 1 — 0-2 amp 2" Panel Meter, 1 — 470 ohm wirewound potentiometer, 1 — 4K7 ohm wirewound potentiometer, Wiring Diagram included. Order No. VPS30 KIT **£20.**

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6 precision screwdrivers in hinged plastic case Sizes — 0.8 1.4 2 2.4 2.9 and 3.8mm **£1.75**

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BUY ALL FOUR SETS 5T21 5T51 and get HEX KEY SET **FREE**

HEX KEY SET ON RING
Sizes 1.5 2 2.5 3 4 5 5.5 and 6mm
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Pak No.	Qty*	Description	Price
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SX12	200	⅛ watt Carbon Resistors	£1
SX13	200	¼ watt Carbon Resistors	£1
SX14	150	½ watt Resistors 22 ohm 2m2 Mixed	£1
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Paks SX12-15 contain a range of Carbon Film Resistors of assorted values from 22 ohms to 2.2 meg. Save pounds on these resistor paks and have a full range to cover your projects
*Quantities approximate, count by weight

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Automatic spiral ratchet. Complete with 2 screwdriver blades, 5 & 65mm. 1 screwdriver cross point No. 1 & three drills — 2, 2.8 and 3.65mm — A MUST FOR ALL HOBBY-BUILDERS & CONSTRUCTORS. Order No. ASD/1 £3.50 each

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SX19	100	Mixed Ceramics 68pf-0.5mf	£1
SX20	100	Assorted Polyester/Polystyrene Capacitors	£1
SX21	60	Mixed C280 type capacitors metal foil	£1
SX22	100	Electrolytics, all sorts	£1
SX23	50	Quality Electrolytics 50-1000mf	£1
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BARGAINS

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RE 188m
LCD 10 MEGOHM INPUT IMPEDANCE
*3½ digit *16 ranges plus hFE test facility for PNP and NPN transistors *Auto zero auto polarity *Single-handed pushbutton operation *Over range indication *12.5mm (½ inch) large LCD readout *Diode check *Fast circuit protection *Test leads battery and instructions included

Max indication	1999 or −1999
Polarity indication	Negative only. Positive readings appear without + sign
Input impedance	10 Megohms
Zero adjust	Automatic
Sampling time	250 milliseconds
Temperature range	−5°C to 50°C
Power Supply	1 x PP3 or equivalent 9V battery
Consumption	20mW
Size	155 x 88 x 31mm

RANGES
DC Voltage 0-200mV
0.2-20-200-1000V Acc 0.8%
AC Voltage 0-200-1000V
Acc 1.2% DC Current 0-200uA
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American Police type screamer powered from any 12 volt supply into 4 or 8 ohm speaker. Ideal for car burglar alarm, freezer breakdown and other security purposes. 5 watt. 12v max.

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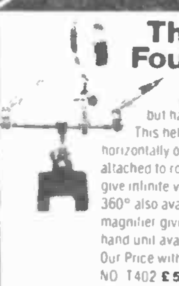

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SX52 6 Black Heatsink will fit TO 3 and TO 220. Ready drilled. Wall price value £1
SX53 1 Power finned Heatsink. This heatsink gives the greatest possible heat dissipation in the smallest space owing to its unique staggered fin design pre drilled TO 3 Size 45mm square×20mm high 40p
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Order No.	Pieces	Size	Sq.Ins.	Price
FB1	4	9 x 2¾"	100	£1.50
FB2	3	11 x 3"	100	£1.50
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FB4	2	14 x 4"	110	£2.00

SILICON POWER TRANSISTORS — T03

NPN like 2N3055 — but not full spec
100 watts 50V min.
10 for £1.50 — Very Good Value
100s of uses — no duds
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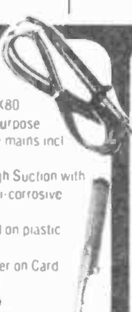
BI-PAK SOLDER – DESOLDER KIT



Kit comprises ORDER NO. SX80
1 High Quality 40 watt General Purpose Lightweight Soldering Iron 240v mains incl 3/16" (4.7mm) bit
1 Quality Desoldering pump. High Suction with automatic ejection. Knurled, anti-corrosive casing and teflon nozzle
1.5 metres of De-soldering braid on plastic dispenser
2 yds (1.83m) Resin Cored Solder on Card
1 Heat Shunt tool tweezer Type
Total Retail Value over **£12.00**
OUR SPECIAL KIT PRICE **£8.95**

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Complete PCB Kit comprises
1 Expo Mini Drill 10.000RPM 12v DC incl 3 collets & 1 x 1mm Twist bit
1 Sheet PCB Transfers 210mm x 150mm
1 Etch Resist Pen
1 ½lb pack FERRIC CHLORIDE crystals
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Full instructions for making your own PCB boards
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PROGRAMMABLE UNIJUNCTION TRANSISTOR

"PUT" case TO106 plastic MEU22 Similar to 2N6027/6028 PNPN Silicon

Price	1-9	10-49	50-99	100+	Normal Retail
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High Quality audio amplifier Module. Ideal for use in record players, tape recorders, stereo amps and cassette players, etc. Full data and back up diagrams with each module
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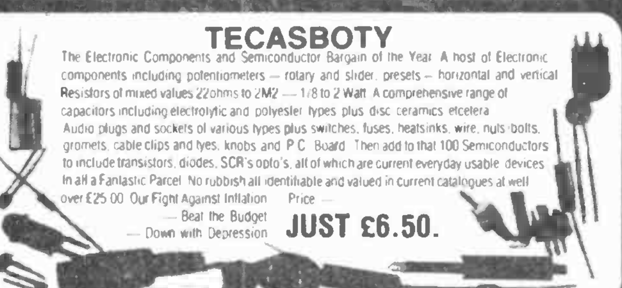

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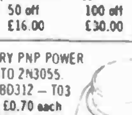

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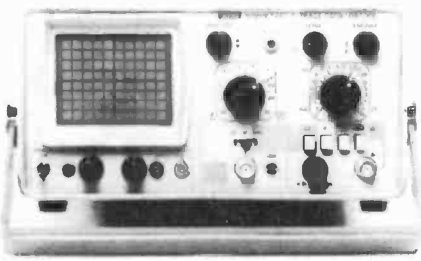

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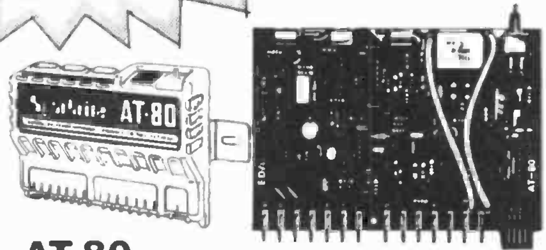

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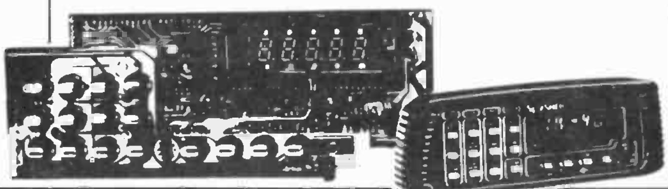

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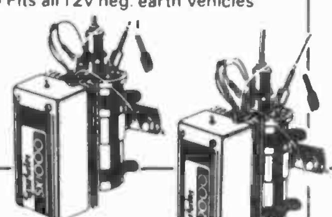
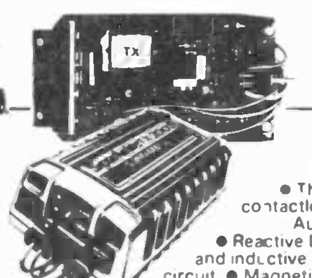
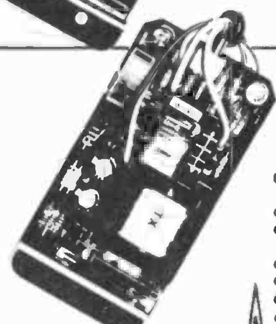
- Patented clip-to-coil fitting
- Fits all 12v neg. earth vehicles



TX1002
Electronic Ignition

● Contactless or contact triggered
● Extended coil energy storage circuit
● Inductive Discharge ● Three position changeover switch ● Distributor triggerhead adaptors included ● Die cast weatherproof case ● Clip-to-coil or remote mounting facility ● Fits majority of 4 & 6 cyl. 12V. neg. earth vehicles ● Over 145 components to assemble.





SX2000
Electronic Ignition

- The brandleading system on the market today
- Unique Reactive Discharge
- Combined Inductive and Capacitive Discharge
- Contact breaker driven
- Three position changeover switch
- Over 130 components to assemble
- Patented clip-to-coil fitting
- Fits all 12v neg. earth vehicles

TX2002
Electronic Ignition

● The ultimate system ● Switchable contactless ● Three position switch with Auxiliary back-up inductive circuit ● Reactive Discharge Combined capacitive and inductive ● Extended coil energy storage circuit ● Magnetic contactless distributor trigger-head ● Distributor triggerhead adaptors included ● Can also be triggered by existing contact breakers. ● Die cast waterproof case with clip-to-coil fitting ● Fits majority of 4 and 6 cylinder 12v neg. earth vehicles. ● Over 150 components to assemble

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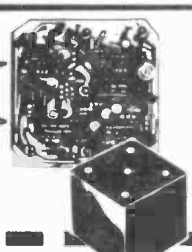

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- Over 100 components to assemble

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MICRO MINI 100V CERAMIC PLATE CAPS 5% or better
E12 Series
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5% 7.5mm 250V
CAPACITORS E12

1nf-68nf	10p
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5% 7.5mm 160V
CAPACITORS E12

100nf-180nf	12p
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330nf, 390nf,	20p
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680nf	32p
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Complete range of other voltages & spacings in stock. Please phone

TANTALUM BEADS

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.33/35V	14p
.47/35V	14p
.68/35V	14p
1.0/35V	14p
2.2/16V	14p
2.2/35V	22p
3.3/35V	22p
4.7/16V	22p
4.7/35V	24p
6.8/25V	25p
6.8/35V	25p
10/16V	25p
10/35V	34p
15/10V	22p
15/16V	30p
15/25V	32p
22/6.3V	26p
22/16V	32p
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Feedthrough Capacitor
1000pf 500V 7p

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3.75×5	1.03
2.5×17	2.80
3.75×17	3.55
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Pen + Spool	3.50
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Fully enclosed Pither Presets E 3 Series
100Ω-10M

Mini Vert	14p
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Standard Horiz	17p
Thumbwheel of ¼" Spindle for Standard Presets only	8p

QUALITY ELECTROLYTICS BY MATSUSHITA OR SIEMENS AXIALS

ufd	V	
.47	63	8p
.47	100	9p
.47	350	30p
1	63	8p
1	100	9p
1	500	40p
2.2	25	8p
2.2	63	9p
2.2	100	11p
2.2	350	30p
3.3	25	10p
3.3	40	11p
3.3	63	12p
4.7	16	8p
4.7	25	9p
4.7	40	11p
4.7	63	12p
4.7	100	14p
10	25	8p
10	40	12p
10	63	14p
10	100	16p
22	25	11p
22	40	14p
22	63	16p
22	100	21p
47	25	14p
47	40	18p
47	63	26p
47	100	28p
68	25	18p
68	63	25p
100	16	14p
100	25	16p
100	40	22p
100	63	25p
100	100	30p
220	10	16p
220	16	17p
220	25	22p
220	40	25p
220	63	30p
220	100	40p
330	16	19p
330	25	22p
330	63	38p
470	16	22p
470	25	28p
470	40	33p
470	63	43p
470	100	60p
1000	16	30p
1000	25	38p
1000	40	46p
1000	63	65p
2200	16	40p
2200	25	63p
2200	40	70p
2200	63	134p
4700	16	75p
4700	25	90p

Beautiful Mini Radial Low Voltage Matsushita only

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

ETCH RESIST TRANSFERS
1. Thin lines
2. Thick lines
3. Thin bends
4. Thick bends
5. DIL pads
6. Transistor pads
7. Dots + holes
8. 0.1" edge cons.
9. Mixture

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Set of 13 sheets 3.00

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Prices per metre
Solid Hook up Wire Any colour 5p

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8 Core	39p
12 Core	46p
50 Core	1.37

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Mini Single	12p
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4 Core 1 Screen	54p
8 Core	61p
12 Core	80p

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DIL SOCKETS

Pins	Lo prof	W.Wp
8	8p	25p
14	9p	35p
16	10p	40p
18	16p	50p
20	20p	—
22	22p	—
24	24p	70p
28	28p	79p
40	30p	99p

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203×114	1.85
233×220	3.99
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100×220	2.15
203×114	2.21
233×220	4.55
Developer for above (do not use Sodium Hydroxide) 500ml	2.50

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DIODES

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1N823	82p
1N914	4p
1N916	6p
1N4001	4p
1N4002	4½p
1N4003	5p
1N4004	5½p
1N4005	6p
1N4006	6½p
1N4007	7p
1N4009	20p
1N4148	4p
1N4150	18p
1N4448	22p
1N4517	22p
1N5172	30p
1N5176	94p
1N5400	12p
1N5401	13p
1N5402	14p
1N5403	15p
1N5404	16p
1N5405	17p
1N5406	18p
1N5407	19p
1N5408	20p
1N5024	52p
1N5625	60p
1N5626	62p
1N5627	68p
1S44	10p
1S131	40p
1S134	56p
1S421	1.00
1S421R	1.00
1S940	10p
1S941	11p
1S961	22p
AA118	28p
AA129	57p
AA144	25p
AAY30	44p
AAY33	46p
AA217	27p
BA100	22p
BA102	25p
BA115	25p
BA133	40p
BA136	30p
BA142	20p
BA144	15p
BA155	15p
BA156	30p
BA182	40p
BA201	18p
BA202	26p
BA316	25p
BA317	25p
BA318	30p
BAV10	16p
BAV19	15p
BAV20	15p
BAV49	15p
BAX13	10p
BAX16	11p
BAT38	20p
BAY44	15p
BAY93	10p
BB103B	70p
BB103G	70p
BB104B	80p
BB104G	80p
BB105	52p
BB105A	57p
BB105B	58p
BB109G	65p
BY126	20p
BY127	22p
BY134	52p
BY182	1.26
BY188A	65p
BY206	36p
BY207	36p
BY223	1.56
BY297	48p
BY299	56p
MZ2361	1.80
OA10	70p
OA47	20p
OA90	10p
OA91	10p
OA95	20p
OA200	20p
OA202	20p
RAS508AF	75p
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1½ amp type	
W01 (100)	20p
W02 (200)	26p
W04 (400)	28p
W08 (800)	40p
6 amp type Square with hole	
PW01 (100)	50p
PW02 (200)	78p
PW04 (400)	86p
PW06 (600)	90p
25 amp type Metal clad with hole	
K01 (100	2.20
K02 (200)	2.30
K04 (400)	2.80
K06 (600)	3.40

DIACS

BR100	40p
ST2	25p

THYRISTORS Sensitive Gate Small Signal

2N5060	30p
2N5061	32p
2N5062	36p
2N5063	37p
2N5064	40p
BR101	75p
BRY39	80p
BRY55-100	60p
BRY55-300	67p
BRY56	50p
TIC44	36p
TIC47	50p

4.8 & 12 Amps Texas TO220
Suffix A=100V B=200V C=300V D=400V M=600V

4A	
TIC106A	46p
TIC106B	47p
TIC106C	49p
TIC106D	59p
TIC106M	69p
8A	
TIC116A	68p
TIC116B	68p
TIC116C	71p
TIC116D	73p
TIC116M	80p
12A	
TIC126A	72p
TIC126B	72p
TIC126C	73p
TIC126D	77p
TIC126M	96p

TRIACS Texas 400V
TO220 Case

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BPX25	2.47
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TIL99	1.25
TIL116	1.10
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RSD	15p	12p
YSD	15p	12p
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GSC	17p	13p
YSC	17p	13p
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2N917	65p
2N918	33p
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2N1131	24p
2N1132	25p
2N1302	45p
2N1303	65p
2N1304	60p
2N1306	65p
2N1308	65p
2N1890	50p
2N1893	30p
2N2102	30p
2N2217	39p
2N2218	33p
2N2218A	25p
2N2219	27p
2N2219A	28p
2N2220	22p
2N2221	22p
2N2221A	23p
2N2222	24p
2N2222A	25p
2N2223	2.60
2N2223A	4.15
2N2303	39p
2N2368	25p
2N2369	19p
2N2369A	18p
2N2405	88p
2N2410	1.15
2N2411	3.60
2N2412	80p
2N2477	95p
2N2483	25p
2N2484	26p
2N2890	2.10
2N2891	2.28
2N2892	3.00
2N2904A	27p
2N2905	28p
2N2905A	29p
2N2906	25p
2N2906A	30p
2N2907	25p
2N2907A	26p
2N2920	3.47
2N2923	25p
2N2924	15p
2N2925	15p
2N2926	10p
2N3010	75p
2N3011	25p
2N3019	50p
2N3053	27p
2N3054	56p
2N3055SCSF	80p
2N3055RCA	80p
2N3055H	1.20
2N3108	42p
2N3109	48p
2N3232	1.50
2N3250	36p
2N3251	36p
2N3300	60p
2N3301	68p
2N3303	80p
2N3390	38p
2N3391	30p
2N3391A	34p
2N3392	27p
2N2393	24p
2N3394	20p
2N3395	25p
2N3396	26p
2N3397	27p
2N3439	98p
2N3440	80p
2N3441	1.25
2N3442	1.35
2N3444	1.70
2N3445	4.80
2N3446	6.09
2N3447	5.72
2N3448	6.56
2N3468	1.00
2N3517	1.06
2N3553	2.30
2N3570	2.54
2N3571	2.19
2N3572	2.06
2N3584	2.76
2N3585	2.99
2N3605	36p
2N3606	28p
2N3607	28p
2N3632	9.88
2N3638	25p
2N3638A	37p
2N3639	36p
2N3641	39p
2N3642	25p
2N3643	15p
2N3644	28p
2N3645	33p
2N3646	28p
2N3702	10p
2N3703	10p
2N3704	10p
2N3705	10p
2N3706	10p
2N3707	10p
2N3708	10p
2N3709	10p
2N3710	10p
2N3711	10p
2N3712	2.00
2N3713	1.38
2N3714	2.98
2N3715	3.31
2N3771	1.75
2N3772	1.83
2N3773	2.06
2N3779	1.70
2N3789	3.27
2N3790	2.73
2N3791	2.47
2N3792	2.68
2N3794	25p
2N3819	21p
2N3820	38p
2N3821	1.84
2N3822	90p
2N3823	45p
2N3824	1.70
2N3866	80p
2N3877A	35p
2N3900	25p
2N3901	30p
2N3902	6.65
2N3903	15p
2N3904	15p
2N3905	15p
2N3906	15p
2N3945	85p
2N3962	30p
2N3964	1.42
2N4030	66p
2N4031	55p
2N4032	65p
2N4036	58p
2N4037	43p
2N4058	10p
2N4059	17p
2N4240	3.00
2N4248	15p
2N4249	17p
2N4250	17p
2N4284	32p
2N4285	35p
2N4287	45p
2N4288	22p
2N4289	15p
2N4290	45p
2N4291	45p
2N4292	45p
2N4294	45p
2N4297	2.50
2N4302	39p
2N4303	40p
2N4304	43p
2N4314	60p
2N4247	68p
2N4347	2.26
2N4351	1.16
2N4400	15p
2N4401	27p
2N4402	30p
2N4403	30p
2N4409	36p
2N4410	42p
2N4427	79p
2N4440	12.58
2N4870	80p
2N4871	55p
2N4888	92p
2N4898	1.29
2N4901	1.69
2N4902	3.52
2N4903	3.24
2N4904	2.75
2N4906	3.25
2N4906	3.42
2N4907	3.20
2N4908	3.70
2N4909	2.90
2N4910	1.95
2N4913	2.59
2N4914	2.69
2N4915	2.95
2N4916	48p
2N4917	47p
2N4918	95p
2N4919	1.28
2N4920	1.34
2N4921	55p
2N4922	69p
2N4923	99p
2N4924	92p
2N4926	95p
2N4927	95p
2N4928	1.59
2N5086	35p
2N5087	38p
2N5088	37p
2N5089	37p
2N5126	48p
2N5127	38p
2N5128	38p
2N5129	30p
2N5130	37p
2N5131	22p
2N5133	22p
2N5135	38p
2N5136	38p
2N5137	23p
2N5138	18p
2N5139	48p
2N5140	25p
2N5141	25p
2N5143	25p
2N5172	15p
2N5175	58p
2N5179	39p
2N5180	43p
2N5183	1.00
2N5184	1.10
2N5188	1.15
2N5189	1.00
2N5190	68p
2N5191	70p
2N5193	90p
2N5194	79p
2N5245	37p
2N5246	40p
2N5247	45p
2N5248	46p
2N5249	48p
2N5266	2.88
2N5293	98p
2N5294	1.28
2N5295	1.37
2N5296	1.28
2N5298	1.37
2N5302	3.20
2N5303	3.80
2N5305	25p
2N5306	37p
2N5307	40p
2N5308	25p
2N5401	35p
2N5415	1.10
2N5416	1.54
2N5447	16p
2N5448	19p
2N5449	21p
2N5450	23p
2N5451	25p
2N5457	29p
2N5458	29p
2N5459	29p
2N5460	72p
2N5461	60p
2N5462	80p
2N5484	40p
2N5485	29p
2N5490	1.37
2N5493	1.56
2N5494	1.37
2N5496	1.59
2N5551	37p
2N5648	45p
2N5664	35p
2N5785	90p
2N5813	23p
2N6027	20p
2N6030	6.60
2N6082	11.09
2N6099	1.20
2N6191	1.30
2N6109	1.15
2N6111	1.00
2N6121	54p
2N6122	56p
2N6123	59p
2N6124	55p
2N6125	59p
2N6126	71p
2N6129	79p
2N6130	93p
2N6131	98p
2N6132	83p
2N6133	1.14
2N6134	1.36
2N6250	1.45
2N6254	1.55
2SC1306	56p
2SC1444	2.50
2SC2078	7.70
3N128	1.12
3N136	3.50
3N139	3.30
3N140	2.37

PE VOLUME 19 No. 2 FEBRUARY 1983

EFFICIENT RECESSION

WE have recently heard many comments about how the recession will make sure businesses are run in a highly efficient manner, will weed out the dead wood and eventually lead to a boom in the U K economy and a long period of prosperity. Although this is little consolation for those that have been made jobless over the past couple of years, it does appear to have some foundation and a promise of better things ahead.

Having worked in a Government department there is no doubt that some of them need to be more efficient and cost effective. Can you believe that the British Standard for Electronic Symbols (Section 20 Semiconductor Devices) has not been changed since 1968?

There have been many changes in the semiconductor area since 1968 and this was brought home recently when we looked in BS3939 for a programmable unijunction transistor symbol. Of course such a device is simply not covered.

NEW GROUND

A development that we feel may have more than a little to do with the recession is the recent introduction of retail sales operations by a couple of industrial suppliers. EMOS, part of Grenson Electronics was formed to supply the hobbyist, and we on PE like to think we had something to do with it. Back in February '82 we published a design for a Bench PSU, which had been developed by Grenson and they supplied a kit for it. The kits sold so well it encouraged Grenson to start EMOS—something they had been considering anyway. Of course the recession and available stock may have had some bearing on their intention to break new ground and find extra outlets for their products.

The same may be true of JEE Distribution. This industrial distributor operates from premises with a shop front in South West London. They have recently decided that they may as well use the shop to sell to hobbyists, since it is there, and stocked with a range of 4000 different items. JEE are also "putting a finger in the wind" to test the mail order market.

We wish these companies well, perhaps the recession will result in an overall gain for our hobby.

THEIR DUTY

There is one area where the Government could help "at a stroke" the UK and the working population. A duty change would encourage manufacture in the UK rather than in Taiwan or Hong Kong. The required change is to either lower import duty on electronic components or impose a similar duty on imported manufactured electronic items.

Take the humble Sinclair computer; some of the chips are made in the UK, but many are imported, duty paid, from abroad.

The cost of assembly on each computer is very low in comparison with its final selling price and there is therefore little to be gained by manufacturing in Taiwan, as far as this cost is concerned. However, add this small saving to the additional saving on import duty when a ready made unit is shipped in, and you can see one of the reasons why foreign manufacture is attractive. (We should also be aware that the more items made in each Taiwan factory the bigger their buying power and therefore the lower the component costs; this can lead to a snowball effect). So come on Maggie why not sort that one out soon so Uncle Clive stays with the UK?

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Letters and Queries
We are unable to offer any advice on the use or purchase of commercial equipment or the incorporation or modification of designs published in PE. All letters requiring a reply should be accompanied by a stamped, self addressed envelope, or addressed envelope and international reply coupons, and each letter should relate to one **published project only.**

Components and p.c.b.s are usually available from advertisers; where we anticipate difficulties a source will be suggested.

Back Numbers
Copies of most of our recent issues are available from: Post Sales Department (Practical Electronics), IPC Magazines Ltd., Lavington House, 25 Lavington Street, London SE1 0PF, at £1 each including Inland/Overseas p&p. Please state month and year of issue required.

Binders
Binders for PE are available from the same address as back numbers at £4·60 each to UK or overseas addresses, including postage and packing, and VAT where appropriate. Orders should state the year and volume required.

Subscriptions
Copies of PE are available by post, inland or overseas, for £13·00 per 12 issues, from: Practical Electronics, Subscription Department, Oakfield House, Perrymount Road, Haywards Heath, West Sussex RH16 3DH. Cheques and postal orders should be made payable to IPC Magazines Limited.

Items mentioned are available through normal retail outlets, unless otherwise specified. Prices correct at time of going to press.

...NEWS &

MOTOROLA'S MOTORCAR

Motorola's Director of Strategic Marketing has forecast that the automotive semiconductor market will treble by 1987. Setting this against a somewhat gloomier outlook for other market segments has led to the setting up of the Milton Keynes Strategic Automotive Group.

Here, the focal point of an effort to evolve the microelectronics to revolutionise the motorcar is – *the Motorcar*! This is a stripped out hatchback from which *half a kilometre* of conventional wire has been removed, and replaced with a mere 65 metres of wire and 10 metres of fibre optic cable. The Motorcar has many electronic systems installed which, it is claimed, will become standard over the next decade. The purpose of Motorola's Milton Keynes facility is not to sell black box systems, but to act as a chip source and data base for companies who wish to take their technology to the market place.

For example, the Motorcar's ignition design has given birth to a specialised 6805 microcomputer called the MC6805S2, and this will interface to the engine by way of a *two chip* ignition system currently being developed in Geneva. Single wire control systems around the vehicle have necessitated the development of a TMOS power switch with *integral* CMOS decoder.

The Vehicle Condition Monitor gathers information on fluid levels and temperatures etc. All timings, including those of the windscreen wipers and indicators, are set up by the Central Timer Unit. Each piece of electrical apparatus around the car is addressed via the bus. Being referred to as *outstations*, each load will report its status back to the processing unit.

SOME SORT OF PHASE ANOMALY IN THE HIGH RESOLUTION A TO D CONVERTER,EH? RIGHT, WHERE'S ME 'AMMER?

Even repeatability of creature comfort is catered for by the fibre-optic multiplex Seat unit which controls and memorises the driver's seat position. The Driver Information system provides normal dashboard and trip computer readout, plus warning messages from the vehicle's condition monitors.

48K LYNX

A new microcomputer from a British manufacturer is now in the shops. The 48K Lynx from Camputers has a wide range of facilities and is ultimately expandable to 192K. All the professional High Street buyers give it the thumbs up, and are favouring it against its more expensive counterparts. Features include high resolution colour graphics and add on memory to 96K, 128K or right up to 192K. Although Camputers

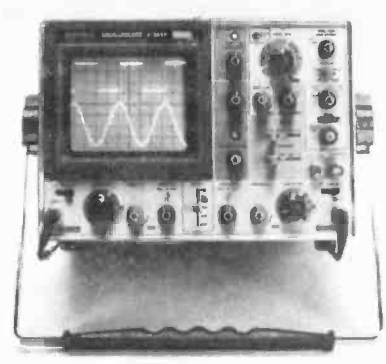
are launching a full range of peripherals specially designed for the Lynx, this does not exclude connecting to other manufacturers' equipment, as there is an RS232 port and RGB + sync and composite video sockets. The standard Lynx comes with a fast and comprehensive Basic which was specially written to make the most of the Z80A microprocessor. Good for the beginner and the experienced operator alike this new computer offers great value at £225 inc. VAT.

NEW SCOPE

The newly introduced V-203F and V-353F oscilloscopes from Hitachi-Denshi feature a fully variable sweep delay system which enables any section of a waveform to be greatly expanded thus allowing more detailed examination of complex signals.

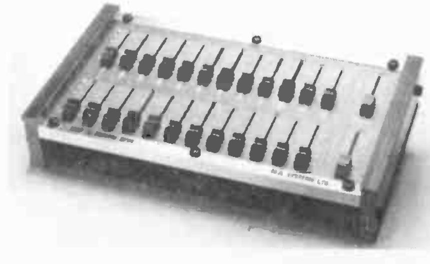
The sweep delay time is variable between 1µsec and 100msec via a five way switch and coarse and fine variable controls. Delay time jitter is better than 1 part in 5,000 so very high levels of expansion can be achieved.

The V-203F is a 20MHz dual trace model featuring 1mV/div vertical sensitivity, add and subtract modes, active sync, separation for video signals, and a rectangular CRT with internal graticule and variable illumination. The V-353F has a 35MHz bandwidth, a higher tube E.H.T., a signal delay line, and a higher calibrated max sweep speed of 20 nsec/div. Costing £340 for the V-203F, and £480 for the V-353F (excluding VAT), these competitively priced items are available from Reltech Instruments, Coach Mews, St Ives, Huntingdon, Cambs, PE17 4BN. (0480 63570).



DIMMING DESK

M.J.L. Systems Ltd. have announced a range of dimming desks and power packs, utilising digital control. For both fixed and portable installations, the new systems combine versatility with lower costs. Bringing professional power dimming within the reach of those previously excluded by prohibitive costs, these desks should be a welcome change to lower budget buyers. Currently available are desks with between 6 and 18 channels (12 channel pictured). Ranging from £55 to £260 (exc. VAT) this equipment or free information is available from M.J.L. Systems Ltd., 45 Worthley Road, W. Croydon, Surrey. (01-689 4138).



MARKET PLACE

RS Move

Our good friends R.S. Components, the well known electromechanical distributors, are planning a big move for 1984. They will be moving the majority of their existing operations to one massive new HQ complex at Weldon, near Corby in Northamptonshire. This mammoth task has been brought about by company expansion and a need for future growth. A large amount of the 1000 employees will also be making the move, nevertheless some will not, and of course this will be good news for the people of the Corby area who have had few job opportunities in recent years.

The new premises costing £12·5 million includes 335,000 square feet of high bay warehouse, factory and office space. Ground work began on the 28 acre site earlier last summer and completion is planned for early in 1984. The only remaining operations will be the Birmingham and Manchester distribution centres and a London trade counter. R.S. Components rely heavily on the Post Office for their efficient same day despatch service, and expect a comparable if not better service after their move. At present the London branch are handling up to 10,000 parcels per day.

IBA Guide

The annual publication and guide to independent broadcasting from the IBA is now on the stands. Entitled 'Television and Radio 1983', it gives lots of in depth information about all aspects of broadcasting, from breakfast television to independent local radio. Sport, art, religion, drama and science are among the main topics covered, and this handbook gives a good insight into the industry. Priced at £3·50 it is available from all leading booksellers.

CABLETIME

The blackness, oh the echoing blackness
In the labyrinth beneath the street
Where dank and dripping walls perspire
By rats with pattering feet
A robot from a cavern will come
Its servo's, Satan's choir
And *it* shall be armed with superglue
And one hundred miles of wire

Nonsense rhyme, but true! If the viability study of the water industry and the UEI high technology group yields positive results, Britain may be spared the judder of the pneumatic drill when laying in those television cables. For beneath our feet, the decaying Victorian sewers, a network of pipes reaching 99 per cent of Britain's homes, could provide the answer. A cheaper answer. A quieter answer to the problem of cabling the new television networks.

The ingenious cabling system has been devised by the water industry's Water Research Centre, in co-participation with UEI (United Engineering Industries). The three companies active within the UEI are: Link Electronics, Micro Consultants and Quantel.

Cabletime is the joint venture's company name, and its aim is to prove by trials that television conduits could be superglued to the ceilings of sewers by small robots.

Bearing in mind recent media glimpses of overseas cable television, let us hope that we have no cause to look upon this mode of delivery as appropriate to the programme material.

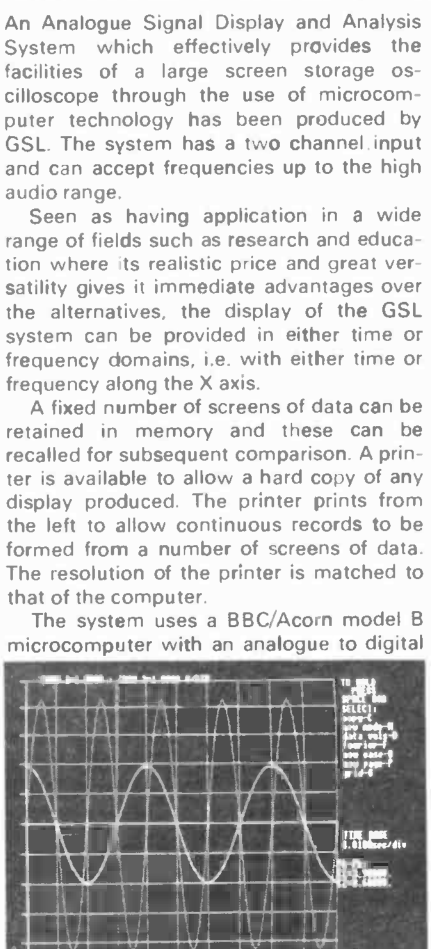
ANALOGUE SIGNAL ANALYSER

An Analogue Signal Display and Analysis System which effectively provides the facilities of a large screen storage oscilloscope through the use of microcomputer technology has been produced by GSL. The system has a two channel input and can accept frequencies up to the high audio range.

Seen as having application in a wide range of fields such as research and education where its realistic price and great versatility gives it immediate advantages over the alternatives, the display of the GSL system can be provided in either time or frequency domains, i.e. with either time or frequency along the X axis.

A fixed number of screens of data can be retained in memory and these can be recalled for subsequent comparison. A printer is available to allow a hard copy of any display produced. The printer prints from the left to allow continuous records to be formed from a number of screens of data. The resolution of the printer is matched to that of the computer.

The system uses a BBC/Acorn model B microcomputer with an analogue to digital



interface unit connected to the computer via its 1MHz bus.

The computer features high resolution graphics, the display has a resolution of 1 in 250 on the Y axis and 1 in 500 across the X axis. In the time domain 100 sample values are taken per channel per plot, this is reduced to 50 when in the frequency domain which is analysed via a fourier transformation. This analysis can be performed on either channel. Up to five frequency domain plots can be held in memory for comparison with the current plot.

A colour version of the system is priced at £1407·60, a black and white version at £1206·35 and the Analogue Signal Analyser at £263·00 (all prices include VAT). GSL, 2 North Way, Andover, Hants (0264) 58744.

CAR COMPUTER

The PE Car Computer (published in December 81, and January 82 issues) has a special mode of operation which can be used to measure the acceleration performance of the car. An article on using this feature to tune the car for best performance and economy, and to evaluate the effect of various fuel saving devices, is now available from the PE editorial office. Six graphs are included which show the effect of adjustments, and of a couple of 'bolt on goodies'; one of which produces improved acceleration time and mpg.

To receive the article, send a large self-addressed envelope carrying a 22p stamp to the PE editorial office (address on page 17) with a request for the 'PE Computer Dynamic Car Tuning' article.

Fidelity Cordless Telephones

British Telecom has awarded its first order for cordless telephones to Fidelity Radio, the London based manufacturer and supplier of consumer electronics equipment.

This initial order, which is worth over £1 million, covers the design, development and the supply of the cordless telephone system. Deliveries will start early this year and should be completed by the summer.

The Fidelity system will operate with a compact base unit linked to an independent handset via Home Office approved radio frequencies.

The handset will be lightweight and portable and have a range of up to 200 metres from the base unit. The system will incorporate full duplex facilities, push-button dialling, re-dial capability, patented security device and other features. It will comply with all the required technical specifications and thus be compatible with the existing British Telecom network.

DBS News

Suggestions recently submitted by the advisory council set up by the Government to recommend technical standards for direct broadcasting by satellite (DBS) have been adopted by the government. The BBC's proposed systems, PAL and E-PAL, have been given the elbow. The panel much preferred the IBA system MAC, as a generally more compatible and technically superior option. The panel also favour the IBA's sound system Type C, as opposed to the BBC's Type A. Further suggestions urged the Government to adopt these proposals as soon as possible, to secure maximum international collaboration and hopefully influence European options for a future standard and have resulted in the Government's swift action. The two-channel service due in 1986 will permit both individual household reception and community reception for cable distribution. The system has better picture quality and stereophonic sound. The initial capital cost to the consumer is estimated to be around £400, falling to £300 or less when demand grows. The outdoor units with improved sound arrangements dominate the total cost, and are compatible with existing receivers. The BBC have been awarded the first two channels.

VHD Video Disc Postponed

In a recent joint statement from Thorn EMI and JVC the "uncertain economic and market environment" was blamed for the indefinite suspension of the VHD video disc launch.

This news which will enable Philips and other licensees of the optical video disc technology the opportunity to establish the LaserVision system as the accepted format for disc players, will also hopefully mean that the conflicts experienced with the three incompatible video cassette formats will be avoided.

It would also appear that the future of the audio digital system (ADS) developed by JVC is to be reconsidered. The company has signed a technology cross licensing agreement with Philips to manufacture their compact disc digital audio system which has rapidly become the accepted standard for audio digital replay.

Despite the reasons given by JVC and Thorn EMI for postponing their launch, Philips are continuing to heavily promote LaserVision with this year's advertising budget being in excess of £3 million and although the penetration into the UK market has been slow, Jimmy Dunkley, Philips UK Audio and LaserVision director, recently commented that the long term prospects for the system were encouraging and a progressive upturn in sales is expected.

SONY STEREO VIDEO

The video boom continues to gather momentum in the UK, with the introduction of yet another quality machine from Sony. Planned for the top end of the market the C9 is a stereo, Beta-format recorder.

A front loading slimline, and fully rackable system such as this will certainly stimulate both hardware and software manufacturers alike to further explore the stereo video market. Already the main distributors of pre-recorded video cassettes are producing their titles in stereo wherever possible, suggesting 1983 will be another big year for video in the UK. The C9 will be compatible with the F1 system offering portability to those with a more creative outlook. Sony believe that once consumers have experienced stereo video they will be 'dissatisfied' with anything less, 'a bold statement', but if it turns out to be true then it will certainly put pressure on the broadcasting companies to provide stereo transmission sooner than their (mid eighties) predictions.

Tuning is automatic, and the C9's nine-event, two-week timer is set by a simple logic-controlled sequence of button pushes.

Warning circuitry is incorporated which is activated in the event of, for example, someone endeavouring to set the time to record two over-lapping programmes. Also built-in is a battery which will protect timer programming in the event of short interruptions to the power supply.

The C9 is fitted with a real-time tape counter and tape-remaining indicator. These features, coupled with dramatically improved automatic programme search and a "go-to-zero" facility make the tasks of planning and locating recordings particularly easy to perform.

A full-feature infra-red remote control is standard equipment with the C9, which is also fitted with a powered camera socket and the facility to playback or record PCM encoded tapes.

The C9 retails at around £699.

MARKET PLACE

Briefly...

A solar powered aeroplane capable of carrying payloads of up to 100lbs of cameras and equipment, has been developed by Lockheed Missiles and Space, under a NASA contract. Christened the 'Solar High Altitude Powered Platform' it is said to be capable of heights between 60,000 and 80,000 feet. Powered by its solar cells which drive a large propeller and refuel batteries for night flying, it will be able to maintain these altitudes for months at a time. The solar cells cover the whole of the top surface of the wing. They provide enough power to take the 2000lb plane to 70,000 feet in less than four hours. Prospective applications include military surveillance and agricultural monitoring.

●●●●

If ideas presently being discussed by the Government at the Industry Department come to fruition, then Mr. Kenneth Baker, the Information Technology Minister, could announce a £12 million spending spree on 50 new IT centres; some to be situated out of the main city areas. It is hoped they will bring training opportunities to more than 1000 young unemployed. Sites for the new centres (ITECS) have not yet been decided. Local organisations including banks, councils and private companies are co-sponsoring the scheme with the Industry Department, in which the trainees will learn such skills as programming, operating and electronics. In the lower population areas, smaller centres (SUBITECS) may be used, whereas existing ITECS have been in the worst affected unemployment areas.

●●●●

Good news for hobbyists in all areas. The already well established company JEE Distribution, have opened their doors to the public, and indeed are also entering into the mail order business. Offering a range of over 4000 component and hardware items at competitive prices, the range includes everything from discrete components to instrument cases. The shop will be open during office hours, and on Saturdays between 10am and 4pm. A short catalogue is available from, and callers welcome at 43 Strathville Road, London, SW18 4QX. (01-870 0075).

POINTS ARISING...

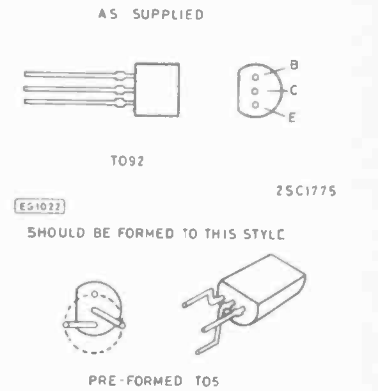
STYLOCHORD (Dec. '82)

For those constructors who have been experiencing difficulty in obtaining the Top Octave Generator i.c. S50240 for this project, the device is manufactured by and available from, AMI Microsystems Ltd., 108a Commercial Road, Swindon, Wiltshire SN1 5PL. Tel: 0793 37852. It is also available as MOSTEX device MK50240.

COMBO AMPLIFIER (Sept. '82)

In Fig. 2.7, the pin-outs of TR4 and TR5 (2SC1775e) were shown incorrectly. The illustration below shows the correct orientation, and how these transistors should be pre-formed to suit the Combo p.c.b.

These Hitachi devices are available from Hart Electronic Kits Ltd., Penylan Mill, Oswestry, Shropshire. Tel: 0691 2894.



Countdown...

Please check dates before setting out, as we cannot *guarantee* the accuracy of the information presented below. Note: some exhibitions may be trade only. If you are organising any electrical/electronics, radio or scientific event, big or small, we shall be glad to include it here. Address details to Mike Abbott.

Christmas Holography (+ items for sale) Dec. 2–Mar. Light Fantastic Gallery, London. A8
Home Computer Fair Jan. 20–22. Central Library, Sutton. (✆ 01-661) 5050).
Peripherals Feb. 2–4. Cunard Int. Hotel, Hammersmith, London. Z1
BEX Bournemouth Feb. 9–10. The Pavilion. K
Microsystems Feb 23–25. West Cntr. Hotel, Fulham, London. Z1
CAD North Mar. 1–3. Belle Vue Ex. Cntr., Manchester Z1
Mailing Efficiency Mar. 1–3. Bloomsbury Cntr. Hotel, London. Z
Local Networks Mar. 8–10. Royal Lancaster Hotel, London. O
Component Fair (Pontefract & District Amateur Radio Society) Mar. 13. Carlton Grange Community Centre, Carlton, Pontefract. F2
Laboratory Edinburgh Mar. 16–17. Assembly Rooms, George St. E
Brighton Electronics March. T
BEX Leeds Mar. 16–17. Dragonara Hotel. K
INSPEX Mar. 21–25. National Exhibition Cntr. Birmingham International. Z1
Sensors & Systems Mar. 22–24. The Forum, Wythenshawe. T
Compec Wales Mar. 22–24. Cardiff University. Z1
ETM (Electronic Test/Measurement) Mar. 22–24. The Forum, Wythenshawe, Manchester. T
Laboratory Manchester Mar. 23–24. New Century Hall, Corporation St. E
American Holography Mar.–June inc. Light Fantastic Gallery, Covent Garden, London. A8
London Computer Fair April 14–16. Central Hall, Westminster. B5
All Electronics Show April 19–21. Barbican Cntr. London. E
Fibre Optics April 19–21. Porter Tun Rooms, The Brewery (!), Chiswell St., London EC1. E
International Materials Handling April 19–26. Earls Court. I
International Packaging Exhibition April 25–29. NEC B/ham. I
HEVAC (Heating, Ventilation & Air Cond.) Apr. 26–28. Barbican. I
Biotech May 4–6. Wembley. O
The Business Computer Show May 10–12. Wembley. O
Defence Components Expo May 10–12. Metropole, Brighton. I
Computers In The City (conf. & ex.) May 24–26. Barbican. O
Business Telecom May 24–26. Barbican. O
International Wood Processing May 24–27. Wembley Conf. Cntr. Z

A7	Institute Of Acoustics ✆ 031 225 2143
A8	Holographic Exhibitions ✆ 01-836 6423
E	Evan Steadman ✆ 0799 22612
F2	Pontefract & District Am. Rad. Soc. ✆ 0977 791071
I	Industrial Trade Fairs ✆ 021 705 6707
K	Douglas Temple Studios ✆ 0202 20533
L1	World Trade Cntr., Europe Ho., London E1
N	Institute Electrical & Electronic Engineers
O	Online ✆ 09274 28211
Q	Exhibitions For Industry ✆ 08833 4371
T	Trident ✆ 0822 4671
V1	Jack Tootill, Ipswich Radio Club
Z	BETA Exhibitions ✆ 01-405 6233
Z1	IPC Exhibitions ✆ 01-643 8040

BATTERY to MAINS INVERTER

Michael Tooley *B.A.* **David Whitfield** *M.A. M.Sc.*

THE keen DIY motorist who has a garage which is separate from the house or, even worse, which is in a separate block altogether, will be only too familiar with the frustrations of working without mains electricity. What is often described as "conveniently nearby" in estate agents' particulars, all too often turns out to be alarmingly expensive in terms of the length of mains extension lead required. Sometimes, however, even a temporary extension lead is not a practical proposition because of an intervening road or footpath.

A popular solution to this problem is to use tools, lamps and accessories which have been specifically designed to operate from a standard 12 volt battery supply. This unfortunately greatly limits the choice available, and involves maintaining a range of equipment which may only be used for working on the car.

An alternative approach is to provide a substitute mains supply, usually from either a petrol driven generator or from a 12 volt-to-mains inverter. Generators require a signficant capital investment and, unless required for sustained use, are usually hired when required. Rotary electromechanical inverters are often used from 24/28 volt supplies, but are not usually cost effective for DIY applications. This article describes an electronic 12 volt-to-mains inverter for loads of up to 50 watts, using only standard stock components. The use of the inverter as an automatic standby mains supply (e.g. for central heating pump power during power interruptions) is also described.

DESIGN CONSIDERATIONS

When contemplating the design of an electronic d.c.-to-mains inverter, one of the first considerations is inevitably the nature of the load(s) to be supplied. Typical loads for the DIY motorist fall mainly into one of three categories; loads of below approximately 50 to 100 watts (inspection lamps, soldering irons, diagnostic test equipment, etc.), loads of around 250 to 500 watts (electric drills, power tools, etc.), and those of the full 3 kW type (electric fires, arc welders, etc.).

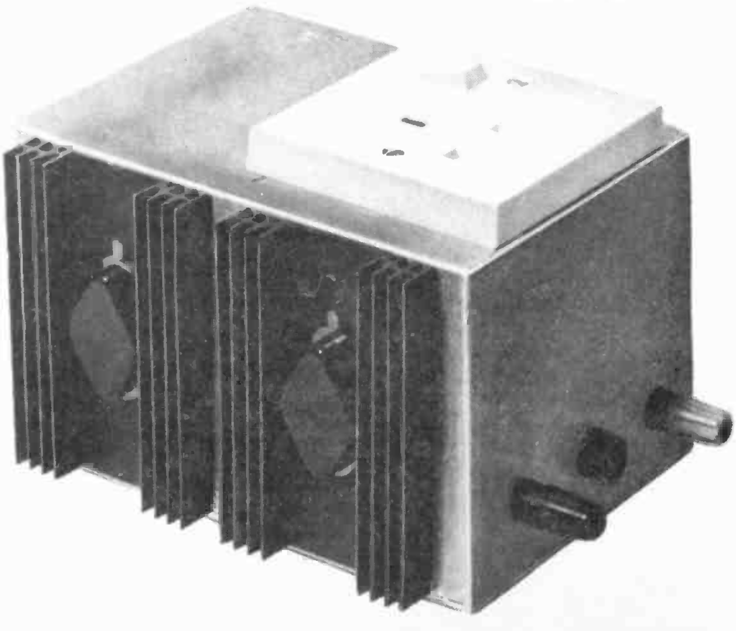
Assuming that an electrical efficiency of around 75 to 80% may be expected from an electronic inverter, the load categories above represent demand currents from a standard car battery (nominal voltage=13·2 volts) of approximately 5 to 10 amps, 25 to 50 amps, and 300 amps, respectively. By contrast, the storage capacity of a car battery is typically somewhere in the range 40 to 60 ampere-hours, depending on size and discharge rate.

The required battery load current immediately rules out the possibility of using an electronic inverter with a standard car battery for loads of around 3 kW. This is the type of application which really requires a petrol or diesel generator (unless, of course, money or batteries are no object!). The 250 to 500 watt class of load is practical, but really only in situations where the load is to be supplied for only a relatively short period of time; otherwise the battery will become significantly depleted and the inverter performance will suffer. Detailed consideration of the cost and availability of suitable mains transformers and other components usually lead to the conclusion that this is a possible, but far from ideal application for an electronic inverter.

The 50 to 100 watt load range is where the concept of the electronic inverter really comes into its own. Suitable components are available ex-stock at reasonable cost, and the load imposed on a car battery is moderate enough to allow continuous operation for a number of hours. This type of inverter is also ideal for providing an automatic standby supply during periods when there is the possibility of the domestic mains supply being interrupted. A car battery may be kept permanently connected to a float charging circuit, and then be automatically switched over to the inverter supply connections when the mains is interrupted. Typically, the inverter could supply a lighting circuit and a central heating pump/controller, providing some basic amenities until power is restored; there is, after all, nothing more frustrating than having a gas central heating system rendered useless by lack of power for the pump. When the mains supply is restored, the battery charge is replenished by the float charging circuit, all without user intervention.

CIRCUIT DESCRIPTION

The circuit for the basic inverter unit is shown in full in Fig. 1. A low-power CMOS timebase i.c. is used to provide the fundamental 50Hz timing signal. This arrangement ensures frequency stability, and the use of an integrated circuit helps to minimise the overall component count. IC1 incorporates an on-chip high frequency oscillator, permitting direct connection to an external crystal, XL1. The internal divider chain has a division ratio of 2^{16}, and when used in conjunction with a



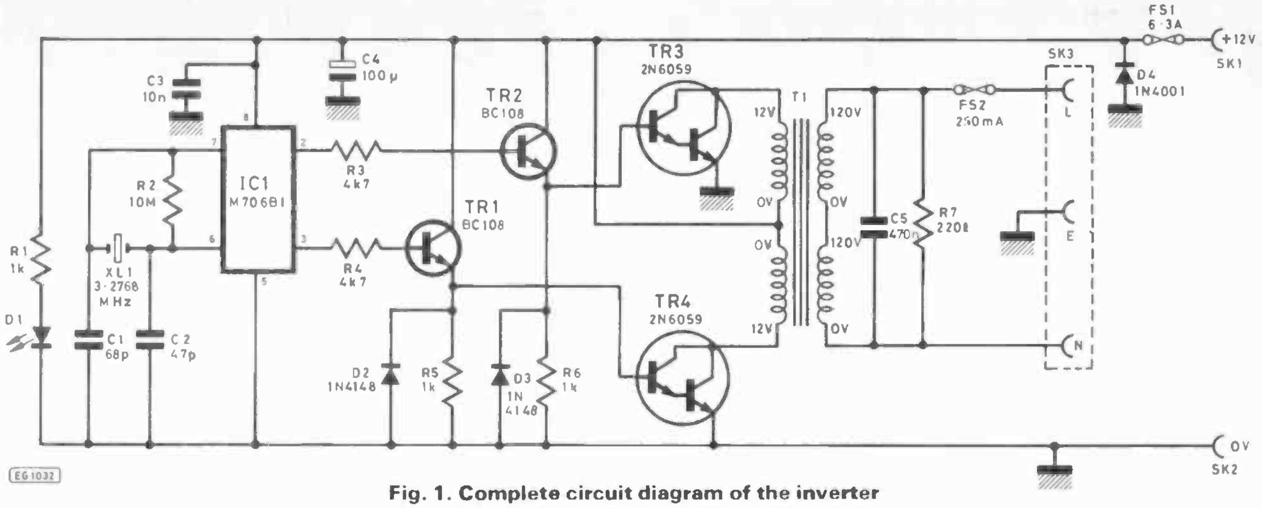


Fig. 1. Complete circuit diagram of the inverter

3·2768 MHz crystal, produces complementary 50Hz outputs. The outputs are CMOS and low power Schottky TTL compatible. In applications where frequency accuracy is important, C1 may be replaced by a 5·5 to 65 pF trimmer capacitor.

The outputs from the timebase i.c. are buffered by TR1 and TR2, which are arranged as emitter followers providing current gain, but almost unity voltage gain. Diodes D2 and D3 provide protection against induced high voltage spikes. The outputs from the buffers drive two high gain power Darlington devices, TR3 and TR4. These are very rugged devices which have a gain of approximately 750 at 6 amps, and can each dissipate up to 150 watts! They are internally protected against spikes, and can be used simply as very high gain transistors, with the proviso that their collector-emitter saturation voltage is higher than a single transistor (approximately 2V at a collector current of 6 amps). TR3 and TR4 come in standard TO3 packages which are also conveniently mounted on standard heatsinks, or simply on a diecast box.

The transformer, T1, is arranged back-to-front in that the mains winding is now effectively the secondary. The two 12 volt secondary windings are fed with complementary waveforms, with the supply centre-tapped. On the secondary side, C5 removes the high frequency output components. Reverse polarity supply protection is provided by FS1/D4, and d.c. supply indication by D1.

CONSTRUCTIONAL DETAILS

A printed circuit board is used to mount most of the low current components in the inverter. A copper foil pattern for this board is shown in Fig. 2, with the corresponding component layout shown in Fig. 3. The actual layout, however, is not of critical importance, and a small piece of Veroboard approximately 60mmx90mm may be used instead of the p.c.b.

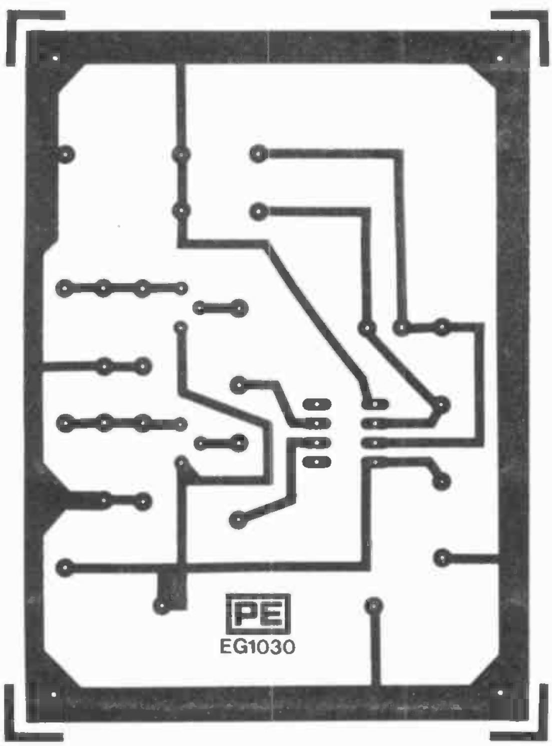


Fig. 2. P.c.b. design

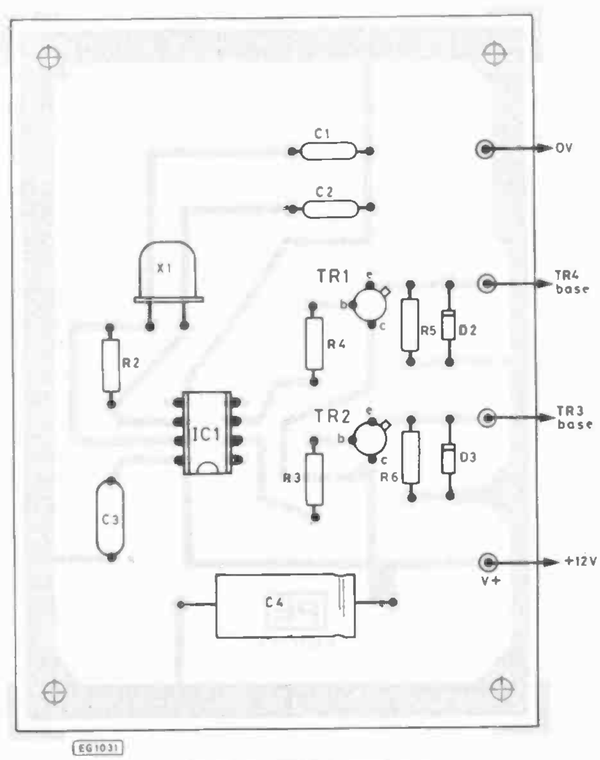


Fig. 3. Component layout

COMPONENTS . . .

Resistors

R1, R5, R6	1k (3 off)
R2	10M
R3, R4	4k7 (2 off)
R7	220k

All resistors $\frac{1}{4}$w 5% carbon

Capacitors

C1	68p ceramics or polystyrene
C2	47p ceramic or polystyrene
C3	10n polyester
C4	100µ 16V elect
C5	470n polyester 250V a.c. minimum working voltage

Semiconductors

D1	red l.e.d.
D2, D3	1N4148 (2 off)
D4	1N4001
TR1, TR2	BC108 or similar (2 off)
TR3, TR4	2N6059 or similar npn power Darlington (2 off)
IC1	M706BI

Miscellaneous

T1 2 x 0-12V at 2 amps

SK1 4mm screw terminal red

FS1 6·3 amp fuse and holder

FS2 250 mA fuse and safety holder

XL1 3·2768 MHz crystal

Terminal pins

2 off TO3 transistor covers

Optional: 2 off TO3 heatsinks

SK2 4mm screw terminal black

SK3 Switched 13A mains outlet

Printed circuit board or Veroboard

Diecast box 170mm x 120mm x 105mm

4 off stick-on feet

2 off TO3 insulating kits

The following additional components are required for the automatic standby mains supply:—

D5, D6	1N5402 (2 off)
R8	1Ω 10 watt wirewound
RLA	3 pole changeover relay with contacts rated at 5 amps and a 240V a.c. coil e.g. RS type 349-563

Constructor's Note

In case of difficulty, IC1, TR3, TR4 and XL1 may be obtained from **Howard Associates, 59 Oatlands Avenue, Weybridge, Surrey, KT13 9SU.** SAE for details.

When mounting the components on the board, particular care should be taken to ensure the correct orientation of the polarised components, particularly the semiconductors. It is advisable to use a heatshunt, such as a pair of long-nosed pliers, when soldering the crystal in place to avoid overheating the quartz element. After soldering, the crystal should be fixed to the board to prevent damage by vibration; a piece of double-sided tape is ideal for this purpose. IC1 may be mounted in a socket if preferred, and terminal pins are recommended for all interconnection wiring points.

The next step is to mount the remaining components in the diecast box. It is suggested that the cutout for the mains socket be made first, but the socket should not be mounted at this stage. The cutout dimensions will depend on the type of socket used; if hard use is to be expected, a socket with a metal faceplate is strongly recommended. The mains transformer should then be securely mounted adjacent to the cutout for the mains socket, and the necessary wire links fitted. The filter components, C5 and R7, should be mounted directly on the terminals of the mains winding.

The output transistors, TR3 and TR4, should be mounted with insulating kits on the long side of the case. The use of heatsinks for these devices is advantageous if sustained full-load operation is anticipated; they serve as much to dissipate the heat generated by the transformer as by the transistors themselves. The remaining components should be mounted on the end of the case adjacent to the mains outlet, taking care to leave adequate clearance around components at mains potential. The p.c.b. should be mounted opposite the output transistors, and spaced from the case with pillars.

The final step is to install the interconnection wiring and the mains socket. All wiring should be capable of carrying the appropriate currents; the +12 volt supply should be capable of carrying in excess of 5 amps. It is suggested that the wires from the transformer to the mains socket should be terminated in 4 mm plugs; these can then be secured in the terminals of the socket with the screw fixings supplied. The socket may then be mounted on the top of the case. Details of the interconnection wiring as shown in Fig 4. All components should be securely mounted, and special care should be taken to ensure adequate insulation and clearance for all components carrying mains potentials.

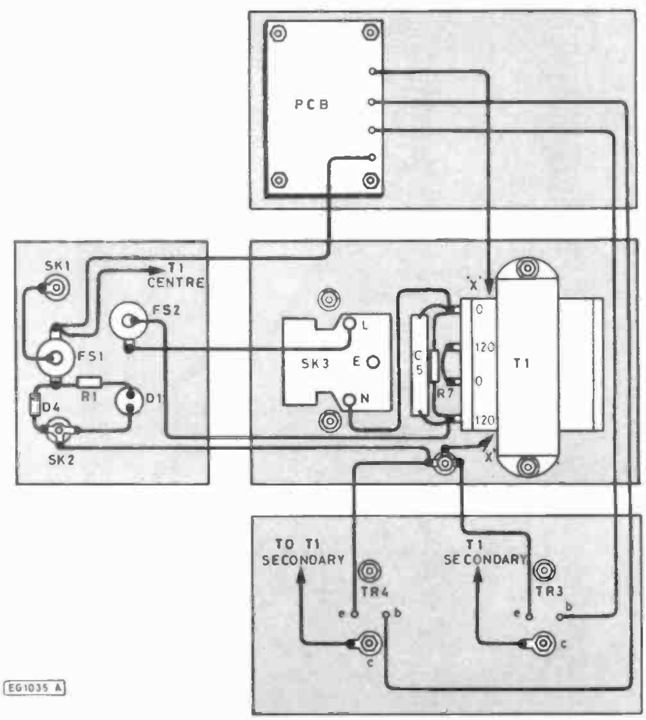


Fig. 4. Wiring diagram

TESTING AND PERFORMANCE

Testing of the mains inverter requires a car battery, or a mains power supply rated at 13·2 volts and capable of supplying at least 5 amps. In addition, a meter able to measure up to 250 volts a.c. and up to 5 amps d.c. will be required. Before starting any tests, it is essential that the correct fuses are fitted in FS1 and FS2, and the meter should be inserted in the d.c. supply line.

Connect the d.c. supply and measure the current with no load connected to the mains outlet. With a supply potential of 13·2 volts, the current should be approximately 1 amp; the mains transformer may also be heard to buzz quietly due to the square wave drive signal. If D1 is not illuminated, and no supply current is being drawn, it is likely that FS1 has blown due to a short circuit or wiring error. Before replacing FS1, the cause of the error should be determined. If no fault is evident after a careful check, it is possible that the timebase is not functioning correctly. This may be checked by disconnecting the 12 volt supply from the centre-tap of the transformer, replacing FS1 and seeing if D1 remains illuminated; if so, the fault is probably lack of 50Hz drive to the output transistors. Another possible source of problem is with the wiring of the mains transformer. The labelling of the low-voltage windings should be very carefully checked against that shown in Fig 1; the windings are polarised, and this is significant in this application. When the supply conditions are correct, the mains output may then be measured. Using a standard moving coil multimeter, the no-load output will show approximately 240 volts a.c.; the actual r.m.s. value will be somewhat higher due to the non-sinusoidal waveform.

The final test is to connect a known load to the inverter; a 40 watt light bulb provides a very convenient load. When the lamp is turned on, the current should rise to between 3 and 4 amps, but the mains output voltage will be seen to fall to approximately 210 volts as indicated on the meter.

The performance of the inverter is shown in detail in Fig 5. The graphs indicate how the load voltage falls steadily as the load increases, whereas the overall efficiency shows a peak of around 83% at approximately 33 watts. The shapes of the curves are significantly affected by the no-load input current and the performance of the magnetic core of the transformer. Improvement in the no-load current (i.e. a reduction) would raise the low-power efficiency, while a higher saturation current for the transformer would improve the high-power performance.

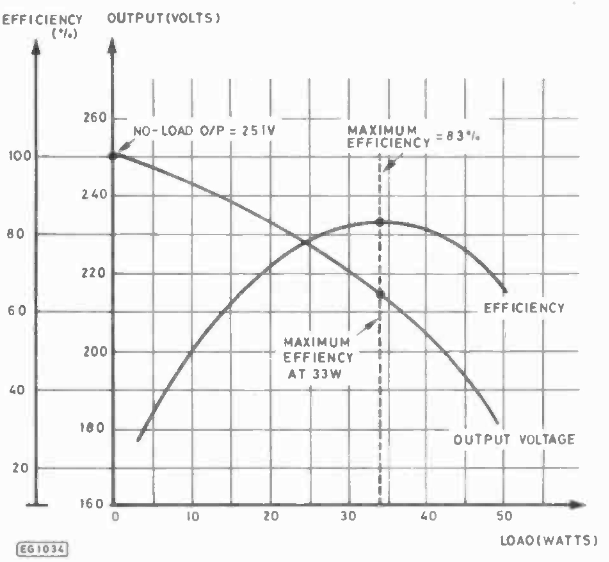


Fig. 5. Performance results for the inverter

AUTOMATIC STANDBY SUPPLY

There are many situations where even a brief interruption in the mains supply cannot be tolerated. The mains inverter described here can be modified to provide automatic changeover between the public supply and an inverter-derived supply in the event of a mains failure. The battery used to provide the inverter supply is kept on float charge when not in use, i.e. when the public supply is available.

The modified output stage for the inverter is shown in Fig 6. When the public supply is present, the relay drives the transformer in the conventional fashion. The mains input from SK4 is routed straight out to SK3 and to the mains side of T1. The low voltage output from the transformer is full-wave rectified by D5 and D6, and R8 sets the float charge rate for the battery connected across SK1 and SK2. In the event of a public supply failure, the relay 'drops out', and assumes the state shown in Fig 6. This is then identical to the circuit shown in Fig 1, and the output is SK3 is inverter-derived, while the rest of the mains circuit attached to SK4 is isolated by RLA.

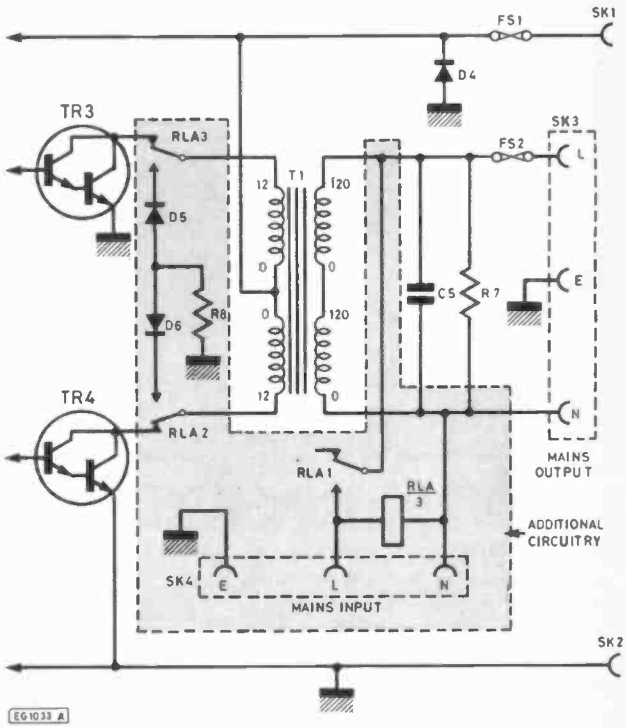


Fig. 6. An automatic standby mains supply with float charger

CIRCUIT VARIATIONS

The efficiency of the inverter will be improved if a larger transformer (100VA or even 200VA) is used. This will require no circuit change as such, but may require the use of a larger diecast box. To take advantage of the larger transformer to obtain a higher maximum output power, it will be necessary to also change TR3, TR4, FS1, FS2 for components rated at the appropriately increased current. For a 100 watt inverter, a 100 VA transformer will require FS1 and FS2 to be changed to 10 or 15 amps, and 500 mA, respectively. The existing devices may be retained for TR3 and TR4 since they have an absolute maximum rating of 12 amps, but for a more rugged unit, substitution by MJ4035 devices is recommended. Heatsinks will be required! ★

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In the cut-throat world of consumer electronics, one of the questions designers apparently ponder over is "Will anyone notice if we save money by chopping this out?" In the domestic TV set, one of the first casualties seems to be the sound quality. Small speakers and no tone controls are common and all this is really quite sad, as the TV companies do their best to transmit the highest quality sound. Given this background a compact and independent TV tuner that connects direct to your Hi-Fi is a must for quality reproduction.

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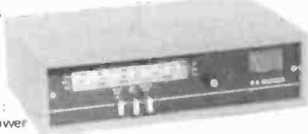

This easy to build 3 band stereo AM/FM tuner kit is designed in conjunction with Practical Electronics (July '81). For ease of construction and alignment it incorporates three Mullard modules and an I.C. IF System.

FEATURES: VHF, MW, LW Bands, interstation muting and AFC on VHF. Tuning meter. Two back printed PCB's. Ready made chassis and scale. Aerial: AM - ferrite rod. FM -75 or 300 ohms. Stablised power supply with 'C' core mains transformer. All components supplied are to P.E. strict specification. Front scale size 10½"x 2½" approx. Complete with diagram and instructions.

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Sell assembly simulated wood cabinet sleeve to suit tuner only. Finish size: 11¼"x 8½"x 3¼". £3.50 Plus £1.50 p&p.

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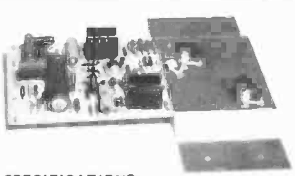

The power amp kit is a module for high power applications - disco units, guitar amplifiers, public address systems and even high power domestic systems. The unit is protected against short circuiting of the load and is safe in an open circuit condition. A large safety margin exists by use of generously rated components, result, a high powered rugged unit. The PC board is back printed, etched and ready to drill for ease of construction and the aluminium chassis is preformed and ready to use. Supplied with all parts, circuit diagrams and instructions.

SPECIFICATIONS: Max. output power (RMS): 125 W. Operating voltage (DC): 50 - 80 max. Loads: 4 - 16 ohm. Frequency response measured @ 100 watts: 25Hz - 20KHz. Sensitivity for 100w: 400mV @ 47K. Typical T.H.D. @ 50 watts, 4 ohms: 0.1%. Dimensions: 205x90 and 190x36mm.

ACCESSORIES: Suitable mains power supply kit with transformer: £8.50 + £2.00 p&p. Suitable LS coupling electrolytic. £1 + 25p p&p.

KIT **£10.50** +£1.15 p&p

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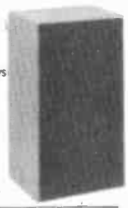

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Space Watch...

AMERICAN ANXIETY ABOUT MILITARY SPACE CONTROL

Two defence relay satellites were launched at the end of October 1982 by the US Air Force using the Titan 34D with an inertial stage. This was the first successful launch with the new system. The satellites DSCS-2 and DSCS-3 are engineered by the General Electric Company. The full title is Defence Satellite Communication System. These first launches are the initial part of a 13 unit series.

The early read-out data indicated that the launch was more accurate than had been predicted. The perigee was 22,751 nautical miles. This was some 17 nautical miles lower than the planned orbit. The inclination angle was 0·007 deg. and the drift rate was 0·06 deg. The launch plan was designed for an orbital injection of the inertial upper stage into a parking orbit of 100 × 82 nautical miles. A two-stage burn then moved the satellites into the synchronous orbit.

The technical details of the launch are as follows:

—The solid fuel rocket motors, from United Technologies Corporation, were jettisoned at about 125 seconds after the first burn. As it turned out the solid fuel rockets burned for one second less than planned and this was compensated by a two second burn at the core ignition stage.

—Stage two some 120 seconds later and the stage one was separated.

—The shroud was then jettisoned and the second stage shut down.

—The first satellite was ejected into the transfer orbit. The second satellite was injected into the transfer orbit some 6 hours later.

The DSCS-3 has a design lifetime of 10 years. It has three aerials and is Sun orientated. One of the aerials has 61-beam receive facilities and two 19-beam transmitting units. The systems are electronically steered and the elements are radiation hardened.

The satellites use travelling-wave tube amplifiers and incorporates six super-high frequency channels. Two of these work with a 40W output and four with a 10W output. The bandwidths available are between 50 and 85MHz. Reception is available both in super high frequency and ultra-high frequency. Transmission is in ultra-high frequency.

The payloads are designed to provide a world-wide super-high frequency military communications system for secure strategic and tactical voice and data transmissions. The relay facilities will be used for army command and control, defence communications and ground mobile communications. The system will also be available to the National Command Authority, The White House Communications Agency and the Diplomatic Telecommunications Service.

WAR AND SPACE

Once again it seems that SPACEWATCH cannot ignore the aggressive side of the opening up of more and more efficient use of space. Just as real advances in peaceful and useful applications of manufacturing advantages and health improvement offered by developing techniques have been proven, we have to accept that now large sums will be available for the principal benefit of armed forces. Most of us reluctantly accepted that when new frontiers stared us in the face the 'cut' of peaceful development would be small. At least there would be something for things that mattered. It is a great tribute that the shoestring projects managed to produce the inspiration that has more than satisfied the defence and offence projects. It must be understood that there is, however, no support from the writer for the sentiments or activities of the misguided groups who carry banners and generally make themselves a nuisance.

However escalation does in fact seem to increase in about equal levels and therefore the condition of 'Mexican Stand-Off' remains. The world may therefore go about its business, ingenuity playing its usual part.

The Russian situation has changed, but to what extent is not known. It is known that the former premier regarded the Shuttle as a military vehicle and Russia has already made an attempt to copy it. Other countries would no doubt hope to do the same. It is certain that it will be a commercial success and will still be in considerable demand for the next 20 years. Only benefit to the peoples of the Earth can result from the peaceful use of space.

The success of the Russian space stations is to be admired and it has always been the majority view that space stations, space platforms and shuttle-like systems represent the most economical use of men, materials and fuel. President Reagan, it seems, is set on a formal military recognition and the Air Force already has a Space Command. Perhaps a little closer examination of the situation might be worth while. The international situation of common understanding and operation in Antarctica has shown that co-operation works well. After all, this is Man in the collective adventure against the elements. That the Soviet Union's activities in space have always been regarded as being controlled by an armed state and that this is now part of the normal thinking, that everything in Russia is under military control. No real exception has been taken to this, rather perhaps it has been seen by those engaged in the space field as, 'Of course they can do things, they have all the resources available to them'. The space programmes in the West have undeniably been largely orientated to the areas of greater fiscal magnitude. It was recognised that up till now private enterprise could not foot the bill when the actually monetary returns were low. The benefits have been, from the civilian view, in the spin-off advantages. If military push is to be the order of things in the USA then civilian spin-off and employment will be boosted.

SATELLITES AS SPIES IN SPACE

The Soviet Union and the United States are the acknowledged leaders in this area of Space. However, others are catching up. India, China and France have made quite substantial progress in this area already. Financial delays may make the late 1980's a final operational period. However, France does already have an operational military satellite system called SAMRO. This is based on the Earth-mapping SPOT. There was a postponement of further work on fiscal grounds. There is every possibility that this position might be eased soon.

The Soviet Union has a record for the release of photographic satellites, the rate being of the order of 35 launches a year. This is a somewhat deceiving statement since compared with a lifetime of two to three years for a US satellite the Soviet version seems to 'burn up' in as short a period as 50 days. The Soviet satellites usually go singly into space, whereas the US may pack them as passengers on other major launch missions. Reconnaisance satellites could be called the ears of space because generally they are listening to activities which result from military activities. Information also comes from listening to transfer calls in telephone networks and the transfer of computer data from one system to another. Almost any radio or telephone link can be tapped. A great tightening exercise is at work and no doubt as the slots become more crowded there will have to be pruning. There has been for some time now intense research into the propagation in those channels thought to be useless. Now that all other avenues are becoming full, a solution must be found. Improvement to existing facilities is difficult because all possible juggling with agile frequencies and other 'tricks' have been used up. There are still some channels in the higher GHz levels to be explored. Perhaps the whole of the radio frequency bands await a new lead. Perhaps if the solution of the silicon chip problem (it is already apparent that a new technique is needed, for at the moment it is limited by being 'too slow') could be found. Perhaps we could do a piggy back on the lower frequencies. At any rate, much time is being spent on the problem.

The satellites are at different levels. Reconnaisance satellites are usually at the low orbit level 200 to 600 km. Early warning units are in elliptical orbits 700 to 40,000 km. Communications satellites are in orbits of the order of 36,000 km. This leaves the nuclear detection systems at altitudes of 110,000 km, and the navigation craft at elliptical orbits of 1000 to 20,000 km. Added to these, of course, are the infra-red systems of detection.

Frank W. Hyde

We let the Robot in for half price— he claimed to be only a year old!

EHF Review...

MORE than 60 exhibitors took part in the first Electronic Hobbies Fair filling over 90 stands in the splendid new venue of Alexandra Pavilion. The successful event, which attracted media attention from newspapers, radio and t.v. will be repeated from October 27 to 30 1983 so make a date now.

The photographs on these pages set the scene and are "worth 1000 words". Exhibitors are already rebooking stands for next year so the Fair will go from strength to strength. As we said before **"the best event ever for the hobbyist in this country".**

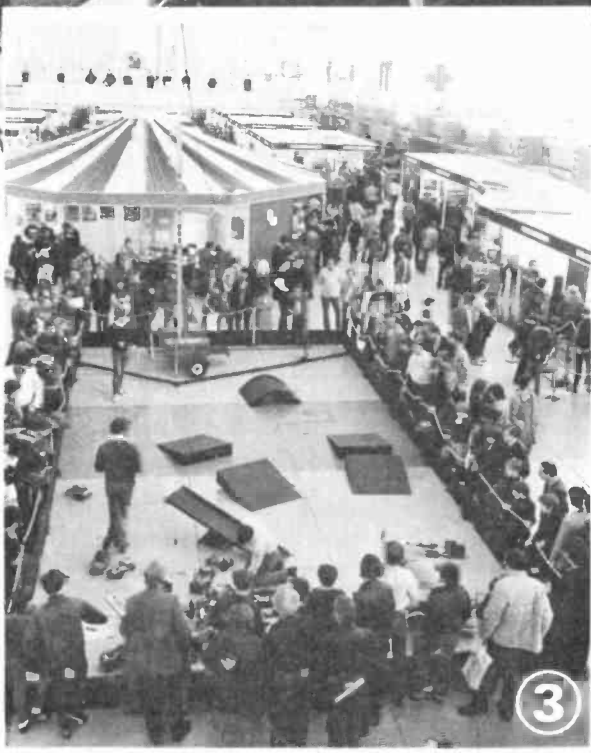
The exhibitors list read like a Who's Who in the electronic hobby business, from Absonglen, Allweld, Ambit and Armon through Babani, BICC Vero, Bi-Pak, Chromasonics, Clef, Electrovalue, EMOS, EE, GSC, JPR, Kansas City, Lightsold, Maplin, Marco, Midwich, PE, PW, Radio Shack, Roadrunner, Service Trading, Shesto, Sparkrite and Velleman to Westlake and Wireless World; to mention just a few.

Many special attractions were mounted by organisations like the Army, RSGB, Holographic Developments, EOCS, BAEC, BBC and BVS. The display of radio controlled models, courtesy of Model Land, and the robots by Advance Robotics proved highly entertaining and continually drew large crowds. Numerous visitors watched the news according to Russia via the Luxor satellite t.v. system, just how many understood Russian is another matter!

The "bargain sales" area was always well attended and amateur radio operators talked mobile visitors in and chatted with operators around the world. Kids and creative computing abounded and one kind gentleman from Chordgate wrote a short program that turned our Micrograsp robot into a "padded cell and straight jacket" case.

We enjoyed it all, we hope you did, or will next year!

Waiting to get in. The Luxor satellite dish can be seen on the right.



1. Microsynth and, a future project, Percussion Microsynth on our stand.

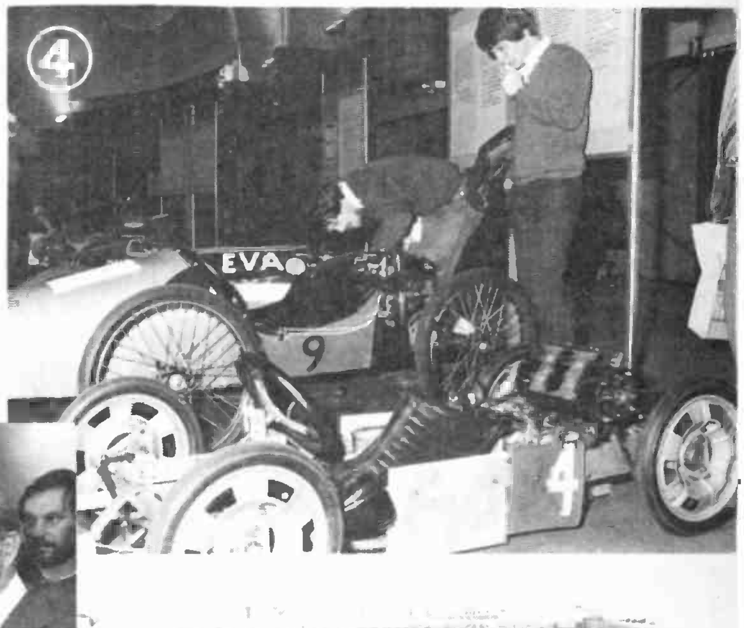
2. The ITV camera watching the robots, watching the camera!

3. The IPC Magazines rotunda formed a centrepiece for the special attraction area. Radio controlled models in the foreground.

4. Battery vehicles of all shapes and size.

5. Members of the Electronic Organ Constructors Society exercise their vocal chords—thankfully the organ was in tune!

6. The "bargain sales" area was always well attended.



into the REAL
CONTROL CIRCUITS

THE early microprocessors often attracted comments along the lines of, "A solution in search of a problem". In the time since its introduction, however, the microprocessor has become an accepted and important design component, almost to the point of becoming the electronic equivalent of the all-curing medical aspirin. The micro has been hailed as a shining example of what the "White Heat of Technology" has to offer; the answer to our design problems for the foreseeable future.

The reality of the situation, needless to say, lies somewhere between these two extremes. The microprocessor has a great deal to offer in terms of speed, performance, flexibility and cost-effectiveness when applied to the solution of a wide range of problems. However, it is this very versatility which raises one of the greatest problems for many potential users. The question is when and how to make use of the micro's vast potential. The aim of this short series, therefore, is to try and bridge the gap between the undoubted technological brilliance of the microprocessor, on the one hand, and the practical aspects of how to use it, on the other.

MICROS FOR REAL APPLICATIONS

The world of the micro is a well-ordered one; the signals which circulate are glitch-free, the loads are all properly matched, the connections short, and the levels are purely digital. The designers have gone to considerable lengths to ensure that everything behaves in a predictable fashion. The essence of the microprocessor is its predictability; it is basically a finite state machine. Once programmed, its behaviour in given situations can be predicted with some certainty, and its performance will be repeatable.

It is essential that the environment in which a micro is expected to work is carefully specified if the control program is to perform correctly under operational conditions. A popular approach to the problem, and one of the subjects of this series, is to condition all signals before they reach the micro. This ensures that unexpected or unwanted effects are eliminated, or at least that their consequences are minimised. In this way, the requirement to be able to predict the total range of inputs (which is almost impossible in any real system) is eliminated, and instead the possible inputs are limited to a manageable range. From this starting point, it is then a much more straightforward problem to produce some robust control software.

The other aspect of microprocessors in real applications involves their control of peripheral hardware, particularly that which was not necessarily designed specifically for use with a micro. In some cases the interface can easily be implemented using one of the standard ranges of interface i.c.s, e.g. a serial link can be implemented with a standard UART device. The majority of real control loads, however, have not necessarily been designed with microprocessor control in mind. The requirement then is to provide the appropriate conversion between the control signals produced by the micro, and those required by the peripheral hardware. This may involve some simple signal manipulation, e.g. level shifting or power amplification. Alternatively, the conversion may involve matching the speed of the control system to the speed of the peripheral system, e.g. a micro can change the state of a lamp in a few microseconds, but the lamp takes milliseconds to respond, and the human operator must be allowed at least 20 milliseconds before any change begins to register.

This series will describe some of the more commonly used signal conditioning and peripheral control techniques. On the whole, the examples given will be directly applicable to the hardware used in the PE Microcontroller, but the techniques themselves will be applicable to a much wider range of micro-based applications. The choice of techniques to be used in a particular system will necessarily depend on the nature of the particular application. The intention here is to encourage the use of the microprocessor in ways which move away from technological abstraction, and out "Into the Real World".

The article this month will concentrate on systems which

WORLD part 1

Michael Tooley B.A. David Whitfield M.A. M.Sc.

involve purely digital control, i.e. where a line can take only one of two states. Next month the topic of analogue signals will be covered.

PERIPHERAL LINE DRIVING

The usual method of driving peripheral hardware under microprocessor control involves some sort of adaptor between the CPU and the peripheral. This adaptor acts as a filter for the peripheral, and it separates out those CPU instructions and commands which are relevant to its operation. An example of such a peripheral adaptor is the 6821 PIA, designed primarily for the 6800 microprocessor family, which provides two independent sets of eight peripheral I/O lines. The PIA also has a considerable amount of control logic which simplifies the CPU's task in controlling any peripheral hardware. Similar adaptors, with a wide range of different functions, are available for almost every family of microprocessor. Indeed, it is now common for the selection of a micro for a particular job to be influenced as much by the available range of interface adaptors as by the capabilities of the CPU itself.

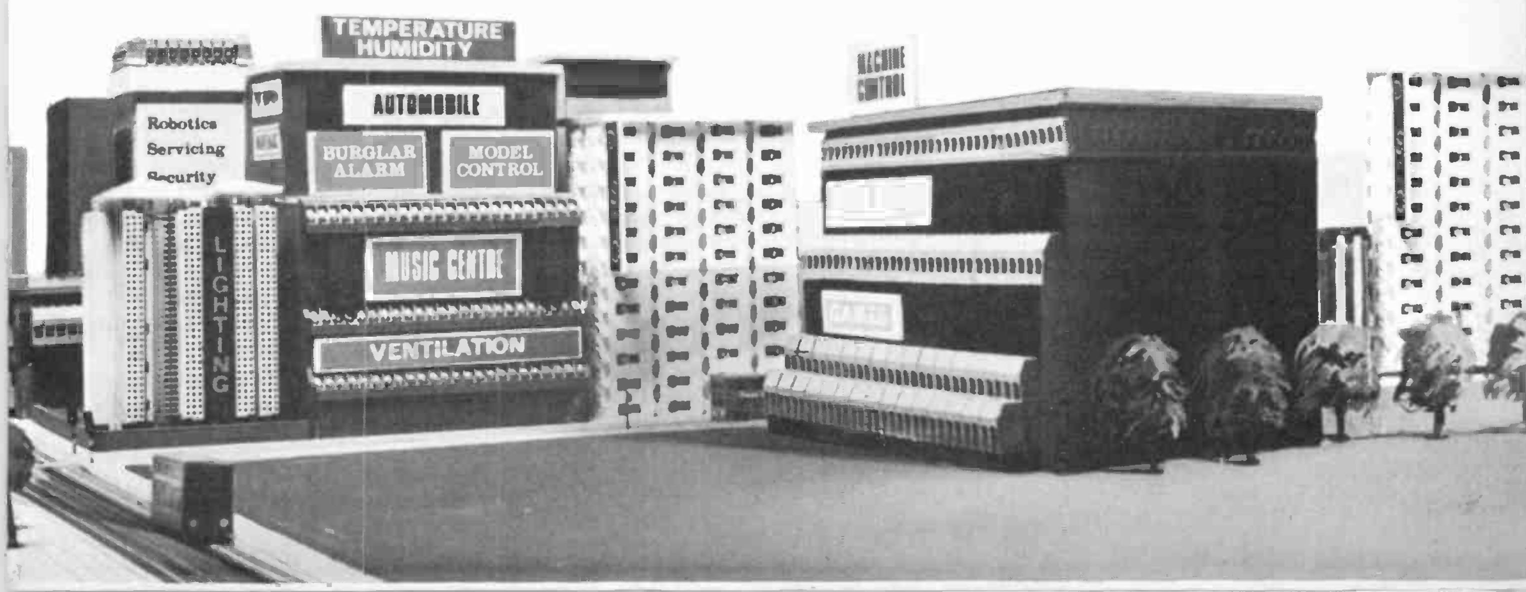
The simplest type of interface is the situation where the peripheral hardware presents a buffered digital interface to the outside world. In such cases, it is simply a matter of connecting the peripheral directly to the adaptor, and then configuring the interface under software control to satisfy the peripheral's requirements. A simple example of such an arrangement is the connection of an 8-bit digital-to-analogue converter (DAC) to one of the ports of a 6821 PIA; this example will be described, with applications, next month.

There will be many cases, however, where the peripheral hardware presents a load which exceeds the drive capability of the peripheral adaptor. In such cases the modification to the interface is only a matter of increasing the logic drive capability of the adaptor. The easiest way of achieving an increase in the fanout (which in the case of the 6821 PIA is two standard LS TTL loads) is to introduce additional logic gates, configured as buffers, between the adaptor and the peripheral. These buffers may be formed of any convenient gates, and will typically increase the fanout to around 10 to 20. For buffering groups of eight peripheral lines, a range of i.c.s is available which will each handle eight lines. Table 1 shows a random selection of LS TTL devices which are available, and there are other ranges of devices containing 4, 6, and 8 gates per package. It will be noted that the devices listed have tri-state (high, low and high-impedance) outputs; this allows the simple construction of bus-connected interfaces without the need for complex switching logic. For peripheral applications requiring bi-directional lines, bus transceivers are available; these are effectively a driver and a receiver in parallel, with direction switching logic. In general, driving logic circuitry is usually simply a matter of direct connection to the interface adaptor, or the inclusion of appropriate buffers in the interface.

The final category of digital load to be considered includes applications where the load operates on levels in excess of the standard logic levels, and often requires significantly increased drive capability. Typical examples include 12/24V relay coils, filament lamps, and gas discharge displays.

DEVICE NUMBER	FUNCTION	OUTPUTS
74LS240	Octal inverter buffer	3-S
74LS241	Octal buffer	3-S
74LS244	Octal buffer	3-S
74LS245	Octal transceiver	3-S
74LS363	Octal transparent latch	3-S MOS-compatible
74LS364	Octal D-type flip-flop	3-S MOS-compatible
74LS373	Octal transparent latch	3-S
74LS374	Octal D-type flip-flop	3-S

Table 1. Selection of byte-wide peripheral output i.c.s



The simplest interface to a load is to include a switching transistor, or VMOS FET power transistor, between the peripheral adaptor and the load. Fig. 1 shows some examples of this technique for driving an l.e.d. indicator and a relay, respectively. This approach is ideally suited to simple interfaces, especially where the requirements of each peripheral I/O line are different. For large numbers of lines, especially with similar drive requirements, however, the cost and component count begins to escalate, and integrated circuit drivers become appropriate.

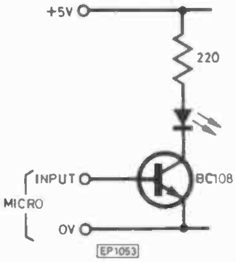


Fig. 1a. Switching transistor interface to 10mA l.e.d. load

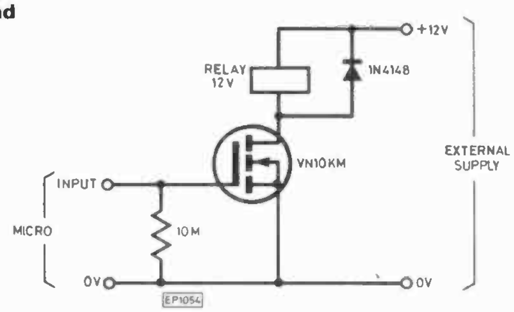


Fig. 1b. VMOS power transistor interface to 12V relay coil

The cheapest peripheral driver (under 20p per package of six drivers!) is to be found in the 7400 series of open collector buffers. These are suited to sinking currents of 16 to 48mA, depending on collector voltage, and brief details of the characteristics of commonly available devices are shown in Table 2. An application circuit using a 7416 is shown in Fig. 2.

	7407 7406	7417 7416	7426	7438 7433	
High-level output voltage max	30	15	15	5·5	V
Low-level output current max	−40	−40	−16	−48	mA
High-level output current max	250	250	1000	250	µA
Low-level output voltage max	0·7	0·7	0·4	0·4	V

Open-Collector	7406	Hex inverter buffers/drivers
	7407	Hex buffers/drivers
	7416	Hex inverter buffers/drivers
	7417	Hex buffers/drivers
	7426	Quad 2-I/P NAND buffers
	7433	Quad 2-I/P NOR buffers
	7438	Quad 2-I/P NAND buffers

Table 2. Characteristics of some 74 Series Open-Collector Buffers

The selection of an integrated peripheral driver for a non-logic type of load can be a daunting task when looking through the huge range of devices which is now available. A driver for a particular application, however, can usually be identified by considering the following factors in relation to the load to be driven:

(1) The type of input signals to be provided (TTL, CMOS, etc).

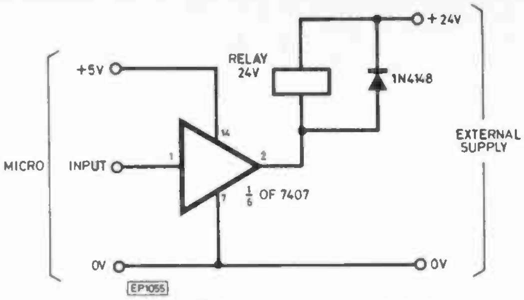


Fig. 2. Driving a 24V relay using a TTL buffer

(2) Whether the output requires current source, sink, or both.
(3) The load supply voltage.
(4) The logic function of the driver (buffer, inverter/buffer, AND, etc).
(5) Whether transient protection (for inductive loads etc) is required.

If selection from this list of criteria still leaves a wide field of choice, details of packaging (e.g. number of drivers per device) and cost/availability will usually narrow down the choice to a suitable device.

The PE Microcontroller contains an example of an integrated peripheral driver. The user PIA outputs were originally intended to drive 12 volt solenoids connected between the output line and 0V. The drivers selected were of type UDN2981A; these are high-voltage, high-current source drivers which are TTL, DTL, PMOS or CMOS compatible, with 500mA output source capability which is protected against transients. Each output is switched on by an active high input level, and the output stages (shown in the circuit of Fig. 3) will each sustain a maximum off voltage of +50V. The maximum output current for a single driver is 500mA, or 120mA continuously for all drivers in operation at once.

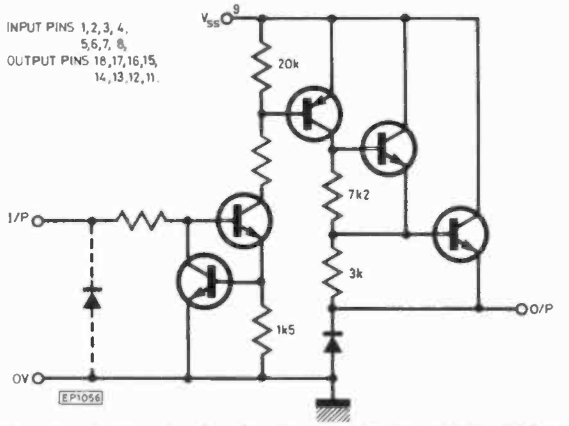


Fig. 3. Internal circuit for a single UDN 2981A peripheral driver

CONTACT BOUNCE

Switches and similar electromechanical devices are used in many control applications for a wide variety of purposes. There are, however, many occasions when they do not behave quite as would be expected. Consider, for example, the use of a microswitch in a gate turnstile where a count of the number of admissions is required for comparison with the gate receipts (also calculated by the same microprocessor). This would seem to be an ideal situation for an interrupt-driven counter routine, with the turnstile causing an interrupt each time a customer enters, and the interrupt service routine incrementing the total count by one.

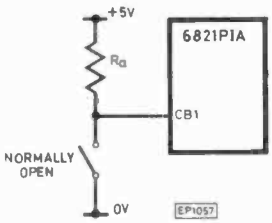


Fig. 4. Interrupt-driven switch circuit

Fig. 4 shows what would seem to be a reasonable way to achieve this function.

The problem in practice is that the switch is not perfect, and when the contacts are closed they tend to bounce mechanically. The number of bounces, and the interval between them, will vary between types of switch, and even between samples of the same type. The result of this difference between the theoretical switch and a real switch is that the total count value may, depending on the switch and the length of time to execute the interrupt service routine, be in error by any amount between 0 and 500%. Even worse, the performance will not be predictable.

There are a number of possible solutions to this problem. The first is to use a better switch; this will not necessarily solve the problem, and could involve a significant increase in cost. A better solution is to keep the switch, which was probably chosen for a combination of physical considerations, and acknowledge the fact that switch bounce will occur. A way of doing this is to make the interrupt service routine, which in the example is triggered by the high-to-low edge, ignore further interrupts for a period longer than the bounce period. This duration will typically be in the range 0·1 to 10 milliseconds. Achieving the 'ignore' period involves keeping the switch interrupt masked out (done automatically on entry to the service routine on most microprocessors, so really only a matter of not re-enabling interrupts), and including a software delay of appropriate length.

Such software delay routines typically choose a period of 20 milliseconds to be on the safe side. A suitable delay routine for the PE Microcontroller would be as follows (the time is calculated from the individual instruction timings and the number of times round the loop):

```
                            Op Codes
KDLY: LDX #08E0             CE 08 E0
 DLY: DEX                   09
      BNE DLY               26 FD
      (RTS)                 39
```

This may be implemented as a subroutine, or as in-line code (in which case the RTS should be omitted). After the delay has finished, it is a good idea to look again at the switch line if possible (via a PIA I/O line is the easiest way) to check that the signal is still there; this will avoid responding to spurious spikes on the lines. If the total count is incremented only after the delay and re-check, the final system should be relatively immune from the problems of both switch bounce and noise spikes.

Software debounce is not always possible in a system due to the amount of CPU time required to implement the delay routine, especially if noise spikes are a frequent occurrence. The alternative to software debouncing, therefore, is to use hardware debounce circuitry. A circuit for providing a debounce delay of 1ms is shown in Fig. 5. The use of a Schmitt type of gate is recommended to avoid switching oscillations on delays with long time constants. This circuit will have the same effect on short duration noise spikes, and will

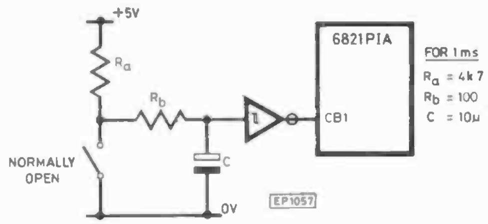


Fig. 5. Modified circuit with debounce components

thus reduce the incidence of 'false alarm' interrupts. The value of R_b used in the circuit should take account of the sink current required (1·6mA for standard TTL gates) for a logic low; with standard TTL the maximum value recognised as a 'low' is 0·8V, making the upper limit on R_b around 470Ω.

In general it is recommended that some form of debouncing is used with all switches in control applications. This will usually also have the added benefit that the system will be more immune to the effects of transient spikes; a feature which is always enhanced by the use of active-low control signals. As a final point, it should be remembered that the debounce circuit shown in Fig. 5 must be charged up at power-up, and the initialisation sequence must allow time for this to be completed before recognising any interrupts.

KEYBOARDS

A keyboard is a common component in any microprocessor application which involves any sort of user interaction. Its normal function is to transfer commands from the user to the resident control program to initiate the required action. Typical keyboards range from simple collections of function keys, right up to a full typewriter-style layout with additional function keypads.

Keyboards represent particularly good examples of the hardware/software tradeoffs which must be considered when configuring a system. They range from simple arrays of switches on the one hand, to fully decoded keyboards with multiple-key rollover protection and a data available strobe signal on the other. The simple type of keyboard minimises the amount of additional hardware required, but represents a higher software overhead on the system, i.e. more CPU time must be spent in detecting and identifying keystrokes. Fully decoded keyboards represent the smallest system software overhead, but they are more expensive in terms of the additional hardware required; this penalty is, however, continuously being eroded by the increasing availability of custom keyboard i.c.s and low cost key arrays. In the majority of control applications, where a full QWERTY typewriter type of keyboard is rarely necessary, the trend is still to make use of relatively simple hardware; usually a simple array of switches, with possibly some additional logic to minimise the software overhead. A typical compromise between simplicity and full decoding is shown in the keyboard for the PE Microcontroller; here the keyboard is an array of switches, but the keyboard software is simplified by the addition of a line decoder, IC23.

In order to make use of a keyboard, of whatever type, there are a number of requirements which must be met by the control system (i.e. by the combination of the hardware and the software). First of all the system must detect that a key has in fact been depressed. The key must then be identified before the control program can proceed to take the appropriate action in response to the implied user command; a function often performed by a module called a command processor.

KEYBOARD CONFIGURATIONS

A standard 16-key hexadecimal keypad is the keyboard used as an example in the discussion which follows. There are essentially two ways in which the 16 keys may be arranged, and these are shown in Fig. 6. Most larger or smaller keyboard switch arrays are simple variations on these two schemes. The standard and matrix arrangements may each be made up from a collection of individual switches, or the keyboard layout may be available as a stock component.

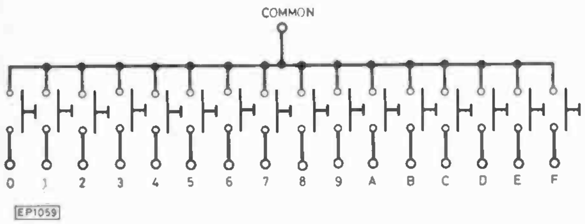


Fig. 6a. Standard key layout for 16 keys

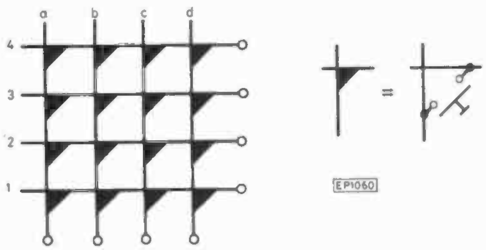


Fig. 6b. Matrix key layout for 16 keys

The matrix scheme has the advantages of fewer interconnections, less wiring, and only half the number of peripheral I/O lines. It does, however, require a more complex software driver for the keyboard. The standard array, on the other hand, has a very simple decoding scheme, and a non-matrix number of keys may easily be handled. It does, however, use more peripheral lines (and consequently more wiring), but these lines need only be configured as inputs. The scheme chosen will inevitably be a compromise influenced by the overall specification for the system, and the availability of appropriate switch arrays.

The actual detection of a key depression is usually performed in one of two ways. Both techniques may be used for either type of keyboard, and one example of each will be given by way of illustration. The first method involves software polling of the keyboard. A modified version of this method is used in conjunction with a matrix keyboard in the PE Microcontroller. Basically, the control software is required to look regularly (typically more than 20 times per second) at the keyboard to see if a key has been depressed. Fig. 7 shows how a standard keyboard could be connected to a 6821 PIA; all peripheral lines would be set up as inputs, and would float 'high' in the absence of a key depression. Polling the keyboard in this case, therefore, amounts to the following sequence: read the ORA and ORB registers, invert the values, and test for a non-zero value to detect a key depression. If no key is depressed, the control routine can either perform some other task which may require service, or start the polling sequence again; the sequence used in the PE Microcontroller is shown in the last issue. The subsequent action taken in the event of a key depression is discussed later.

Software polling of the keyboard is simple and requires the minimum of additional hardware. It does, however, require the control program to be continually looking at the keyboard to determine whether or not a key has been depressed. The interval between polls can be used to perform any necessary processing to respond to a keyboard

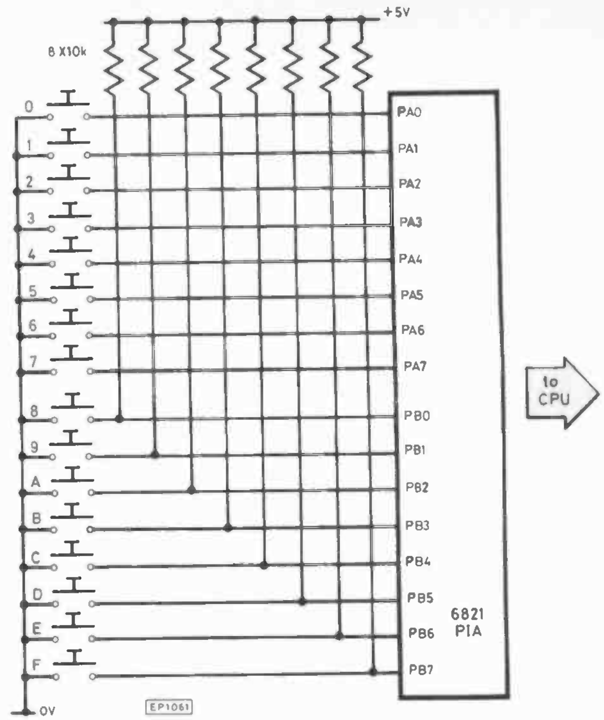


Fig. 7. Simple key array configured for software polling.

command, but the time taken to implement this can vary, thus producing varying intervals between polls; this should not be a problem unless a significant amount of processing (say, more than 200 msec) is performed. The technique does have the advantage that the keyboard is automatically 'locked-out' whenever a previous entry is being processed.

The alternative to software polling is to use an interrupt-driven approach. This requires some additional hardware which will generate a logic signal whenever a key is depressed. This can then be used to drive the user interrupt request line on the processor. Thus an interrupt will be generated whenever a key is depressed, and the control program will be freed of the requirement to constantly scan the keyboard. Fig. 8 shows how a matrix keyboard could be arranged to generate an interrupt whenever a key is

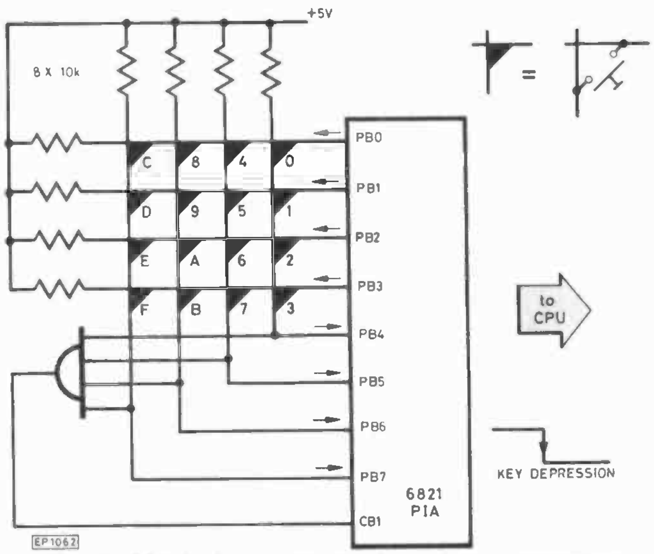


Fig. 8. Matrix key array configured for generating interrupts

depressed. In this circuit, it is assumed that the 6821 PIA is arranged with four I/O lines configured as inputs, and four as outputs. For the simple interrupt logic shown, the lines configured as outputs must be left in the 'low' state when not in the interrupt service routine, and the input lines will float 'high'. The interrupt logic simply looks for one of the inputs to be pulled 'low' by a key depression, and the AND gate will then generate a high-to-low interrupt request to the PIA.

The interrupt driven keyboard driver will require an interrupt service routine to handle the keyboard interrupt. Users of the PE Microcontroller should place the address of this routine in RAM locations 03DC (MS byte) and 03DD (LS byte), rather than the locations defined for the 6800 by the manufacturer, because DISBUG uses an indirect software vectoring technique. The service routine should then simply be written as a subroutine, since DISBUG hides many of the details of interrupt handling from the user. Further details will be found in the series of Microcontroller datasheets which start this month in *PE*.

So far we have seen how a key depression may be detected, and the next step is to determine which key (or was it keys?) was pressed. In general this process involves identifying the position of the key in the keyboard switch array, and then converting the position of the key into an internal code for use by the rest of the control program. This latter step is necessary in order to allow a compact representation of the key identity (e.g. a simple 4-bit code may be used to represent 16 keys), and to optimise the performance of the rest of the control software (e.g. using Ø to F to represent the keys Ø to F can save literally hundreds of lines of code). An added benefit of performing this code conversion is that, if the key layout is changed at a later stage, only the code conversion routine need be changed rather than all the control routines which process the key entries. First of all, however, the key pressed must be found in the switch array.

IDENTIFICATION OF KEY DEPRESSIONS

Identifying a key for the standard keyboard shown in Fig. 7 is quite a simple problem. First, the PIA ORA is read into, say, rA and then inverted; rA will then have a bit set to '1' for each key depressed. If rA is tested and found to be non-zero, then the key pressed is in the range '0' to '7'. The key may then be identified by performing a logic shift right and testing the carry bit until it is set; the number of shift operations should be counted, and will give a result in the range 1 to 8. If the inverted value read from ORA was zero, then the key depressed must be in the range '8' to 'F'. To identify this key, read ORB, invert it, test for a non-zero value (if the inverted values of ORA and ORB are both zero, then no key has been depressed), and the shift-and-test-carry should be repeated. In this case, however, the count of the number of shifts should start at 8, rather than zero. The shift count when a bit is found will be in the range 9 to 10 (hex), and will correspond to the keys '8' to 'F', respectively. The number of shift operations will indicate the identity of the first key found, or will be zero if no key is found, and will thus be a number in the range 00 to 10 (hex).

Converting from the key identity, in terms of number of shift operations, into an internal key code is a straightforward operation for a standard keyboard. The simplest way is to use a look-up table. The table is a list of key codes organised so that the first code corresponds to 'no key found', the second to '0', the third to '1', etc. The appropriate key code is then found by setting the index register to point to the start of the table, and using the shift count as an offset into this table. Thus, for example, a count of 7 indicates that the key pressed was the '6', and that its code will be found at table start + 7. The conversion routine will then pick up the code and return it as the identity of the key to the command processing routine.

Identifying key depressions for the matrix keyboard shown in Fig. 8 must be done with user interrupts disabled (which happens automatically when an interrupt service routine is entered after a key depression), otherwise the identification process itself may generate further, unwanted, interrupts. The basic principle for indentifying the key depressed is to select each output line (PBO to PB3) in turn, and see if any key on this line (e.g. '0', '4', '8' or 'C' on PBO) has been pressed. At the start of the routine, as mentioned earlier, all output lines will be set low. Reading the input lines from PB4 to PB7 should show that the top four bits of ORB are not all high if a key is depressed; this should be the first step in the key identification. Assuming that at least one of the input lines are low, the next step is to identify which key is down; no keys down means that the interrupt was either spurious, or for some other peripheral, and the keyboard routine should be exited.

Each of the output lines are selected in turn until one of the input lines goes low. Remembering that the circuit uses active low logic, this selection is done by output of FE, FD, FB and F7 to ORB in turn until the value read back from ORB has a value other than F in the top four bits. If the key depressed was 'A', the value output to the bottom four bits to locate the key would have to be B, and the value in the top four bits read back from the PIA would be also B. The situation at this point is that we have an output value of FE, FD, FB or FD, at which a key depression was detected, and an input value corresponding to the key depression. Only the four least significant bits of the output value, and the four most significant bits of the input value are of interest. First of all, however, the input value must be checked to remove any multiple-key values, otherwise the code conversion routine will fail. The best way to do this is to perform a bit test on each of the top four bits of the input value in turn, stopping at the first bit set to zero, and forcing all of the rest high (with an OR instruction). When this has been done, a composite key code can be formed, with the 4 least significant bits of the output value in the least significant half of the composite, and the 4 most significant bits of the input value in the upper half of the composite.

The conversion of the composite key code to the internal key code used by the rest of the software is best performed using a look-up table again. A typical table, for the circuit in Fig. 8 and the same codes used for the standard keyboard, would contain the following values in consecutive locations:

EE, 00, ED, 01, EB, 02, E7, 03, DE, 04, DD, 05, DB, 06, D7, 07, BE, 08, BD, 09, BB, 0A, B7, 0B, 7E, 0C, 7D, 0D, 7B, 0E, 77, 0F

This table contains pairs of values; each pair is the composite key code, followed by the internal key code. The conversion is performed by first setting the index register to point to the start of the table. The composite code is then compared with the contents of the location indicated by the index register. If it is equal, the contents of the location pointed to by the index register plus one are loaded into the key code store, and the conversion routine exited. Otherwise, the index register is incremented by TWO, and the process repeated until either a match is obtained, or the end of the table (checked separately) is reached.

This table-based conversion technique is by no means the only way to convert from a key position related value to an internal representation. Other techniques may be used which will be more efficient with particular hardware configurations. The table-driven method is, however, applicable to all conversion problems, and it represents the most flexible and easily modified technique.

KEY DEBOUNCING

The problem of switch bounce applies to keyboards as much as to individual switches. The techniques for handling the problem are broadly similar. Hardware debouncing, however, is usually applied to complete keyboards, rather than to individual keys, and is therefore only usually found on completely decoded keyboards. In control applications, therefore, where fully decoded keyboards are the exception rather than the rule, software debouncing is most commonly employed.

The method of applying software debounce to a keyboard is usually embodied in the keyboard driver routine. The principle is to perform the key identification process twice, separated by typically 20 milliseconds, and then compare the results. Only if the result is the same on the two iterations is a valid code passed on to the command processor, otherwise the results of the two passes through the identification routine are ignored. The 20 millisecond delay is most easily implemented as a software delay loop; typically 2000 times round a short loop will give the required delay.

NEXT MONTH: The next part of the Into the Real World series will concentrate on the problems of handling analogue signals. Practical applications will be given for digital-to-analogue and analogue-to-digital conversion interfaces using low-cost conversion components.

Future issues will continue with the discussion of problems with using micros in the real world. Opto-isolators, glitch removal, pulse stretching and multiplexed display driving will be among the topics covered.

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SHIRA STEREO amp 20 x 20. £9. Holdway, Flat 9, No. 10 Westwood Road, Portswood, Southampton, Hants.

ORGAN Grosvenor Spinet, kit built, two manuals, pedals, playable, needs slight attention £150 o.n.o. Buyer collects. 07842 58878 (Middlesex).

ZX81 SINCLAIR built, 16K RAM. Complete with leads p.s.u. manual £65. Unmarked, months old. Tel: 0206 62597. M. H. Moody.

BOUGHT in error. 30 npn + pnp. Includes equivalents—2N1132, 2N2905A, BC207, BC177B, BC171, BC172B, BC178. £2.00. Mr. A. Cooper, Broomside, Logger Heads, Market Drayton, Salop TF9 4NZ (Tel: Ashley 2634).

TEXAN amp PE FM Tuner WW Dolby unit, Mullard amp units unused, offers. Tel: Blackpool 691976. S. Rigby.

SINCLAIR ZX81 ROM disassembly Part 'A' by Doctor Ian Logan (book) much sought after only £6. Laurence Cook, 7 Plum Tree Close, Prescot, Merseyside L35 7JT. Tel: 051 426 5138.

UK101, 8K, Invaders, assembler manual, leads, uncased, £80.00 or £95.00 with 32 x 48 screen format, 300/600 Baud. K. P. Wood, 35 Milnthorpe Drive, Wakefield, W. Yorks WF2 7HU. Wakefield (0924) 256100.

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WANTED 500V Megger. Tel: 085 677 279. G. Grieve, Makerhouse, Dounby, Orkney.

TELEQUIPMENT/dual beam oscilloscope v.g.c. £100 o.n.o. Sumbro Maple neck strat copy £40. Rob McGrath, 471 Rosam Grove, Southgate, Runcorn, Cheshire. Tel: Runcorn 712081 Rob or Ken.

MICROSYNTH: unwanted 4-octave model requires good home. One only. New condition. Fully tested. Unrepeatable bargain £200. A. R. Bradford, 76 Holly Lane, Birmingham B24 9JR. Tel: 021 373 0461.

DOUBLE beam scope by S.E., Labs., mains-batt. 30MHz. 8cm x 10cm c.r.t. £145. Tel: 01 504 6957. Mr. A. Rabicano, 110 Kings Ave, Woodford Green, Essex IG8 0JN.

SAD1024A delay line i.c. two available still in sealed packs £5 each. Somerton 72663 (Evenings).

UK101 32K. Cegmon 32-line, New BASIC 1, 2, 4, 5, tool kit. 1-2MHz 300-600 Baud, sound, parallel ports, software. £240. R. G. C. Asher. 125 Hawthorne Ave, Long Eaton, Nottingham. Tel: 06076 66593.

INCOTERM v.d.u. K26-02 keyboard D10-24 pcb's for sale. D. J. Herries, 3 Court Garden, Marlow, Bucks SL7 2AE. Tel: 06284 5978.

ACORN Atom 8K ROM 12K RAM p.s.u. leads £150. Salisbury 332491. M. Beard, 6 Aston Mead, Salisbury.

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PE BAZAAR FEBRUARY '83

SEMICONDUCTOR UPDATE

R.W.Coles

FEATURING Am 7910, LC502, Micro/J-11

MODEM CHIP

Sending microcomputer data over short distances is easy, thanks to RS232 or current-loop standards and the easy availability of UARTs and PIAs which do all the hard work for you. But what if you want to exchange PAC-MAN programs with your granny in Edinburgh? Or access a bigger computer in Dallas, Texas? Short of laying your own cable (not recommended!) there is only one solution, and that is to use the telephone network.

Don't try connecting RS232 data to your telephone, though, because a) it won't work, and b) you will end up with a mushroom cloud over your UART! The trouble is, RS232 signals need d.c. links with logic states represented by positive and negative voltages. The phone system, however, is essentially an a.c. system with the only d.c. voltages being provided and controlled by your local exchange.

To send data on the telephone system it must appear to be similar to speech, and one way of achieving this is to code the ones and zeros as different audio tones within the audio bandwidth of the network. This technique is in wide use, but unfortunately it requires the use of a modem (modulator/demodulator) at each end of the link, and old age pensions being what they are, granny probably couldn't afford one.

Modems have, however, become cheaper lately, especially the acoustic coupled variety which uses the standard telephone microphone and earpiece to couple into the network, but the cost of the necessary oscillators filters and detectors with all those inductors, capacitors, and OP-AMPs is still preventing most of the home computer fraternity from indulging.

But never fear! Your fearless columnist, friend of all PAC-MAN playing grannies, has news of a new device which should bring the cost of modems tumbling! The Am 7910 single chip modem subsystem from Advanced Micro Devices sweeps away the need for all those old-fashioned inductors and capacitors and replaces them with nice modern digital circuits. Hook the RS232 signals from your micro to one set of pins, add a few discrete components, wire up to your acoustic-coupler and hey presto! The world is your oyster.

Inside the Am 7910's 28 pin package is an amazing selection of goodies. On the transmit side, it takes the RS232 digits and uses them to control a digital sine wave synthesiser which after filtering drives a digital to analogue converter (DAC) and a post analogue filter before being fed out to the telephone coupler as a Frequency Shift Keyed (FSK) tone sequence. On the receive side, the tones from the coupler are analogue prefiltered, digitised in an ADC and then separated by means of a digital filter before demodulation and RS232 output.

In addition to those basic features, the Am 7910 also has amazing flexibility. The world is a real "tower of Babel" as far as modem frequencies and data rates are concerned, but the Am 7910 can be switched to handle nine different modem standards, which would not have been possible for the older analogue systems. For remote data collection, the Am 7910 even has an automatic-answer capability so you could dial up your home from a call box using an acoustic coupler and get back data on all those exciting household parameters like the gas meter reading or the oven temperature. Beats string and tin cans, doesn't it?

EASY AS A.G.C.

Many audio systems face the problem of wildly fluctuating input levels, and a Canadian firm called Linear Technology Incorporated has just come up with a neat little Automatic Gain Control (AGC) circuit to help solve it. Usable in hearing aids, telephone systems, CB transceivers, and portable tape recorders, their new LC502 device can live in an 8 pin mini d.i.p. or a tiny flat-pack and will operate on supplies of between 1 and 10 volts thanks to a built in 0·94 volt regulator.

Providing up to 70dB of gain control range, the LC502 tries to keep its output signal level at a constant 20 millivolts r.m.s. regardless of variations in the input signal amplitude due to speaker position or loudness.

The user can set any nominal gain for the circuit of between −6dB and +64dB by means of an external resistor and the LC502 will adjust its gain automatically down to the −6dB limit as the input signal level increases. Inside the chip there is an inverting operational amplifier with an electronically variable resistance in its feedback path, and a full wave detector with a smoothing circuit. As the input signal level increases, the d.c. output voltage from the detector also increases and this is used to control the variable feedback resistance which in turn reduces the gain of the circuit.

For obvious reasons, two important parameters of any AGC system are the attack and release times. The LC502 settles to within 2dB of final value within one millisecond after a 25dB input step, and release time can be adjusted to between 25 and 500 milliseconds. The noise performance, whilst not of hi-fi standard, is perfectly adequate for the sort of applications in which the LC502 will be used.

An added bonus is that the input circuitry of the device is designed for direct connection to an f.e.t. buffered electret microphone.

MICRO MONSTER

A short while ago I covered the new DEC "PDP11-on-a-chip" T-11 microprocessor which is now becoming available. I was more than impressed by that device, but now DEC have done it again by announcing a new device coded the Micro/J-11 which can actually outperform the most powerful of all their existing PDP 11s, the 11/70. Now, the 11/70 is a big expensive machine, and the prospect of someone putting the CPU of such a monster into a single 60 pin package has never really occurred to me. If I pass on a few of its salient features you will see what I mean!

The J-11 contains two sets of six 16 bit general purpose registers plus six 64 bit floating point arithmetic registers plus three stack pointers and several specials. It runs on a 20MHz clock and can do a 16 bit register addition in 200 nanoseconds or a 16 bit multiply in 4·4 microseconds. An on-chip memory management unit gives 22 bit addressing to cover 4 megabytes of memory at 128K bytes per page, and the internal data bus is 32 bits wide for a really sizzling performance. This amazing device even runs its own diagnostic programs when power is applied, and reports its state of health to the system interface!

There's lots more, but we haven't got the space. As a parting shot I will just mention that despite all that raw power the J-11 consumes only 1 watt from a 5 volt supply which is less than many 8 bit devices!

To take advantage of such a monster, it will be necessary to add buckets of memory and plenty of disk storage, but no doubt before long we will all have one in our electric toaster and think nothing of it. Ah well, that's progress!

AVAILABILITY

Devices featured in Semiconductor Update should, under normal circumstances, be available from good component retailers, but bear in mind that retailers will often not receive stocks of a device until some time after it has been featured in Update.

INDUSTRY NOTEBOOK

By Nexus

THEMES

All public speakers have favourite themes they like to promote. Leading industrialists are no exception, and although they may open with words suitable to the occasion and use a few topical jokes you can bet they'll work in their pet thought, their main message, before they sit down.

When Dr F. E. Jones was managing director of Mullard, he seldom missed an opportunity to inform his audience of the facts of industrial life. All Mullard had was a handful of sand (silicon) and a few other basic raw materials. Everything after depended on human invention and human skills diligently applied to transform such unlikely stuff into valves, TV picture tubes and semiconductors. His message was 'added value', the difference between raw material cost, entering at one end of the factory, and the sales value of what left at the other end.

This added value, Jones would continue, was the only true measure of wealth generated and it was this wealth which was needed to support the big spenders in health, education and welfare services. Of course he was right but he did rather keep on about it. He needed to when addressing those to whom simple truths, honestly expressed, are anathema, such as progressives who find private enterprise distasteful, profit practically obscene and business success somewhat immoral. Unhappily he was talking to the deaf. They didn't want to know and since his days at Mullard, a new generation of progressives still cling to the same prejudices.

SIR E. HARRISON

More recently Sir Ernest Harrison had the opportunity to air his 'no magic formula' theory, to explain the success of the Racal Electronics Group. This came up yet again when he accepted the Business Enterprise Award 1982. His pet theme is people, his own team of Racal people, all 12,500 of them who believe in Britain and in themselves, the finest team in the world. He was saying this when Racal had a couple of thousand people and has been saying it ever since, and with absolute sincerity.

Harrison, like Jones, is also keenly aware of added value (i.e. high productivity) but employs an oblique approach. He points out, with justifiable pride, that exports per UK head of his employees has reached £21,000, more than three times the average for the whole of Britain's manufacturing industry.

I can add a figure or two of my own. In the last ten years Racal's world-wide turnover has multiplied by a factor of 30, while the number of Racal people has grown only by a factor of six. This tells us something about Racal, something about technological advance and something about general unemployment.

PEOPLE

Sir Ernest's belief in people is well-founded, but I think he is being too modest. My own observation is that management style as well as competence is the key to success.

I remember as a keen one-time motorcyclist my reverence for the BMW machine and the consequent shock of learning that they were assembled not, as I had imagined, by skilled German craftsmen but by a largely ex-patriate Turkish workforce. The machines nevertheless, remained immaculate.

And why, one wonders, has Japanese discipline and dedication to the work ethic been not only accepted but even welcomed in industrial South Wales by a workforce which hitherto has not been known for acquiescence in new patterns of work.

I commented on this phenomenon a couple of years ago but had over-looked further developments. Some 6,000 people are now employed by eight Japanese companies in South Wales and all appear to be prospering. The one common factor is that all have single union agreements which largely eliminate squabbles over who does what. Compare this with factories with a dozen unions, a multiplicity of shop stewards and constant friction over demarcation. In the one case unity of purpose, in the other potential chaos.

JAPANESE STYLE

True that at least some of the Japanese-style managements prefer to recruit shop-floor operatives straight from school, uncontaminated by bad practices. The difficulty of finding a job probably helps in recruits accepting a high standard of discipline and total involvement, and reports suggest that this leads to contentment rather than the reverse. Staff turnover, always a problem in a largely female electronic assembly shop, has declined since the pioneer companies came into the area six years or so ago, setting standards for work practices which then appeared to be difficult to enforce. The Japanese invasion, one is tempted to say revolution, in South Wales is good for the area, good for the people and no doubt good for the Japanese.

Now what about Racal people? The Decca electronics interests bought by Racal were doing badly at the time. Today they are again successful, and yet the workforce is composed of substantially, if not entirely, the same people as before.

Of course people and their individual qualities are important at all levels of employment but without leadership and direction their abilities and talents remain undeveloped, even willingness to work undermined.

In military circles there is a saying that there are no bad troops, only bad officers. Could it not be that General Sir Ernest Harrison is an inspired leader of his Racal Regiments in attacking world markets? That his shock troops down to the lowest ranks have the confidence in themselves only because of their own confidence and trust in a leadership that has never let them down?

OUTLOOK

1982 proved a dramatic year at home and overseas. Now in the first weeks of a new year it is even more difficult to project the future. We have yet to get the feel of a new regime in the Kremlin. With so many countries on the brink of bankruptcy it seems unlikely that the world recession will improve, if ever. Wars and rumours of war continue, both economic and military. Political warfare too, with a hard fought election at home in prospect.

The electronics industry is still good news. Even television broadcasting, with all its triviality, has brought benefits. Channel 4 resulted in millions of pounds of new equipment which still runs into this year with extensions to the transmitter network. Breakfast TV will also bring in revenue from hardware, maintenance and re-equipment.

PROSPECTS

On the ground we have the start-up of the Mercury data network, the prospect of cable TV and or cellular mobile radio. In the air the US space shuttle has opened up new possibilities in deployment of communications, scientific and defence satellites.

The home computer market has taken off to the extent that I read somewhere that one clever young man in the business could be worth £100 million by the end of the year. Equally, he might lose it. And apparently Gatwick No 2 Terminal will generate a lot of extra telecommunications business.

Companies like Cable & Wireless, GEC, Plessey, Racal, Ferranti and the aerospace companies will all have record turnovers, record profits and hopefully an increase in people employed. The news is not all bad, opportunities are there to be seized. One might say there are no bad times, only bad businesses.

If this is not true how does one account for the entrepreneurs who become millionaires last year in the hard grip of recession. Dick Skipworth of Memec, said now to be worth £10 million at the age of 44, or Alan Sugar running Amstrad in 'consumer electronics', almost universally regarded by others as a disaster area. Or the founders of Micro Consultants up in the million bracket and the founders of Continental Microwave who have nearly reached the magic million. It's not only the big companies who make money. The little 'uns can do very nicely, too.

THE use of side lights or dipped headlights during twilight conditions is now considered mandatory and can be instrumental in reducing both the frequency and severity of road accidents. Unfortunately many drivers often do not recognise the onset of twilight conditions soon enough; their eyes become gradually accustomed to the progressive reduction in ambient light level. The point at which the lights are eventually switched on is then too late; being simply too dark for safe driving without lights.

The unit described provides the driver with both audible and visual warnings of inadequate ambient light level. The threshold is adjustable over a fairly wide range and the alarm action is quite positive. The unit automatically resets when the light level returns to a safe level. The device uses readily available low cost components and can be easily and quickly fitted to any vehicle.

CIRCUIT DESCRIPTION

The light sensitive transducer, IC1, produces an output of +5V when illuminated and 0V when in darkness. The switching threshold of the device is made adjustable by means of VR1 and its supply voltage is regulated with the aid of a simple shunt Zener diode, D1. The output of IC1 is inverted by means of TR1 and then applied to the reset input of a 555 timer, IC2, which is connected in an astable configuration.

The astable provides an output at approximately 1Hz and this is applied to the l.e.d., D2, via an appropriate series resistor, R7. The low frequency square wave output is also connected to a second 555 astable, IC3. This stage operates at approximately 1·2kHz and its output is taken via coupling capacitor, C5, to a miniature loudspeaker.

The unit is protected against inadvertent reverse connection of the supply by means of D3. C1 and C6 provide decoupling of the supply voltage rail.

COMPONENTS

Resistors

R1	10k
R2	10k
R3	270
R4	2k2
R5	10k
R6	47k
R7	1k
R8	10k
R9	1k

All fixed resistors are 0·25W 5% carbon

Capacitors

C1	100μ 16V p.c. electrolytic
C2	100n polyester
C3	22μ 25V axial electrolytic
C4	100n polyester
C5	220n polyester
C6	100μ 16V p.c. electrolytic

Semiconductors

TR1	BC548
D1	BZY88C4V7
D2	Red l.e.d.
D3	1N4002
IC1	5VLAS
IC2	555
IC3	555

Potentiometer

VR1 100k minimum horizontal skeleton pre-set

Miscellaneous

Miniature loudspeaker or earpiece (see text)
Case
8-pin DIL i.c. sockets (2 required)
0·1in matrix Veroboard (17 holes x 28 tracks)
Terminal pins
Grommet
L.e.d. mounting clips (2 required)

Provides audible and visual warning of an inadequate light level

Twilight WARNING

MICHAEL TOOLEY B.A.
DAVID WHITFIELD M.A. M.Sc.

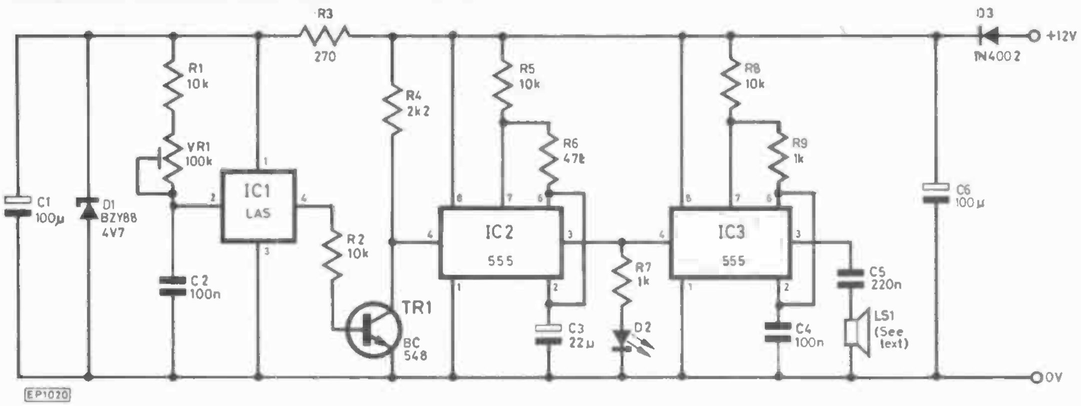


Fig. 1 Circuit of Twilight Warning Indicator

CONSTRUCTION

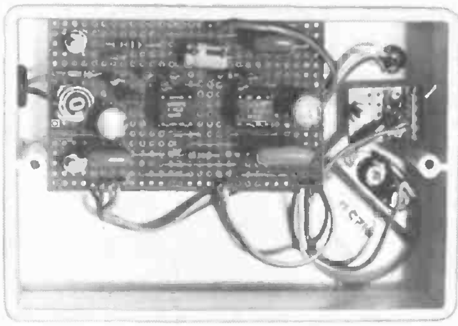
The components are assembled on a small piece of 0·1in matrix Veroboard measuring approximately 70mm x 43mm. as shown in Fig. 2. Terminal pins should be employed for interconnection of the circuit board with the case mounted components.

When assembly is complete, the top side of the board should be examined for correct placement and orientation of components whilst the underside should be inspected for dry joints and solder bridges between tracks. Breaks in the tracks should be made using either a proprietary spot face cutter or with the aid of a small sharp drill.

The circuit board should be mounted in the base of the plastic case using two small stand-off pillars. Interconnections from the board to the case mounted components are made using short lengths of insulated wire.

The transducer used for the alarm output of the alarm can be a conventional loudspeaker, and earpiece, or even a standard telephone insert. The nominal impedance of such a unit can be anywhere in the range 8 ohm to 10 kilohm. Most small transistor radio loudspeakers will produce more than ample volume and the value of the coupling capacitor, C5, may be altered to increase or decrease the sound level accordingly.

The light activated switch i.c. is most conveniently mounted on a separate small piece of Veroboard which may be secured to the upper surface of the case by means of a single nut, bolt and stand-off pillar. The four interconnections to the i.c. are best made using a short length of four-way ribbon cable. To improve the external appearance of the finished unit, the light activated switch i.c. may be fitted with



a standard l.e.d. clip and, furthermore, it is recommended that the device be recessed (by means of an appropriate length of stand-off pillar) so that its upper surface is flush with the surface of the l.e.d. bezel. Such an arrangement not only offers a measure of protection for the i.c. but also restricts the angle over which incident light is received.

INSTALLATION AND ADJUSTMENT

Adjustment of the twilight indicator is best carried out with the unit fitted to the vehicle. Suitable locations for the alarm module include the rear parcel shelf and the front dashboard. The unit should be positioned so that the light sensitive transducer is positioned upwards facing the windscreen or rear window. The acceptance angle of the transducer is fairly wide and can, if desired, be narrowed by means of a short extension tube bonded to the mounting clip. Such a tube should, of course, be sprayed matt black.

The threshold control, VR1, should be adjusted so that the alarm operates at the onset of twilight. The alarm may be cancelled, if desired, by interrupting the supply using a single pole single throw miniature toggle switch. Automatic cancellation of the alarm when the side lights are on can be achieved simply by wiring a 10 kilohm resistor from the side light circuit to the base of TR1. ★

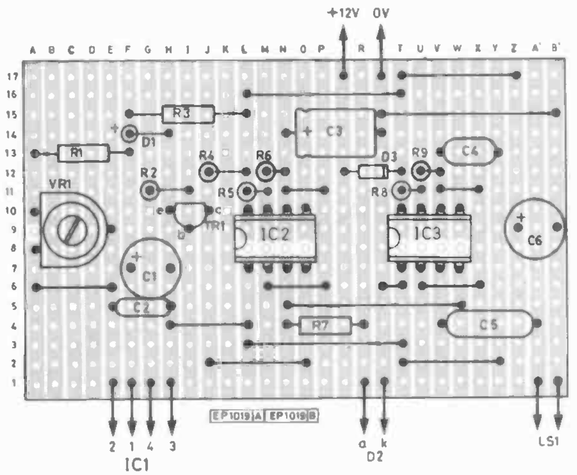
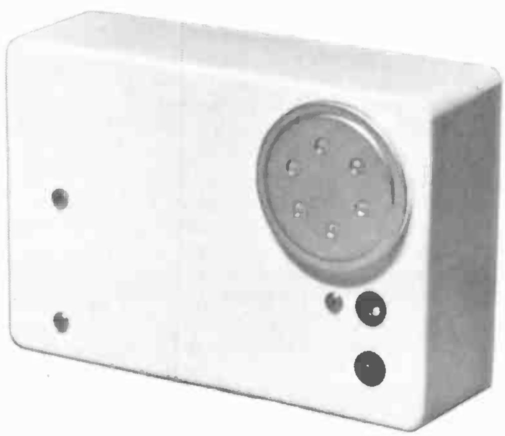


Fig. 2 Veroboard assembly details



Patents Review

Copies of Patents can be obtained from:
the Patents Office Sales, St. Mary Cray, Orpington, Kent. Price £1·60 each.

NO NOISE

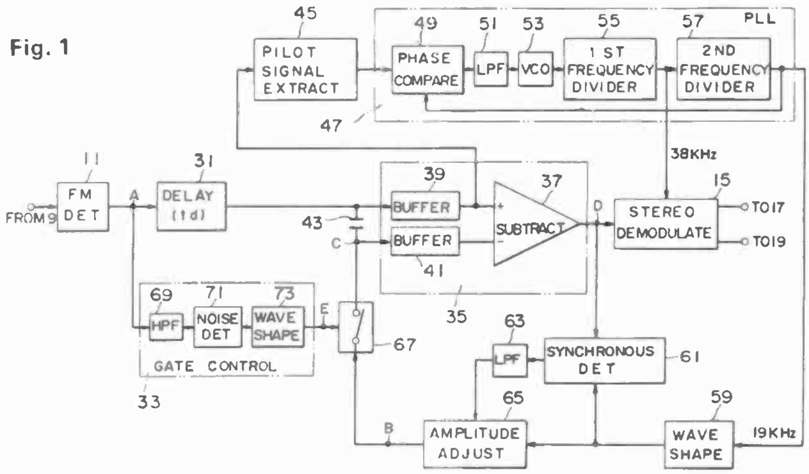
Sanyo, of Osaka city in Japan, has filed a European patent application 0 056 464 on a circuit for removing pulsive noise interference from a radio signal.

Fig. 1 shows the basic idea. FM detector 11 outputs a stereo composite signal to delay circuit 31 and gate control 33. The delayed composite signal is applied to one input of a subtracting circuit 37 via emitter-follower buffer circuit 41. Capacitor 43 bridges to the other input of circuit 35 via another buffer. The subtracted output goes to stereo demodulator 15.

The delayed composite signal also goes to pilot tone extractor 45 which produces a reference signal for a conventional phase lock loop 47, which produces signals at 19kHz and 38kHz. A cancel signal is derived at 65 and fed back to the subtract circuit. Gate 67 is controlled by circuit 33 which has a high pass filter 69, noise detector 71 and shaper 73.

When there is no pulsive noise or interference in the composite signal, gate control circuit 33 produces no pulse and gate 67 conducts. So the cancel signal from circuit 65 goes via gate 67 to one input of subtractor 35, while the other input receives the delayed composite. When there is pulsive noise on the composite it is detected at 71 and gate 67 switched. So the composite and pulsive noise is applied to both inputs of subtract circuit 37. The pulsive noise is removed and the stereo pilot signal cancelled. The lengthy patent gives a detailed breakdown of a convoluted series of events which brings this about.

Fig. 1



It's worth noting in passing that while in Japan recently, visiting JVC, I heard the demonstration of a very new prototype pulsive noise suppressor. This removes interference spikes from an audio waveform and disguises their removal by replacing missing parts of the waveform by extrapolation. No details were available, but it seems likely that the technique used is a spin-off from error concealment in digital audio reproduction, where too many bits are missing for error correction to be possible. The JVC circuit, which works on any audio signal (whether from radio, gramophone or tape recorder) points the way to the future. Circuits like that described in the Sanyo patent are suitable only for FM stereo radio use.

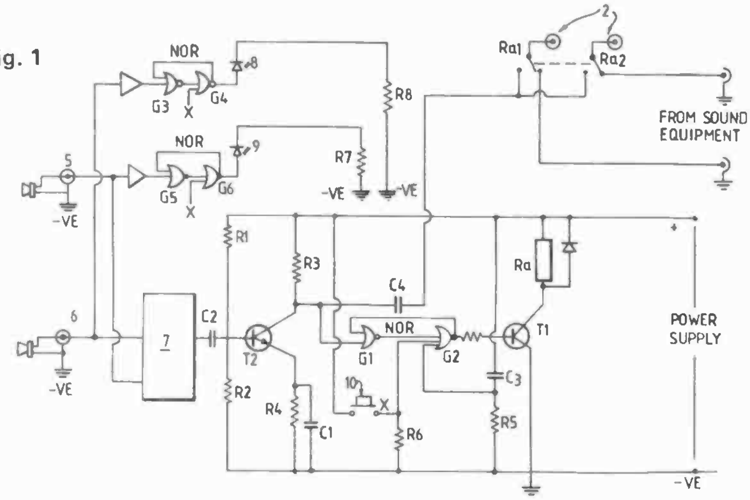
HEADPHONE WARNING

Michael Pears of Leamington Spa, Warwickshire has filed a British patent application 2 093 242 on a warning system which tells anyone wearing headphones when the telephone or doorbell is ringing. The headphones plug into the hi-fi via the warning device, and the microphones are put near the doorbell and telephone.

Fig. 1 shows how the microphones 5, 6 trip the circuit and switch relay Ra to control the headphones. When there is no signal from microphones 5 & 6 transistor T2 is switched on, via resistors R1, R2. The collector voltage of T2 is too low to switch NOR gate G1.

When either or both of the microphones picks up a sound signal, T2 receives a signal via capacitor C2,. This switches it at a rate determined by the frequency of the audio input from the microphone. While T2 is momentarily non-conductive, its collector voltage rises to switch gate G1. Gate G2 now has signals at its inputs and switches T1 to operate relay R2. Gates G1, G2 latch on with feedback and the headphones are disconnected from the hi-fi, and switched to receive the sound from the microphones. So the listener suddenly stops hearing music and hears the door or telephone bell instead. Re-set button 10 puts the system back to normal for music listening.

Fig. 1



There is also a modified time sensitive circuit in which the ringing current is rectified and stored in a capacitor until a threshold value has been built up. In this way brief false alarm sounds cannot trigger the system.

ELECTROVALUE

- 24 HOUR NORMAL DESPATCH TIME
- ESTABLISHED 1965
- ALL GOODS GUARANTEED BRAND NEW AND TO SPECIFICATION
- APPOINTED SIEMENS DISTRIBUTORS

I.Cs – DIGITAL & ANALOGUE

DIGITAL

74LS

74LS00	11	74LS161	37	7413	18	74157	30
74LS02	11	74LS163	38	7414	20	74190	48
74LS04	12	74LS164	43	7420	15	74192	48
74LS05	12	74LS165	60	7430	14	74193	48
74LS08	12	74LS166	90	7440	14	74393	95
74LS10	12	74LS173	55	7442	32	**CMOS**	
74LS11	12	74LS174	45	7443	60	4000	10
74LS14	30	74LS175	40	7444	60	4001	10
74LS20	12	74LS191	50	7447	36	4002	12
74LS30	12	74LS193	40	7448	40	4006	50
74LS32	14	74LS195	39	7450	14	4007	14
74LS37	14	74LS196	48	7451	14	4008	40
74LS38	15	74LS197	60	7453	14	4009	24
74LS42	28	74LS221	51	7454	14	4010	24
74LS47	56	74LS240	55	7460	14	4011	12
74LS51	14	74LS241	55	7470	24	4012	15
74LS73	18	74LS242	75	7472	26	4013	20
74LS74	18	74LS243	75	7473	26	4014	46
74LS75	22	74LS244	60	7474	23	4015	40
74LS76	19	74LS245	85	7475	32	4016	20
74LS85	48	74LS251	55	7476	30	4017	35
74LS86	20	74LS253	43	7480	35	4018	45
74LS90	27	74LS257	35	7482	65	4019	25
74LS92	32	74LS259	84	7483	38	4020	42
74LS93	24	74LS266	28	7485	60	4021	40
74LS107	40	74LS273	60	7486	20	4022	35
74LS112	22	74LS279	40	7489	159	4023	14
74LS123	38	74LS299	250	7490	28	4024	32
74LS125	29	74LS367	34	7491	35	4025	14
74LS126	27	74LS368	24	7492	25	4026	80
74LS132	40	74LS373	84	7493	25	4027	20
74LS136	25	74LS374	68	7494	36	4028	39
74LS137	110	74LS378	60	7495	36	4029	45
74LS138	30	74LS393	60	7496	40	4030	16
74LS139	35	**7400**		74100	80	4041	40
74LS145	70	7400	11	74104	40	4042	40
74LS148	89	7401	11	74107	22	4043	40
74LS151	40	7402	12	74121	24	4044	40
74LS153	40	7403	12	74123	40	4046	46
74LS153	40	7404	13	74125	34	4049	23
74LS155	38	7405	15	74126	33	4050	23
74LS156	35	7406	20	74141	51	4060	45
74LS157	30	7407	20	74151	40	4069	14
		7408	14	74154	60	4070	14
		7409	14	74155	39	4071	14
		7410	14	74156	40	4072	14

4081	14
4082	14
4093	20
4510	46
4511	46
4511	120
4516	53
4518	40
4520	60
4543	120
4583	130

All above prices are NET and shown in pence

ANALOGUE

709C5	49	LM382N	115	TAB1041W	187
709C14	44	LM3900N	50	TBA120AS	62
723C14	36	LM3914N	200	TBA120U	72
741C5	57	LM3915N	200	TBA400	100N
741C8	18	NE555V	23	TBA800	75
741C14	47	NE556A	45	TBA10S	75
747C14	65	NE567N	104	TBA820	75
748C8	35	RC4151NB	80	TBB1458	62
1458C5	62	S041E	290	TBB1458B	40
1458C14	40	S041P	121	TCA105	120
7106	450N	S042E	364	TCA105B	108
7107	500N	S042P	138	TCA105G	140
555	23	S89	11.23	TCA250A	185
7555	86	S178B	31.00	TCA205K	200
556	45	S187	13.28	TCA335A	66
CA3046	78	S566B	214	TCA345A	109
CA3080E	86	S576A	235	TCA345W	177
CA3130E	99	S576B	235	TCA671	131
CA3140E	55	S576C	235	TCA780	211
LM301AN	26	S576D	225	TCA871	114
LM308N	60	S1469	468	TCA955	228
LM317K	321	SAB0600	302	TCA965	136
LM324N	45	SAB3209	497	TCA965K	170
LM348N	65	SAB3210	311	TCA971	92
LM380N	75	SAB3211	168	TCA991	80
LM380N8	104	SAB3271	329	TCA991K	100
LM381N	145	SAB4209	497	TDA2002	120
		SAB8256C	35.40	TDA2003	126
		SAD1024	15.50	TDA2030	150
		SAJ131	238	TDA4050B	144
		SAJ141	224	TDA4290	169
		SAJ205	810	TDA4600	184
		SAS231W	260	TDA4700A	546
		SAS251	142	TDA4713A	436
		SAS580	196	TFA1001W	252
		SAS590	196	TL071CP	45
		SDA5680A	15.56	TL072CP	75
		TAA761	104	TL074CN	120
		TAA761A	49	TL081CP	46
		TAA765A	62	UAA170	165
		TAA861	103	UAA170L	152
		TAA865A	59	UAA180	165
		TAA2761A	72	UAA190	141
		TAA4761A	113	XR2206	520
		TAA4765A	120	ZN414	85
				ZN424P	99
				ZN425E	360

CRYSTALS

(in MHz)

		4.433	128
0.032768	102	4.915	157
0.100000	453	5.000	157
1.000	453	5.026	128
1.8432	320	6.000	157
2.000	268	6.144	157
2.4576	268	6.5536	128
3.2768	188	8.000	1.88
3.579	128	8.867	128
4.000	102	10.000	157
4.194	128	18.432	188

ZENER DIODES

400mW/2.7-30V	7p
1-3W/3.3-100V	15p
20W/7.5-75V	£1.98

CONNECTORS

DIN AUDIO

Pins	plug	skt
2	8p	8p
3	14p	8p
4	18p	14p
5 (180°)	17p	11p
5 (240°)	20p	8p
6	16p	20p
7	19p	30p

JACK PLUGS SKTS
MONO ¼"
chrome P1 53p 34p 42p
plastic P2 32p 14p 20p
STEREO ¼"
chrome P3 81p 52p
plastic P4 60p 15p 20p
Mono 3.5mm 10p 14p
Stereo 73p 42p

D SERIES

	Plug	skt	hood
9	78p	104p	92p
15	108p	140p	96p
25	141p	206p	110p
37	190p	298p	122p

IDC Connectors DIL
14 way 103p
16 way 117p
24 way 170p
40 way 261p

PARALLEL TYPE

		Plug	Skt
2	8 way	132	184
2	10 way	225	205
2	13 way	270	258
2	17 way	333	299
2	20 way	382	318

Plugs have retainers. Sockets have strain relief.

IC Sockets

Pins	each	25 for
8	8p	1.80N
14	12p	2.40N
16	14p	2.80N
18	16p	2.30N
20	18p	3.80N
22	21p	4.20N
24	21p	4.20N
28	22p	4.40N
40	30p	6.00N

TERMINALS
[illegible] 15A [illegible] 24
S14 4mm socket 12
P14 4mm plug 10
Wander plugs & sockets red/black/green ea 14
PC Mounting terminal [illegible]
2 way [illegible] 4 way 33p 8 way 49p 8 way 46p 10 way 62p 12 way [illegible]
QUICK TEST
Mains connector block [illegible]

Very wide range of many other types in stock – see latest price list.

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

1/63	10	1000/10	19
2.2/25	13	1000/16	26
2.2/63	10	1000/25	36
4.7/63	11	1000/40	44
4.7/100	14	1000/63	76
6.8/40	10	2200/6	09
10/6	13	2200/16	44
10/25	10	2200/25	
10/40	11	2200/40	73
10/63	14	4700/16	72
10/100	15	4700/25	90
22/10	10		
22/25	11		
22/40	14	**TANTALUM BEARS**	
22/63	15		
22/100	16	0.1/35	13
47/3	03	0.22/35	13
47/10	11	0.47/35	13
47/25	12	1.0/35	13
47/40	15	2.2/16	13
47/63	17	2.2/35	16
47/100	18	4.7/16	16
100/3	03	4.7/35	18
100/10	13	6.8/16	16
100/16	14	6.8/25	24
100/25	15	10/6.3	16
100/40	15	10/16	18
100/63	20	10/25	18
100/100	27	22/6.3	18
220/10	16	22/16	30
220/16	16	22/25	30
220/25	18	33/6.3	24
220/40	20	33/10	30
220/28	28	47/6.3	30
220/100	42	100/10	80
470/10	19	For full ranges of very many other types please see Cat 82 and/or current price list.	
470/16	19		
470/25	19		
470/40	27		
470/63	45		
470/100	73		

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		
72	47	25	21024	51p
120	50	35	21390	83p
180	110	55	21391	151p

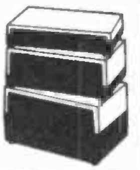
G RANGE professional instrument Cases

134	90	44	21089	£7.28N
224	140	64	21090	£11.02N
302	170	84	21091	£14.96N

VEROBOX CASES

to give a completely professional finish to a much valued project.
ABS, light grey top; dark grey bottom + 2 anodised panels

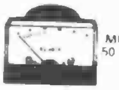
L	D	H	TYPE	PRICE
205	140	40	21034	£4.52
205	140	75	21035	£5.02
205	140	110	21036	£6.54
180	120	39	21037	£4.11
180	120	65	21038	£4.40
180	120	90	21039	£4.69
155	85	39	21040	£3.31
155	85	60	21041	£3.31
155	85	80	21042	£4.30
125	65	30	21047	£2.36
125	65	39	21048	£2.99
125	65	50	21049	£3.37



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.

T Range 60 × 45mm £5.96



MU Range 50 × 45mm £2.68

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

1N914	03	2N3819	22	AA118	14	BD146	30N
1N914B	10	2N3820	40	AA119	13	BD226	45N
1N916	06	3823	60N	AC126	25	B1906	38
1N4007	06	2N3904	15	AC127	25	BA379	25
1N4148	03	2N3906	15	AC128	25	BAS40-03	38
1N5402	14	2N4036	46	AC151R	56	BAS70-03	41
1N5407	18	2N4058-62	09	AC153K	20	BAT14-036	11.75
2N697	23	2N4124	25	AC176	25	BB409	33
2N706	18	2N4126	25	ACY17	156	BC107A,B	16
2N930	20	2N4284	30	ACY18	120	BC108A,B,C	16
2N1132	23	2N4286	15	ACY19	99	BC109B,C	18
2N1302	110	2N4289	23	ACY20	90	BC121W	30N
2N1303	58	2N4291	24	ACY21	85	BC122Y	100
2N1304	82	2N4292	21	ACY39	170	BC125	20
2N1305	82	2N4991	82	ACY41	10	BC125	20
2N1306	90	2N5062	34	AD136	530	BC140	30
2N1307	87	2N5192	110	AD142	90	BC141	30
2N1308	147	2N5195	106	AD149	88	BC147A	10
2N1309	99	2N5457	32	AD161	35	BC149	10
2N1599	100	2N5458	32	AD162	35	BC154	25
2N1613	25	2N5459	38	AF114	37	BC160	30
2N1711	25	2N6050	380	AF115	37	BC161	30
2N1893	32	2N6057	376	AF116	57	BC167A	09
2N2218A	31	6F40	152	AF117	110	BC167B	09
2N2219A	25	16F40	185	AF124 AF125	37	BC168A	09
2N2222A	25	40HF40	226	AF126	37	BC168B	09
2N2369A	21	40361DIS		AF127	37	BC169B	09
2N2484	25	40362	65	AF200	10	BC169C	09
2N2646	46	40406	71	AF239	114	BC177B	16
2N2904	25	40408	95	AF279	30	BC178B	16
2N2904A	25	40412	108	AFY12	204N	BC179B	18
2N2905A	25	40430	100	AFY16	327N	BC182	09
2N3053	23	40594	123	AFY180	310N	BC182L	09
2N3054	55	40595	123	AFY18E	615N	BC183	09
2N3055	48	40636	147	AFY42	461N	BC183L	09
2N3405	64	40673	146	AU106	240	BC184	09
2N3663	15	A9903	16	AU111	(use	BC184L	09
3702-11	08	AA113	13	AU1161		BC202Y	120
2N3771	180	AA116	13	AUY22	10.96	BC212	09
2N3794	21	AA117	13	BD140	25N	BC212L	09
						BC213	09
						BC213L	09

BC214	09	BFR39-41	23	E1210	76
BC214L	09	BFR79-81	23	E2506	154
BC238C	09	BFT65	119	EB383	20
BC239C	09	BFT66	192	MJ2955	90
BC258B	09	BFX29	24	MJE340	56
BC267B	16	BFX84	24	MJE2955	95
BC300	26	BFX85	24	MJE3055	70
BC301	24	BFX87	28	MPF102	40
BC303	30	BFX88	26	MPS6531	40
BC327	16	BFY50	24	MPS6534	42
BC328	11	BFY51	24	MPSA12	36
BC337	14	BFY52	24	MPSA63	38
BC338	11	BFY90	143	NAS206S5	81
BC413	09	BR34	70	OA47	12
BC414	09	BR64	110	OA90	10
BC477	29	BRY39	45	OA91	10
BC546	10	BSX20	22	OA95	DIS
BC547	09	BSX26	22	OA202	14
BC548	09	BSX63	769N	OC28	75
BC549	09	BT106	147	OC29	75
BC550	10	BT108	136	OC35	75
BC556	10	BU105	170	OC36	90
BC557	09	BU124	85	OC84	25
BC558	09	BU208	180	PM7A2	373
BC559	09	BUX26	350N	PN70	10
BC560	10	BUX28	545	PN72	05
BC879	38	BUX81	744	Q4006LT	104
BC880	43	BUX85	249	Q4010LT	115
BCY31A	157	BUZ10A	478	Q4025H	450
BCY58	18	BUZ15	12.27	T2700D	189
BCY70	18	BUZ20	523	T2800D	104
BCY71	18	BUZ23	787	TAG3-400	100
BCY72	18	BUZ24	12.50	TAG209-400	85
BD130	46N	BUZ32	625	TAG209-600	
BD131	48	BUZ33	844		130
BD132	48	BUZ41A	637	TIC106D	48
BD135	27	BUZ44A	9.67	TIC106M	55
BD136	27	BUZ45	12.76	TIC126D	64
BD139	30	BUZ48	18.94	TIC206D	54
BD140	32	BUZ50A	763	TIC226D	61
BD644	42N	BUZ54A	21.43	TIC236D	96
BD679	62	BUZ80	739	TIC246D	105
BD680	64	BUZ83	11.29	TIP31A	36
BF115	35	BUZ83A	11.96	TIP32A	36
BF167	25	BUZ84A	12.75	TIP41A	45
BF173	25	BY164	48	TIP41C	60
BF177	25	C106D1	45	TIP42A	46
BF178	25	C0326	460N4	TIP42C	60
BF244B	40	C0340	490N4	TIP150	75
BF254	14	C407	17	TIP2955	56
BF255	14	C0546	126N1	TIP3055	55
BF420	31	C762	40	TIS43	50
BF421	34	C1406	77	U763	50
BF457	35	D4 clip	for	VN10KM	55
BF458	35	C1406	and	VN46AF	93
BF459	35	E2506	10	VN66AF	105
BF597	12N	D1046	88	VN88AF	123
BFR34A	84	E1110	76	W02	25

RF Chokes

1, 1.1, 4.7, 10, 47μH ea 42p. 100, 22μH 54p. 470μH, 1mH 73p.

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

5V filament
3015F 8 mA 256
3015F 15 mA 256

KNOBS black plastic
K1 skirted with spot 16
K2 as K1, 35mm 21
K3 pointer 15
K7 19 mm knurled 23
K8 as K7 + skirt 23

LED's
5mm red 10
yellow 19
green 16
Mountings, B65 3

RECHARGEABLE CELLS
AA 99p C 227p D (4AH) 376p PP3 cell (7-2V) PP3 charger 495N 410

CHARGERS FOR ABOVE
for any two pairs AA, C or D No NC1230 820N

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

BUZZERS
6-15V solid state 70

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 34p 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
Plessey 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 £5.30N; CSBP £5.45N; XSBP £5.56N; ST4 Stand £1.70N
ORYX 50 watt temp. controlled £13.75N
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 3POT £1.64; S7203 DPDT 96p; Push Button min. 8531 make/8533 break 62p; 8225 DPDT £1.34.
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Michael Tooley B.A.

radio BOOSTER

David Whitfield M.A. M.Sc.

Improves signal level and reduces r.f.i. in radio reception

MANY lower-cost car radio receivers fail to provide satisfactory reception of weaker signals. Whilst this may be of little concern to the motorist who wishes to listen mainly to the BBC Radio Four transmission on long wave and perhaps also one or two local stations, those who are a little more adventurous in their listening habits will derive considerable benefit from enhanced receiver performance.

Many of the problems associated with poor receiver sensitivity can be readily overcome by providing the receiver with a larger input signal. This will considerably improve reception; not only is the signal "louder and clearer" but the effects of ignition interference and miscellaneous noise generated by the engine can be greatly reduced.

The radio Booster described not only provides some 10dB, or so, of additional signal gain, but also improves the efficiency of the aerial matching. The unit offers two separate inputs; one for low and mid-frequencies (100kHz to 3MHz) and one for high and very high-frequencies (3MHz to 120MHz). These inputs exhibit appropriate impedances for matching typical car aerials intended for MW/LW and VHF reception respectively. The result is a properly matched wideband preamplifier system which will be more than adequate for the reception of all but the weakest signals.

The unit is simple to construct, uses only one integrated circuit and one field effect transistor, and requires no alignment or internal modification to the existing receiver.

CIRCUIT DESCRIPTION

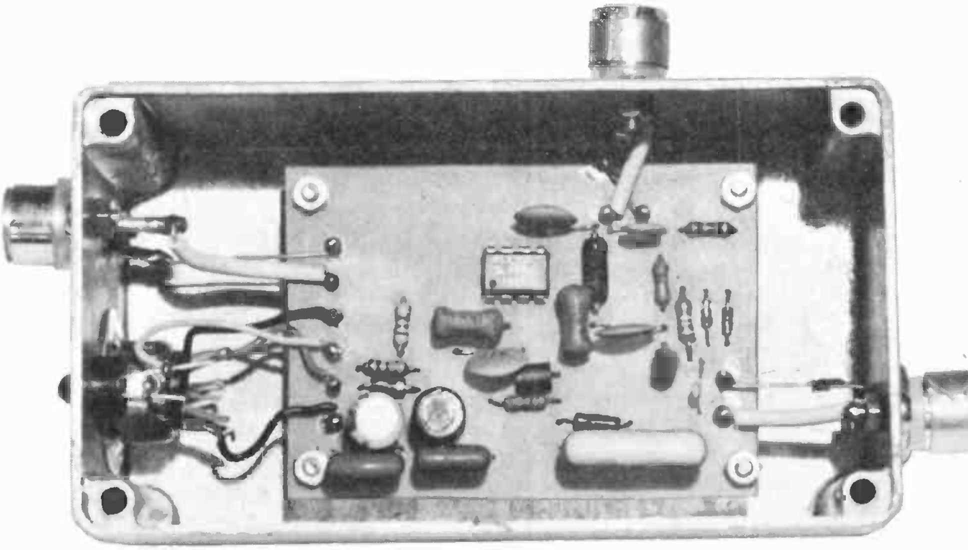
The complete circuit diagram of the radio Booster is shown in Fig. 1. The LF/MF aerial is connected to the high impedance input at SK1. Silicon switching diodes, D1 and D2, provide input protection for TR1 which operates as a source follower in order to buffer the relatively low input impedance of IC1. The HF/VHF aerial is connected to the low impedance input at SK2. Simple frequency compensation is provided by L1, C3 and R3. This network improves stability and assists with the duplexing of the LF/MF and HF/VHF inputs.

IC1 is a fixed gain broadband RF amplifier. This device provides a nominal voltage gain of 10 with an upper frequency 3dB point of typically 140 MHz. Ferrite bead, L2, and capacitor, C5, provide efficient supply decoupling at VHF whilst C11 and C7 decouple the supply at other frequencies. A simple shunt Zener stabiliser, D3, regulates the supply at approximately 6V. The π network provided by L3, C8 and C9 reduces supply-borne ignition and electrical noise to a minimum whilst C10 reduces generator whine. Reverse supply protection is provided by D5 and the presence of the supply is indicated by l.e.d. D4.

CONSTRUCTION

The radio Booster is built using a single-sided p.c.b., the copper foil layout of which is shown in Fig. 2. The layout is quite critical, particularly if good VHF performance is to be maintained, and thus no other form of construction should be attempted.

IC1 should preferably not be fitted with a holder and all other components should be fitted with the minimum lead length. Components are most conveniently fitted in the following order; terminal pins, resistors, capacitors, inductors, diodes, transistor, and integrated circuit. Care should be taken to ensure correct polarity of the electrolytic capacitors, diodes, transistor, and integrated circuit. The p.c.b. component layout is shown in Fig. 3.



The assembled Booster

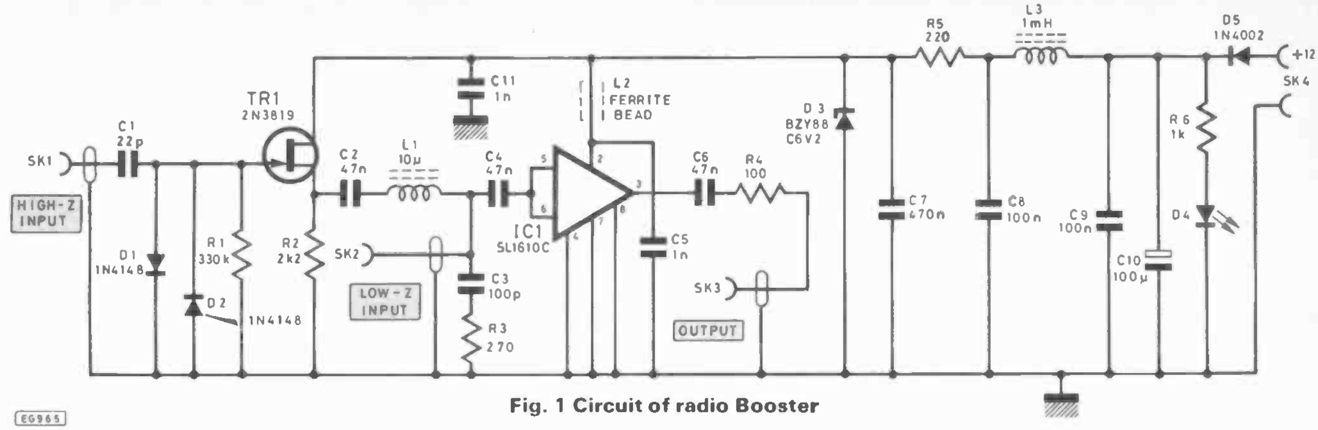


Fig. 1 Circuit of radio Booster

Once complete, both sides of the p.c.b. should be carefully checked. The foil side should be examined for dry joints and solder bridges between tracks. The component side should be checked for correct placement and orientation of components. The p.c.b. should then be mounted into the diecast case using four short stand-off pillars. Note that, to minimise stray pick-up of electrical noise, the use of a screened metal case is absolutely essential.

Wiring from the p.c.b. to the case-mounted components should follow the layout shown in Fig. 4. Note that the 0V connection is made at three separate points, each being a solder tag secured by one of the two retaining nuts of each input socket. Care should be taken to ensure that the polarity of the l.e.d. D4, is correctly observed. A standard 5-pin 180° DIN socket is used for power input; the positive connection being taken to pin 1 whilst the negative connection is taken to pin 3. Constructors may, of course, substitute a different power connector, or pin convention, to suit their own preference.

INITIAL TESTS AND INSTALLATION

Connect the output socket, SK3, to the aerial input of the car receiver using a length of either 75 ohm or 50 ohm coaxial cable terminated with suitable connectors. The length of this cable is not critical.

The radio Booster should, ideally, be located as close to the aerial as is practicable, however, this arrangement may be difficult to realise particularly if the aerial is roof mounted. In any event, the feeder run from the aerial to the Booster should not exceed about 2 metres in length and must be routed well away from any vehicle component which produces a significant amount of electrical noise (eg: wiper motors). The cable used for this run should be the feeder which was originally supplied with the aerial, suitably cut short. It should not be 50 ohm or 75 ohm cable.

Connect a VHF rod aerial to SK2 using a short length of 50 ohm or 75 ohm cable. If only one aerial is to be used for the reception of both LW/MW and VHF, this should be connected to SK2 and not SK1. If VHF reception is not required, the MW/LW aerial should be connected to SK1 and SK2 should be left disconnected. The use of an appropriate base-loaded antenna is recommended for short wave listening in the HF broadcast and amateur bands. Such an aerial should be connected to SK2 via an appropriate length of 50 ohm cable. If an aerial tuning unit is to be employed, this should be connected beween the HF aerial and SK2, taking care to observe adequate screening and earth connections.

Connect SK4 to the vehicle's 12V power source using any convenient length of cable and connecting point. The cable should be routed well away from the aerials and vehicle ignition system. Check that D4 is illuminated. If this is not the case, check the polarity of the supply connections, D5, and the l.e.d. itelf. The voltage developed across D3 may also be checked and this should be approximately 6V.

Tune the receiver across the desired band and note the improvement in signal strength. Note that, unless the receiver has a signal strength indicator, little effect will be noticed on signals which are already strong enough to actuate the receiver's automatic gain control system. Weaker signals, which may not have been audible before, should be greatly improved. A quick check can be made by reverting back to the original aerial system without the radio Booster connected in circuit. If ignition interference is a problem, the diecast case of the Booster should be earthed to the chassis of the vehicle. The earth connection at the aerial end of the input cable should also be checked.

Fig. 2 Copper foil layout

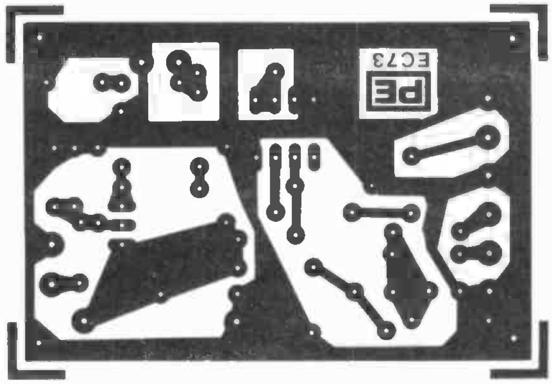
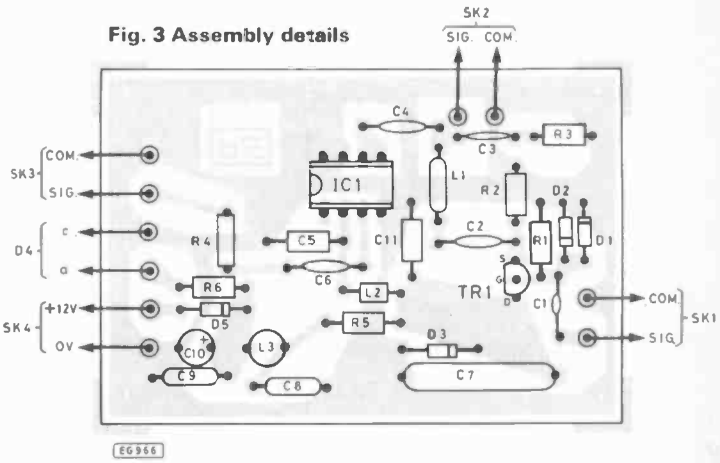


Fig. 3 Assembly details



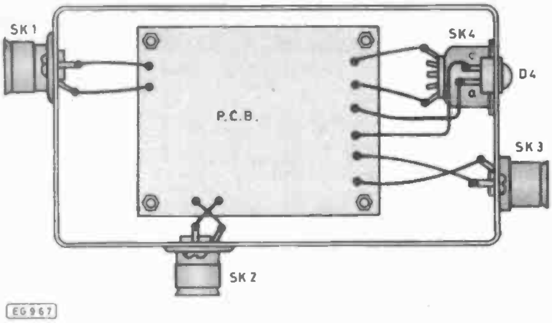
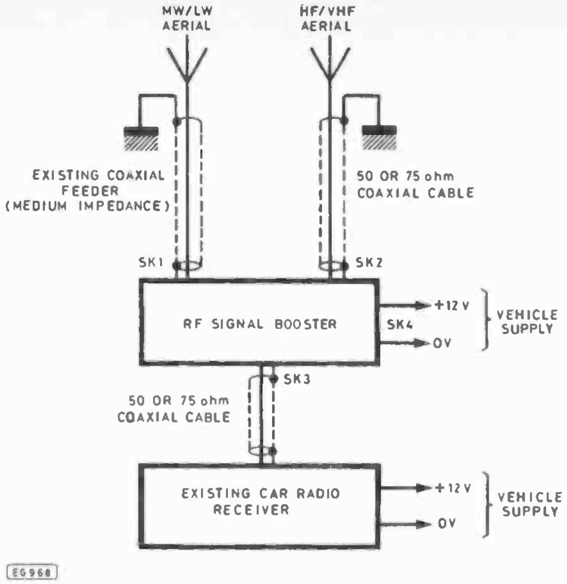


Fig. 4 (above) Internal wiring diagram of the printed circuit board to the external sockets

Fig. 5 (right) Interconnecting diagram for MW/LW and HF/VHF aerials. If only one aerial is to be used for MW/LW and VHF this should be connected to SK2



COMPONENTS

Resistors

R1	330k
R2	2·2k
R3	270
R4	100
R5	220
R6	1k

All resistors are $\frac{1}{4}$W 5% carbon

Semiconductors

D1	1N4148
D2	1N4148
D3	BZY88 C6V2
D4	Red l.e.d.
TR1	2N3819
IC1	SL1610C

Capacitors

C1	22p
C2	47n
C3	100p
C4	47n
C5	1n ceramic
C6	47n
C7	470n polyester
C8	100n polyester
C9	100n polyester
C10	100µ 16V p.c. mounting electrolytic
C11	1n ceramic

Inductors

L1	10µH
L2	Ferrite bead
L3	1mH

Miscellaneous

SK1 Standard Belling Lee coaxial socket
SK2 Standard Belling Lee coaxial socket
SK3 Standard Belling Lee coaxial socket
SK4 3- or 5-pin 180° DIN socket
p.c.b.
Stand-off pillars (4 off)
Diecast case
Terminal pins

Components and p.c.b. are available from **Howard Associates, 59 Oatlands Avenue, Weybridge, Surrey, KT13 9SU.**

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SINCLAIR SC110 scope x 1x 10 probe, mains adaptor, Nicads, manual, case. Pristine, £100. Tel: 0553 86 618. Mr. S. V. Windebank, 36 Springvale, Gayton, Kings Lynn, Norfolk PE32 1QZ.

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WANTED ZX80 any condition. Tel: Cork 021 821766. Denis M. Mahony, 12 Meadowbrook, Riverstown, Co. Cork, Eire.

PRACTICAL Electronics Nov. 1964 Vol. 1 No. 1 to Oct. 1966 Vol 2 No. 10 , offers please. L. V. Westmoreland, Endeavour Hayton Smeath, Retford, Notts DN22 9JT.

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PE MICROCONTROLLER: DATA SHEET 1

THIS is the first single-page data sheet in a series for users of the PE Microcontroller. The aim is to provide some more detailed information on the operation of the DISBUG monitor to assist the development of user control programs. Where appropriate, more detailed data on the hardware will also be included.

DISBUG RAM LOCATIONS

The memory locations at the top of the RAM region are reserved for use by DISBUG. Locations 03A0 up to 03FF are used by the monitor program to record the current status of the monitor, to hold the addresses of various service routines, to record the results of various monitor routines, and for a variety of 'housekeeping' purposes. An understanding of the routines in DISBUG requires a knowledge of the structure of this RAM region, which is shown below. The mnemonic names are also shown to simplify reference to locations in future data sheets. It should be noted that some of the values are stored in two bytes of memory, e.g. PF1SRA.

DISPLAY	STATDIS	03FF	Status code/prompt
		03FE	MS address digit
		03FD	Address digit
		03FC	Address digit
	ADDDIS	03FB	LS address digit
	SEPDIS	03FA	Separator character
		03F9	MS data digit
	DATADIS	03F8	LS data digit
KEYBOARD	KEYFLAG	03F7	Key found in 1st scan
	KEYADD	03F6	1st scan key address
	KEYCD	03F5	Current key code
COMMAND PROC	KEYACT	03F4	Key active flag
	PF1SRA	03F2	PF1 } service routine
	PF2SRA	03F0	PF2 } start address
	CCM	03EF	Current command mode
	CSW	03EE	Command status word
	CAS	03EC	Current address store
	CDS	03EB	Current data store
	IXTEMP	03E9	Index register store
PRESET EDITOR	PLAS	03E7	Preset lower address
	PUAS	03E5	Preset upper address
	PDS	03E4	Preset data store
RTC	TICK	03E2	Seconds count
INTERRUPTS	NMISRA	03E0	NMI service routine
	SWISRA	03DE	Reserved
	IRQSRA	03DC	IRQ service routine
CPU STATUS	RA	03DB	Current rA value
	RB	03DA	Current rB value
	IN	03D8	Current In value
	SP	03D6	Current SP value
	PC	03D4	Current PC value
	CCR	03D3	Current CCr value
BREAKPOINTS	BP0A	03D1	BP0 address store
	BP0I	03D0	BP0 instruction
	BP1A	03CE	BP1 address store
	BP1I	03CD	BP1 instruction
	BP2A	03CB	BP2 address store
	BP2I	03CA	BP2 instruction
	BP3A	03C8	BP3 address store
	BP3I	03C7	BP3 instruction
	CBPS	03C6	Current breakpoint
VARIOUS	UMRSA	03C4	User monitor routine
	CRS	03C3	Current register
	VARS	03BF	Variable storage
	DSTACK	03BE	Top of DISBUG stack
	USTACK	03A0	Top of user stack

KEYBOARD SCAN ROUTINE

The Microcontroller keyboard is scanned by a subroutine called KEYBOARD, which also includes a 20 millisecond debounce routine. The routine assumes that the keyboard PIA has been correctly set up by the DISBUG initialisation routine (which is executed automatically at power-up), and it uses a maximum of four bytes of stack space. The scan routine is called by 'JSR KEYBOARD', which is coded as BD F8 2C. There are no entry parameters, but the routine corrupts all registers except SP. On exit, rB will contain a reply code of: '01'=valid key found; '00'=no key found; 'FF'=uncertain result (differing results from the two key scans). The location (key address in the matrix in an internal code) of the first key found depressed in the first scan will be found in rA; this will only be valid for a reply code of '01'. The KEYADD store will be equal to the contents of rA, and KEYFLAG will be set to 'FF' if a key was found on the first scan, or to '00' if no key was found on the first scan.

KEYBOARD CODE CONVERTER

The address in the key matrix produced by the KEYBOARD routine is converted into the appropriate DISBUG key code by a subroutine called KEYCODE. This will normally only be called if the reply code from KEYBOARD was '01'; the routine will, however, correctly handle a reply code of '00'. The conversion routine is called by 'JSR KEYCODE', which is coded as BD F8 77, and the maximum stack usage to be allowed for is 2 bytes. On entry to the routine, rA should contain the key address from the KEYBOARD routine, and rB should contain a '00' or '01' reply code from KEYBOARD. The KEYCODE routine corrupts all registers except SP, and on return the key code is contained in rA, and also in RAM location KEYCD. The table below shows the correspondence between keys, key addresses and key codes to be expected in DISBUG, and should allow readers to use these routines in their own control programs. **(M.T. & D.W.)**

KEY	ADDRESS	CODE	KEY	ADDRESS	CODE
0	00	00	REGISTER	33	10
1	10	01	BREAKPOINT	23	11
2	11	02	PRESET	13	12
3	12	03	MEMORY	03	13
4	20	04	PF1	35	14
5	21	05	RESTART	17	15
6	22	06	PROCEED	27	16
7	30	07	GO	37	17
8	31	08	PF2	25	18
9	32	09	ENTER	01	19
A	42	0A	NEXT	06	1A
B	43	0B	PRIOR	07	1B
C	44	0C	CANCEL	05	1C
D	64	0D	*	16	1D
E	63	0E	#	40	1E
F	41	0F	(Shift)	54	1F

Key Code of FF=No key pressed

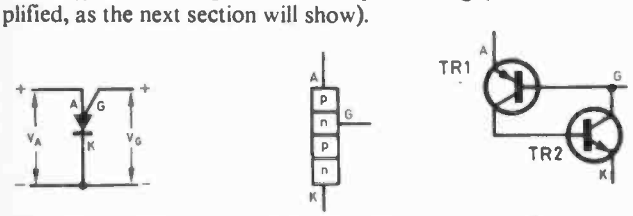
PROGRAMMABLE UNIJUNCTION TRANSISTORS

P. GATEHOUSE

IN this article I shall attempt to do justice to a device which has arrived quietly amongst all the magnificent i.c.s we keep devouring. Programmable Unijunction Transistor (PUT) circuits have proved reliable and sturdy solutions to situations in which I would have placed an i.c. and I hope to convince you that a few PUTs are a useful investment.

THE DEVICE

The circuit symbol (Fig. 1) for the PUT is that of the SCR, but with the gate at the other end. Essentially that's all a PUT is; a "complementary" SCR triggered not by a pulse positive with respect to the cathode, but by a pulse negative with respect to the anode. However, unlike SCRs, the holding (valley point) current is determined by conditions at the gate. Fig. 1 shows a transistor circuit equivalent to the PUT; when $V_G = V_A$, TR1 is biased off and no current flows through the be junction of TR2 so that stays off. As V_G becomes negative with respect to V_A, a current (later I_G) flows through TR1's base allowing it to pass current to the base of TR2 which is negative with respect to V_A. Now that TR2 is biased on it proceeds to increase the eb current of TR1 further, and the circuit conducts current from A to K until V_A is made negative with respect to V_G (this is oversimplified, as the next section will show).



PUT CIRCUT SYMBOL

SEMICONDUCTOR STRUCTURE

TRANSISTOR EQUIVALENT

EG1036

FIG. 1.

PUTs are not high-power devices. Anode currents are of the order of a hundred milliamps maximum, and the anode-cathode breakdown voltage is around $\pm 50V$ for the devices mentioned in this article.

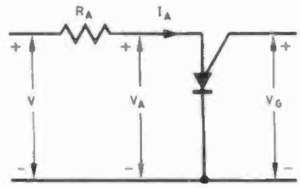
The only PUT widely available is the 2N6027, a general-purpose specimen, with the 2N6028 (for timer applications in particular) not unheard of. An alternative is the BRY39 silicon controlled switch which has leads connected to all four regions (Fig. 1) so you can't go wrong! Leave the cathode gate unconnected and you have a PUT.

ELECTRICAL CHARACTERISTICS

The anode voltage V_A of the PUT in Fig. 2 is plotted against the current flowing through the anode terminal, I_A in Fig. 3. This is not the usual characteristic, which is current against voltage, but for the PUT Fig. 3 is more useful.

In section NO of the curve, $V_A < V_G$ so only a leakage current flows out of the anode: $I_A = I_L$ (which is negative). This is of the order of 0·1mA maximum at high temperatures, and decreases to about 10nA at room temperature. Except in long-delay timer circuits it is negligible. At O, the anode and gate are equipotential so its not surprising that $I_A = 0$, anode-cathode leakage being all but immeasurable.

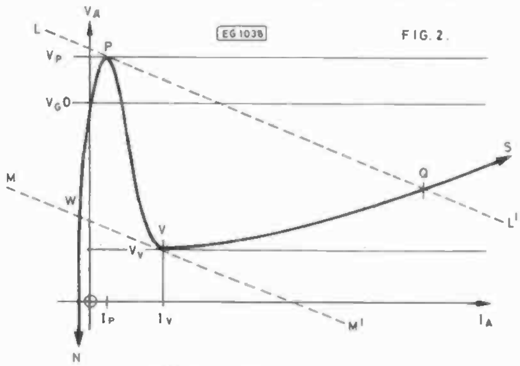
When V_A exceeds V_G by the earlier explanation, the AK circuit is thrown into conduction. The characteristic shows that the PUT still refuses to conduct until P, at V_A about 0·5V greater than V_G, the anode current at P, I_P, being a few µA. V_A at this peak on the graph is termed the peak point voltage, V_P, and the corresponding anode current, the peak point current I_P. The difference $V_P–V_G$ is known as the offset voltage V_T and is due almost entirely to the BE voltage required to pass a current through TR1. V_T is approximately 0·5V and decreases slightly with increasing temperature. Now the programmability becomes apparent, for V_P depends on V_G which is set by the external circuitry; the voltage at which the PUT switches is under your control, or programmable.



CIRCUIT CONDITIONS FOR FIG. 3

EG1038

FIG. 2.



ANODE CHARACTERISTIC OF PUT

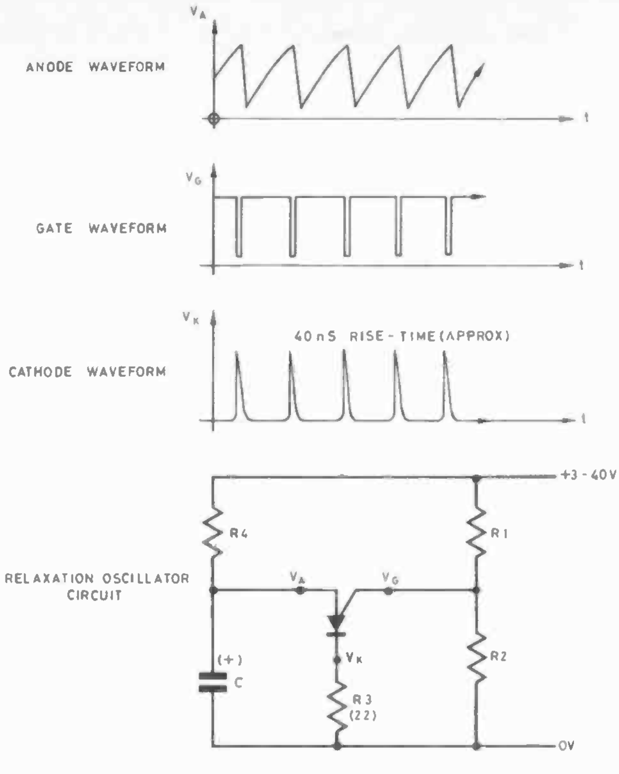
FIG. 3.

EG1037

The switching process is represented by PV on the curve, a "negative resistance" region in that V_A falls as I_A increases. No point on PV is a stable state for the negative gradient simply invites more current to flow. If this current is available, the anode current increases until the PUT is driven past V into saturation. However, if the anode current cannot remain above I_V, or, as a result of the current being $> I_V$, the anode voltage falls below V_V, the PUT returns to a non-conducting state.

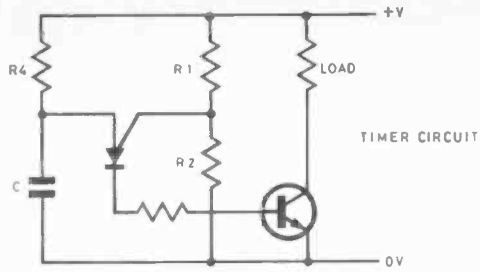
In Fig. 3, this condition is indicated by the load line LL' which is the relation imposed upon V_A and I_A by the anode load resistance R_A when V, which is approximately equal to V_P when $V_A = V_P$, is held constant as the PUT switches on: $V_A = V_P -(I_A–I_P)\ R_A$ simply represents the voltage drop across R_A. Where this line crosses the "on" characteristic are the values of I_A and V_A when the PUT has assumed its new state. As mentioned above, if the anode current is available, Q is on V_S i.e. R_A has a LOW value; the line LL' has a shallow gradient. If R_A were so large as to prevent saturation, LL' would be steeper and Q would be on PV. When a PUT has become saturated and I_A is subsequently reduced below I_V, the load line MM' indicates by the position of W the conditions after the PUT has reverted to the "off" state.

The valley point V is the "holding" current: the value of I_V is dependent upon the gate conditions and is thus programmable as is the peak point voltage. By altering the circuit conditions, the PUT can be used as a latch (driven into saturation and



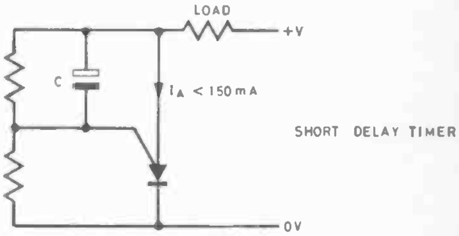
EG1039

FIG.4



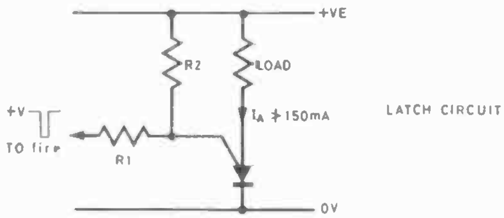
EG1040

FIG.5



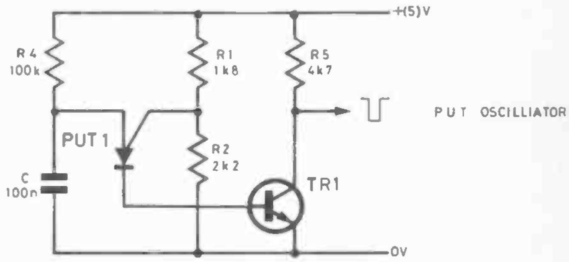
EG1041

FIG.6



EG1042

FIG.7



EG1043

FIG.8

holding the "on" state) or as an oscillator (failing to hold the "on" state). This increased versatility over the UJT is also less expensive for the properties of the UJT are fairly critical; the only apparent disadvantage of the PUT is that its maximum operating frequency is about one fifth that of the UJT—the 2N6027 will not get past approximately 100kHz. The "standoff ratio" frequently encountered in UJT and PUT circuits is another word for the gate voltage V_G : $V_G = \eta \cdot V$ where η is the standoff ratio and V is the supply voltage. It cannot be altered in UJTs unless you make them, but as mentioned before, you are free to select V_G with PUTs.

BASIC APPLICATIONS—RELAXATION OSCILLATOR

This circuit is probably the most simple and reliable relaxation oscillator possible. Fig. 4 shows the general idea and the waveforms seen on a 'scope at the terminals. As C charges through R4 V_A rises. When V_A exceeds V_G the PUT conducts from A to K (depending on the supply voltage you can neglect V_T) and discharges C through R3 which limits the peak discharge current during the pulse seen on V_K. When C is discharged it is vital that R4 is so large that it cannot supply the valley point current I_V of around 50µA depending on R1 and R2. The PUT does not remain saturated if I_A falls below I_V and reverts to the "off" state, allowing C to charge up again. At the gate, V_G is set by the potential, divider R1 and R2 connected across the supply lines; this determines how far C is allowed to charge and thus the frequency of oscillation.

In the conducting state, the PUT draws current from V_G (the gate current I_G) through TR2 in Fig. 1 so do not reduce R1 to below a few hundred ohms. The gate resistors program not only V_G but also control the peak point current and valley point current.

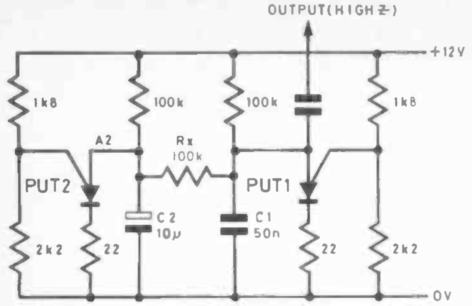
TIMERS

Timer circuits are very similar to the oscillator except the time-constant RC will probably be longer and R4 *is* small enough to supply an adequate holding-current. The leakage current of approximately 10nA must be taken into account when dealing with large time-constants. Once V_A exceeds the PUT gate voltage by V_T, the PUT is saturated by the current through R4 and remains on (Fig. 5).

An alternative employing only the PUT which is probably the simplest timer circuit possible is shown in Fig. 6. This demonstrates a new approach; the gate voltage is gradually reduced as a result of a charging of capacitor C. Here the offset voltage previously neglected is vital to the circuit, for the PUT conducts when the voltage across C reaches V_T i.e. about 0·5V. Low-voltage power supplies are needed for decent delay times with this circuit.

LATCH CIRCUITS

Latch circuits employ the PUT as an SCR triggered by an inverted pulse at the gate (Fig. 7). As soon as V_G falls below +V by more than about 0·5V (V_T again), the PUT "fires" and with an adequate anode current remains on. The circuit is reset either by breaking the anode current circuit at A or K, or by forcing the gate (which will now be less than +V because of the gate current I_G) to +V. R1 and R2 will be needed depending on the exact form the trigger takes; a capacitor could even be used to get the PUT to trigger on any falling edge. Touch switches are not impossible, the PUT is sensitive enough.



PUT SIREN

EG1044

FIG.9

WORKING CIRCUITS—PUT OSCILLATOR

A basic oscillator is shown in Fig. 8. The cathode pulse is very useful as it has a clean, sharp leading-edge and is also fairly powerful as it is the charge of C being dissipated in a much shorter time than it took to build up, TR1 inverts the pulse to provide a yet more powerful pulse to 0V which is very useful as a TTL clock pulse. Resistor R4 can be made variable but use a series resistor to prevent the PUT latching if R4 becomes too small.

If TR1 is replaced by a l.e.d., R5 left out and the time-constant adjusted for the largest possible capacitor, it is safe to exceed the power rating of a l.e.d. in bright flashes. The higher the value of $\frac{1}{2}CV^2$, the more energy per pulse (max. 250μJ—but with a pulse length of around 10–100μS that's over 1W power during a pulse).

PUT SIREN

As with UJTs, relaxation oscillators may be coupled together so that one controls the frequency of oscillation of the other forming a siren (Fig. 9). With C2 charging gradually and the voltage at A2 rising, the charging current supplied to C1 is increased by the larger contribution made through R_X and the time-constant of PUT1 decreased. This cycle repeats, with the frequency of oscillation of PUT1 rising steadily, until PUT2 discharges C2 when the a.f. output returns to the start of the climb.

OPTICAL SENSORS

The PUT is most useful in optical sensor latch configurations for detecting "flashes" of light or darkness. Sensors such as the ORP12 l.d.r. are obvious for Fig. 7. ★

BAZAAR

COMPUTER keyboard suitable for ZX81 £10, swop Heathkit scope for Thandar. Also wanted Wyndsor Vanguard tape recorder. Dave Biddle, 2 Segal Close, Foresthill, London SE23 1PP. Tel: 690 9697.

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I/O PORT for UK101s. 24 lines. Fits J1 socket £7. Nick Hardy, 32 Bentley Grove, Meanwood, Leeds 6. Tel: Leeds 781532.

INCOTERM K26-02 Keyboard for sale £12.00 Harries, 3 Court Garden, Marlow, Bucks. 06284 5978.

EX-COMPUTER p.c.b. 30 transistors 30 CMOS i.c.s one metre 40-way cable plus connectors £2.50 inc. R. J. Smith, 41 Nightingale Road, Selsdon Vale, Croydon, Surrey.

SCOPE probe, 4ft. lead with BNC plug, X1/X10 switch. As new £10. Oxford (0865) 779855. G.B. Dean, 66 Fern Hill Road, Oxford.

HEATHKIT GR78 with manual £40. W. Edwards, 2 Beach Road, Burton Bradstock, Bridport, Dorset DT6 4RF. Tel: 0308 897625.

ACORN Atom 12K + 12K p.s.u. Software inc. Chess plus 12 inch b/w TV set. All for only £215. A. Wilson, 46 Gwydyr Mansions, Holland Road, Hove, Sussex.

WANTED ZX81 assm./kit + accessories in exchange of new components FND-500 531Y 1NY002-7 TTL FY1 etc. Dr. R. Avinery, PO Box 404, Hedera 38TO3, Israel.

32K RAM board + DOC. for UK101 (also for other 6502/680X systems). £50. Nick Hardy, 32 Bentley Grove, Meanwood, Leeds 6. Tel: Leeds 781532.

TANDBERG 3500X $\frac{1}{4}$-track mint (genuinely unused) offers or exch. scope, ZX81, RAM, Printer, keyboard, w.h.y.? Tel: (07605) 402.

HI FI amp quad 33 and 303 with am/fm tuner £130. A. H. Baker, 34 Wenny Estate, Chatteris, Cambs.

WANTED circuit diagram workshop manual EMI L4A tape recorder buy or borrow. Mr. R. Turnbull, 25 Gatton Road, Reigate, Surrey.

PET 8K small keyboard BASIC 2 ROMS manuals, many programs as new could possibly deliver £200. Tel: Denbigh 3401. F. R. Stott, 'Tygwyn', School St. Henllan, Denbigh, Clwyd.

ZX81 16K RAM S/O Port manual £55 o.n.o. Tel: 01 451 1879. Peter Rouse, 27 Christchurch Avenue, London NW6 7QP.

ZX81 Sound Board. Fits between computer and RAM if any. No soldering £9·00. Write to: Dean Parris, 10 Penllwyn, Llanelly Hill, Abergavenny, Gwent NP7 0PY.

P.E. years 1966 to 1973 £5. 3·5 kilogram power supply transformer 7 output tappings. Tel: (0727) 39171. Mr. M. J. Woodbridge, 10 Chiltern Road, St. Albans, Herts.

FOUR digit common cathode multiplex l.e.d. display, new £2.25 inc. p & p. Other components list s.a.e. G. Noble, 50 Crofthill Road, Slough, Berks, SL2 1HF.

UK101 16K ABS case, motherboard, 6821 PIA, Cegmon, assembler, Exmon £130. K. Oldham. Tel: 061 437 5621.

WIRELESS World scientific computer complete with all data newsletters and expansion sockets. Paul 041 332 3841. P. Thompson, 226 West Princes St., Glasgow G4 9DL.

FOUR 813 valves, never used £20. Buyer collect. Tel: 051 6777317. John Sartorius, 52 Caulfield Drive, Greasby, Wirral, Merseyside L49 1SW.

100 PLUS each PE, PW, ERC, WW 1969-79. £10 o.n.o. set. £33 o.n.o. the lot. Rossendale (0706) 213813. J. A. Foll, 104 Burnley Road, Rawtenstall, Rossendale, Lancs BB4 8HH.

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BINATONE 5-star 40-channel mobile 27MHz CB transceiver. 4 watts Japan made. 2 months old. £60. Tel: 041 332 7695 after 7 p.m. K. Y. Chang, 70 1-up, Ashley Street, Glasgow G3 6HW, Scotland.

WANTED in tact alphanumeric display unit as advertised by Chiltern Electronics in Wireless World. Glasgow area preferred. Steven Lynch, 63 King Street, Clydebank, G81 1DS, Scotland. Tel: 041 952 0628 (after 6 p.m.).

WANTED back issues of PE, ETI, WW contact; Sri G. Trivikrama Rao. House No. 1187, 35 C, Cross, 28th Main, 4th T. Block, Jayanagar, Bangalore-560011, India.

INTER-STATE TV game 10 games c/bw joysticks £15 o.n.o. David Ferris, Bankhead Minathort, Kinross-shire, Scotland, KY13 7SB.

SUPERBOARD 24K BASICS's 4, 5, x 20 screen formats, £70 software + more £275 o.n.o. Mr. A. J. Clarke. Tel; St. Albans 34566.

ZX81 and 16K RAM Sinclair built (both), p.s.u. leads manual etc. £80. Tel: 01-778 4889. R. A. Norman, 101 Avenue Road, Beckenham, Kent BR3 4RX.

UK101 uncased, Wemon monitor 300/600 Baud + software, cassette recorder and 12 inch b/w TV £180 o.n.o. after 5 p.m. Tel: 051 922 9565. M. Vicars, 456B Stanley Road, Bootle, Merseyside L20 5AS.

5FT. HIGH (Langley) 19 inch cabinet rack on castors, detachable back, clipnuts, vent panels £80 buyer collects. G. Turner, 6 Ludgate, Tring, Herts GP23 4ES. Tel; Tring 3320.

PE & HE for sale.Will swop for working computer gear HE from Aug 79 PE from April 79 to date. F. W. Webb, 17 Low Downs Road, Hetton-le-Hole, Tyne and Wear. Tel; Hetton 268883.

SPARKRITE Voyager car computer, boxed, unused £40. D. V. Potter. Tel: 021 747 4472.

AVO 8, cased, immaculate condition £70. 12 element high gain v.h.f./f.m. antenna £40. Tel; 03446 2174. N. R. Jones, 'White Cairn', Wellington College, Crowthorne, Berkshire.

ORGAN parts for Maplin MS51/52. Two 49-key keyboards — several boards — reverb unit £70 o.n.o. Buyer collects. G. Roberts, 25 Holmes Road, Breaston, Derby DE7 3BT. Draycott 3919.

FX-60ZP Alpha programmable calculator. 512 steps. Three months old. Lots of software. Any offers? Phone after 7 p.m. Jeffrey 01 458 3025.

UK101 cased 32K RAM, 22K EPROM, printer. EPROM programmer. Assembler / Disassembler / CEGMON / MON 2 EPROMS 32X48. 300/600. Software £325 o.n.o. Mr. D. G. Hubble, Edith House, Stow Road, Outwell, Wisbech 773992.

SCOPE probe X1/X10 switch. Test hook i.c. tip BNC adaptor etc. Up to 150MHz £10. Unused. D. J. Staniforth, 43 Burley Lodge Road, Leeds 6. Tel: (0532) 458947.

ZX-81 original keyboard wanted. Desire borrow SWTP CY-64 manuals, circuits (doing repair). Postage etc. paid. T. K. Boyd, Seaford College, Petworth, W. Sussex GU28 0NB.

ETI VOCODER for sale. Assembled needs line up cash offers? Unused. Tel: 650 2985 after 6 p.m. P. M. Gillett, Flat 2, 51 Albermarle Road, Beckenham, Kent.

IBM PRINTER Z80 software interface. Mechanical fault. £100 o.n.o. Tarbell S100 blank card £15. Porthtowan 890688. J. de Rivaz, West Towan House, Porthtowan, Cornwall TR4 8AX.

SUPERBOARD 2 8K cased Wemon Monitor 32 x 32 Screen 300/600 baud automatic tape control numeric keypad £110. Mr. A. Morten, "Rosswood", Nursery Lane, Burbage, Buxton, Derbyshire. Tel: 0298 4601.

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SUPERBOARD Cased (Challenger 1P) 8K RAM 24 WAY I/O, programmable sound generator, games, software £120 o.n.o. S. F. Astbury, 26 Gregory Close, Harlaxton, Grantham, Lincs. NG32 1JG. Tel: 0476 3477.

PRINTER DAM Dynamics R033 with 6 rolls paper 110 baud good condition £70. C. D. Swift, 32 Cherry Tree Close, Camberley, Surrey. Tel: 03446 77426.

SHARP PC1500 graphic printer 8K RAM module charger, two weeks old. £305. David Stokes, 15 Jacksons Lane, Billericay, Essex, CM11 1AH. Tel: Billericay (02774) 3084 after 6 p.m.

MAPLIN 3800 synthesiser case keyboard and panels and some p.c.b's with manual. For more details contact C. A. Hughes, 141 Haydn Road, Sherwood, Nottingham. Tel: (0602) 873334 (after 6 p.m.).

WANTED Sony Radio Model ICF 5450L for spares. J. H. L. Chapple, Weg Haus, Hurst Lane, Charing Heath, Kent. Tel: 023 371 2868.

I.M.E. 86S Digitron Display Control Unit £6·00. Holiday flat 9, No. 10 Westwood Road, Portswood, Southampton, Hants. Mr. A. C. Holdway, No. 10, Westwood Road, Portswood, Southampton, Hants.

ACORN atom fully expanded, acorn built, lots of s/ware including Invaders, Chess, Manual. All leads £200. David Pound, Crayford 528264.

P.E. GEMINI Stereo Amp. March 1971 £25. P.P5 P.E. Music centre 1978 printed boards components £10. P.P.2. L. T. Hill, 14 Rothesay Terrace, Bedlington, Northumberland.

MPF-1 + BASIC, CTC, PSU + mains lead "Prof-1" custom startup £75. Sharp talking clock CT660 VGC £25. J. Davies, The Waverley, 79 Rhosmaen St., Llandeilo, Dyfed, SA19 6HD.

COMPUKIT UK101 8K cased, 2MHz, Wemon, 300/600 baud with software, tape recorder and TV £140 o.n.o. Mr. S. Day, 6 May Cottages, Chipstead, Surrey, CR3 3SX. Tel: 0737 832825.

PAIR JENNINGS 61 note C to C keyboards full range pedal board sundries £120. Will split. Mr. W. B. Mansell, 10 Wyndham Road, Shaw, Newbury, RG13 2NJ. Tel: Newbury (0635) 40464.

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WANTED Service Sheet Circuit Diagram Elizabethan 4 track tape recorder Model FT1 original or photostat small fee? Mr. M. K. Hayter, 24A St. Albans Road, Moseley, Birmingham B13 9AS. Sorry, no phone.

COLLECTOR of very old transistors seeks other collectors or anyone with old devices or data sheets. Andrew Wylie, 18 Rue de Lausanne, 1201 Geneva, Switzerland.

ATARI Games Console with ten carts including Chess, Space War, Adventure etc., £150—No offers, must collect. L. A. Privett, Essex area. Tel: 01 591 4248.

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CASIO FX-602P programmable calculator, FA-2 Adaptor, manuals and programs, Just M230 99% new condition. Write C. L. Loo, 1352 Road 35, Kepong Garden, Kuala Lumpar, Malaysia.

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VALVES, unused assortment, details from Oxford (0865) 779855. G. B. Dean, 66 Fern Hill Road, Oxford, OX4 2JP.

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ROLAND SH-2 Synthesiser 2 V.C.Os full keyboard. Perfect working order with manual £225. o.n.o. Phone (0372) 376394. W. Bennett, 58 The Street, Fetcham, Leatherhead, Surrey KT22 9RF.

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SMALL quantity unused Omron delay timers (0·12 sec) type STS-12S. Very accurate, possible photographic use. £18 each. Tel: 0279 52129.

WANTED Intel SDK-85 microprocessor kit any condition, good price paid. Tel: 01-886 5614. T. K. Shah, 18 Winchmore Hill Road, Southgate, London N14 6P.

PAIR 813 Valves offers of exchange reel/reel tape recorder. Tel: (0272) 842155. G. Whitlam, 16A Channel View Crescent, Portishead, Bristol, BS20 9LY.

WANTED small quantity "C" cores 100W to 350W for construction of audio transformers for P.A. amplifiers. H. E. Enfield, "Springtime" Withies Lane, Midsomer Norton, Avon BA3 2JE. Tel: 412058.

FREE Cegmon with MY Superboard computer 8K RAM, manuals, 9 User Newsletters 300/600 baud, software £115. Jonathan Saul: Tel: Ipswich 0473 623582.

TELEPRINTER in acoustic case with p.s.u. computer interface. Information available £35·00. Tel: Melksham (0225) 707164.

WANTED Telequipment D66 Circuit diagram original or photostat and technical books radio TV by G. N. Patchett. Urgent. Tel: 01-422 2802 Daytime.

ELEKTOR high com. set of completed circuit boards inc. chips, modules, unused £45. Charles Bowden, 7 Parc Eglos, Helston, Cornwall TR13 8UP.

COLOUR TV panels wanted for G.E.C. C2110 series line and field in particular. Patrick Doherty, 120 Monivea Park, Galway, Ireland.

BELLS 24 volt 6 inch £6 each, ideal for burglar alarms, fire alarms etc. Only 24 available. M. Harries, 152 Leicester Street, Whitmore Reans, Wolverhampton, West Midlands.

WANTED Instruction Handbook for Olivetti OS2 computer to buy or copy. Small fee? Paul Compton, Hadham Hall School, Little Hadham, Ware, Herts.

TANDBERG 3541X 4 track tape deck, 7" mint (genuinely unused). S-on-S £90 o.n.o. (or exchange Jupiter Ace). Tel: 07605 402 (Norfolk).

ET1 Master Mixer 10-2, unfinished, requires some components and wiring, well made woodwork and metal work £50. A. J. Kinch, 2 Hedge End, Woodstock, Oxford, OX7 1NP. Tel: Woodstock 811689.

LOWTHER corner horn wanted. Working/not working. Age, condition unimportant. 024369 4842. A. Coutts, 17 Andrew Avenue, Felpham, Bognor, W. Sussex.

P.E., E.E., P.W. from 70-79 for sale or disposal. Send s.a.e. for list. Bjorn Stromberg. P1.5825 Kolmoror, S-590 80 SODRA VI, Sweden.

UK101 8K Cased Cegmon BASIC-5, Joy stick, sound in/out lots software. £165. Swap W.H.Y. etc Mr. M. A. Saunders, 7 Drumcliff Road, Thurnby Lodge, Leicester, LE5 2LH.

ONE mains splitter (input) 10D/CA1768 £16·50. 2 15A motor switches £1·50 each. Two Hivac GR7M/U Numicators £1·50 each. Mr. J. C. Miller, 4 St. Joseph's Road, Brentry, Bristol BS10 6QL. Tel: (0272) 503364.

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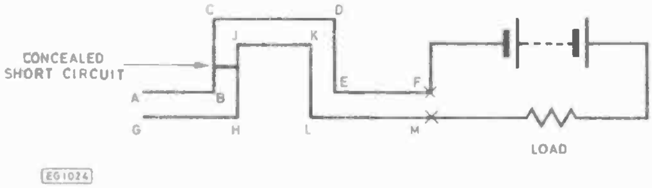
Why not submit *your* idea? Any idea published will be awarded payment according to its merits.

Each idea submitted must be accompanied by a declaration to the effect that it has been tried and tested, is the original work of the undersigned, and that it has not been offered or accepted for publication elsewhere. It should be emphasised that these designs have not been proven by us. They will at any rate stimulate further thought.

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

SHORT-CUT TO 'SHORT' DETECTION



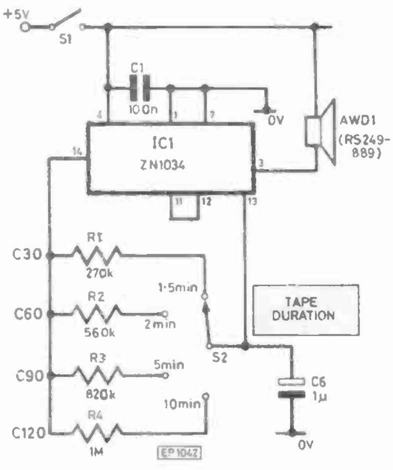
MODERN printed circuit boards with plated-through holes are often soldered very quickly in a production-like situation using a wave soldering technique—i.e. from below.

The constructor working with the board the other way up has to take great care to avoid an excess of solder running into a plated hole, since if the component is a DIL socket, a solder bridge may form out of sight, under the socket, on the other side of the board. If the board is for an expansion memory or is the memory section on a single-board computer, it is possible that such a short circuit could be under one of many sockets and if the fault is sought by systematic removal of these, Murphy's law will ensure that it is lurking beneath the last socket to be removed! Convinced of this fundamental truth and finding myself in the situation described above I devised the following method to locate the fault.

1. Determine which two adjacent lines are shorting with the aid of a multimeter, after have removed all the chips from the board.
2. Trace the two lines throughout the board.
3. Apply a low voltage to one of the two lines and a return path via a suitable load from the other line.
4. The voltage and load should be chosen so that the printed circuit tracks are not overloaded but carrying a current which is a significant proportion of their design maximum.
5. Use the microvolt measurement facility of a sensitive 'scope or similar device having a high input impedance to test for voltage drops along these two tracks e.g. in the circuit shown testing between A and B or G and H will show no voltage drop, but C to D, J to K, D to E, K to L, E to F and L to M will all show small detectable drops in voltage which indicates that the bridge is between sections CB and JH of the two tracks.

David J. Giles,
Edinburgh.

CASSETTE TAPE TIMER



WHEN recording material on audio cassette it is useful to have an indication of the approaching end of tape.

The circuit shown gives an audible warning some 1·5, 2, 5 and 10 minutes before the end of a C30, C60, C90 and C120 respectively.

The ZN1034 timer triggers at switch on and pin 3 goes high. After the chosen delay this pin goes low turning on the audible warning device.

P. Thompson,
Glasgow,
Scotland.

LOW COST MULTIPLE BARGRAPH DRIVER

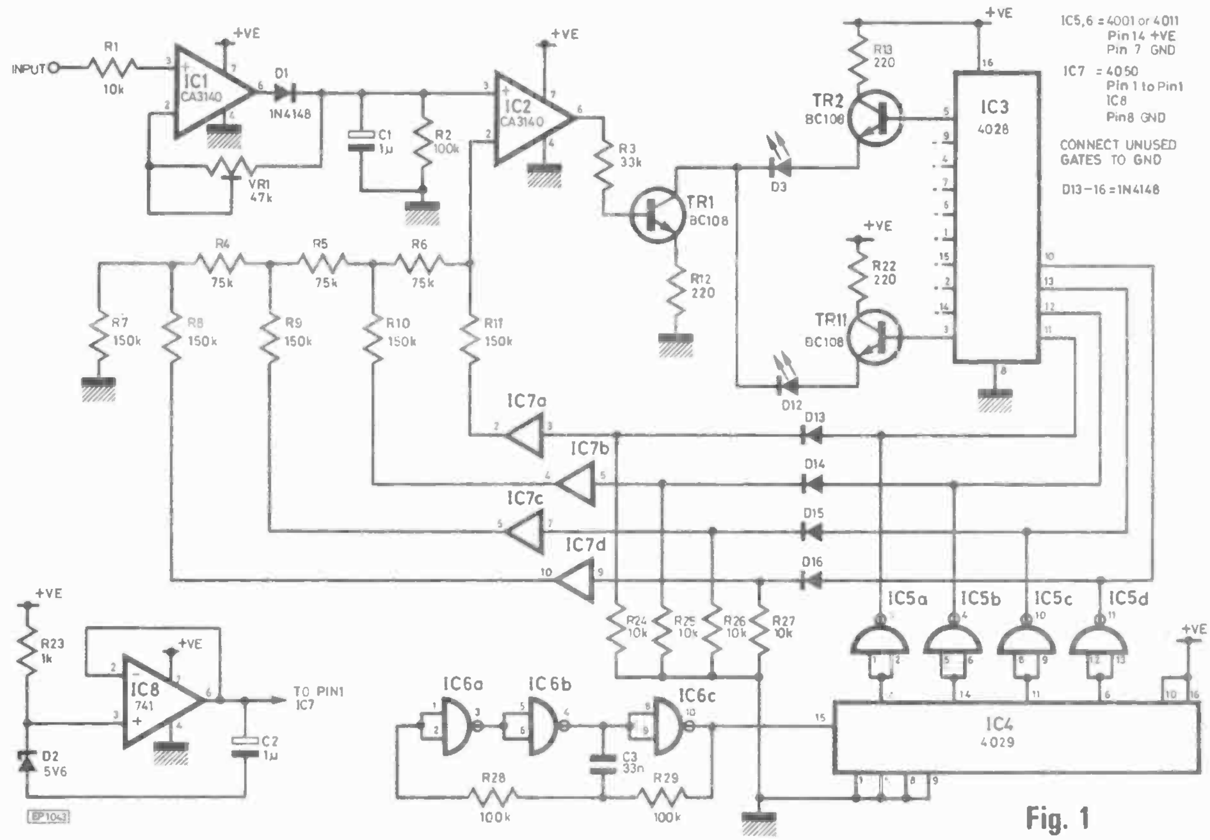


Fig. 1

THIS circuit was designed to combat the essentially high price for the construction of multiple bargraph displays as used in real time Spectrum Analysers etc. The diagram shows the essential parts for a single bar and may be easily extended to as many stages as required.

The heart of the circuit is IC3, a 4028 BCD to decimal decoder, fed by a binary decade counter, IC4. This counter is driven at 200Hz by a simple CMOS clock, IC6. The diagram shows a ten l.e.d. bar, and if higher bars are to be driven, then a higher clock frequency is required to stop visible flickering. The outputs of the counter also drive a simple digital to analogue converter. The binary output is buffered by IC7, the power for which is derived from a simple regulator built around IC8, to provide a consistant display free from supply induced level shifts. IC7 is a 4050, and this was chosen because it can cope with inputs above its supply voltage.

This buffered signal is passed to a simple DAC, known as a R/2R ladder formed by the 150k and 75k resistors. The resulting analogue voltage is connected to the inverting input of IC2, the non inverting input of which is connected to the input signal to be measured via a peak detecting circuit formed around IC1. The input level is variable via the 47k preset in IC1's feedback loop. The output of the comparator IC2 goes to enable the cathodes of all the l.e.d.s in that particular bar. Thus the circuit works as follows.

The counter IC4 starts at 0000 and so pin 3 of the decoder IC3 is high thus enabling the l.e.d.(s) on that line. As all the counter's outputs are low the DAC's output will also be low, i.e. 0V. If the input signal is above 0V then the output of the comparator IC2 will be high and enable the l.e.d. column so that the bottom one will light. Then the counter advances to 0001.

The second l.e.d. is enabled by IC3 and a voltage about half a volt above 0V appears at the comparator. Again if the input level exceeds this the l.e.d. column is enabled, and as only the second l.e.d. has a positive anode, it lights. The counter advances and the cycle repeats. Naturally, if the input level does not exceed the DAC output then the l.e.d. column is not enabled and nothing lights. As all this occurs at high speed, the effect is a steady bar of light, its height being proportional to the input level, the l.e.d.s having 0·5V increments.

If more than one column of l.e.d.s is required, then you only need to duplicate IC1, IC2, TR1 and l.e.d.s, as the counter, decoder, TR2 to TR11, and the DAC are common to all channels.

The simple circuit shown will however

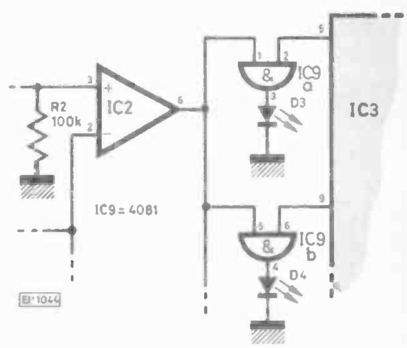


Fig. 2

suffer from a varying of l.e.d. brightness, depending on the number lit, if the basic circuit is extended beyond one or two bars.

This effect may be counteracted by using an AND gate for each l.e.d. as shown in the second diagram. Although more expensive, it does solve the problem of brightness variation and still works out cheaper than a driver using several LM3914 bargraph driver i.c.s.

G. Durant,
Selby.

Ultimum Computer Interface Part 4

THIS month's ULTIMUM daughter board is a Universal PROM programmer designed to allow you to program the 2K, 4K and 8K range of single-rail EPROMS. It complements the RAM/ROM card which will take the 2K or 4K EPROMS (2716, 2732/2532) as well as providing the capability to program the 28 pin 2764. With this, and next months card (a ROM emulator), most of the facilities required to develop microprocessor systems become available.

FEATURES

Several facilities are incorporated to make the PROM programmer reliable and safe to use. A 24 pin header has been provided to allow you to change from one PROM type to another without having to alter messy links. A current limited 5 volt supply is available to prevent damage to your PROMS in the event that they are inserted upside down. All the necessary switching is provided on the programming lines to make verifying etc. straightforward. To keep the software to an absolute minimum, hardware is included to provide the 50 msec pulse needed for correct programming, with software monitoring capability. All the decoding is provided to make sure that the PROM programmer uses the minimum address space.

CIRCUIT DESCRIPTION

The heart of the PROM programmer is an 8255 parallel interface (I.C.1). This provides 24 lines of input/output in the form of three, eight bit ports. The 8255 is addressed by a decoding system which ensures that only 16 bits of address space are used. The 8255 may be mapped to any 16 byte boundary throughout the 'processors 64K address space. This decoding is achieved with IC's 4,5,6 and 7. IC's 5, 6, and 7 are magnitude comparators (74LS85) which are 'ANDed' together to select the 8255 when the 'processor address corresponds to the value set up on switches 1 to 12. By linking the link 1 to ASO (see Fig. 1) it is also possible to de-select the board altogether leaving more space for memory when the programmer is not in use. The 8255 $\overline{CS}$ line also feeds back to the enable line on the motherboard. This decoding arrangement allows you to put the PROM Programmer into any slot without changing links. IC3 (Fig. 1) is a monostable that provides a 50 msec pulse need to program the PROMs. Negative and positive going pulses are available to suit the appropriate PROM.

The 8255 is reset on power-up by a timing circuit comprising one half of the monostable (IC3) and a CR time constant. This reset will make all the lines of the 8255 inputs which are the 'safe' state for PROMS. The 25 volt switching is achieved using a level shifter of two transistors. Because certain PROMs must have Vpp clamped to 5 volts and others to 0 volts, the Vpp output (collector of Q_3) goes to the header (SK1) so this may be wired for each PROM type.

A total of 24 lines is plenty for 2K/4K PROMS, but the 2764 needs extra lines. These are provided by IC9, an eight bit latch, which can be set up by the 8255. Having provided this, we decided that it would simplify the necessary software enormously to dedicate it to address lines. This has the result of providing theoretical capability for half-megabit EPROMS (27512?)

Device IC8 is a 100 mA regulator which may be connected to the PROM Vcc. This will limit the current supply to the PROM in the event that it is inadvertently inserted the wrong way around. Sensing circuitry allows detection of this condition by software and also turns off the high address drivers. IC2 is the zero-insertion force socket which takes the PROM to be programmed. This may be a 24 or a 28 pin socket. If you are not programming 2764 PROMS, we suggest you use a 24 pin socket, as the extra pins will not be used, and a misplaced PROM could be damaged.

ASSEMBLY

Start with the i.c. sockets, then the discrete components. Take care to distinguish between the two transistors, and note their orientation. Refer to the component layout (Fig. 4.2). IC8 is a three pin package which doesn't appreciate being inserted backwards.

Insert all i.c.'s (IC2 and the header will be inserted later). IC1 is a static sensitive device and should be inserted last. This is not a very dense board, but one should always check for solder blobs and shorts before applying power.

SETTING UP

Table 1 shows how to set up the various links. Choose where the programmer will sit in memory and set switches 1 to 12 according to this table. Link 1 should be set to ASO if you wish to de-select the board from the 8255 on the motherboard. For initial testing, it is simplest to wire this to the 5 volt line.

TESTING

The 8255 should be tested for operation on each of its lines. A simple program (Table 4.2) in BASIC can be used to do this. Check that lines A0-A7, B0-B7, C0-C3 pulse from 1 to 0 with a high impedance voltmeter or the simple 'logic probe of Fig. 4.3. Do *not* insert a PROM into socket IC2 while doing this or it will be damaged. The outputs of IC3 (pin 5 and 13) can be tested with the same program. A short 'blip' on your meter (or 'logic probe') will indicate satisfactory

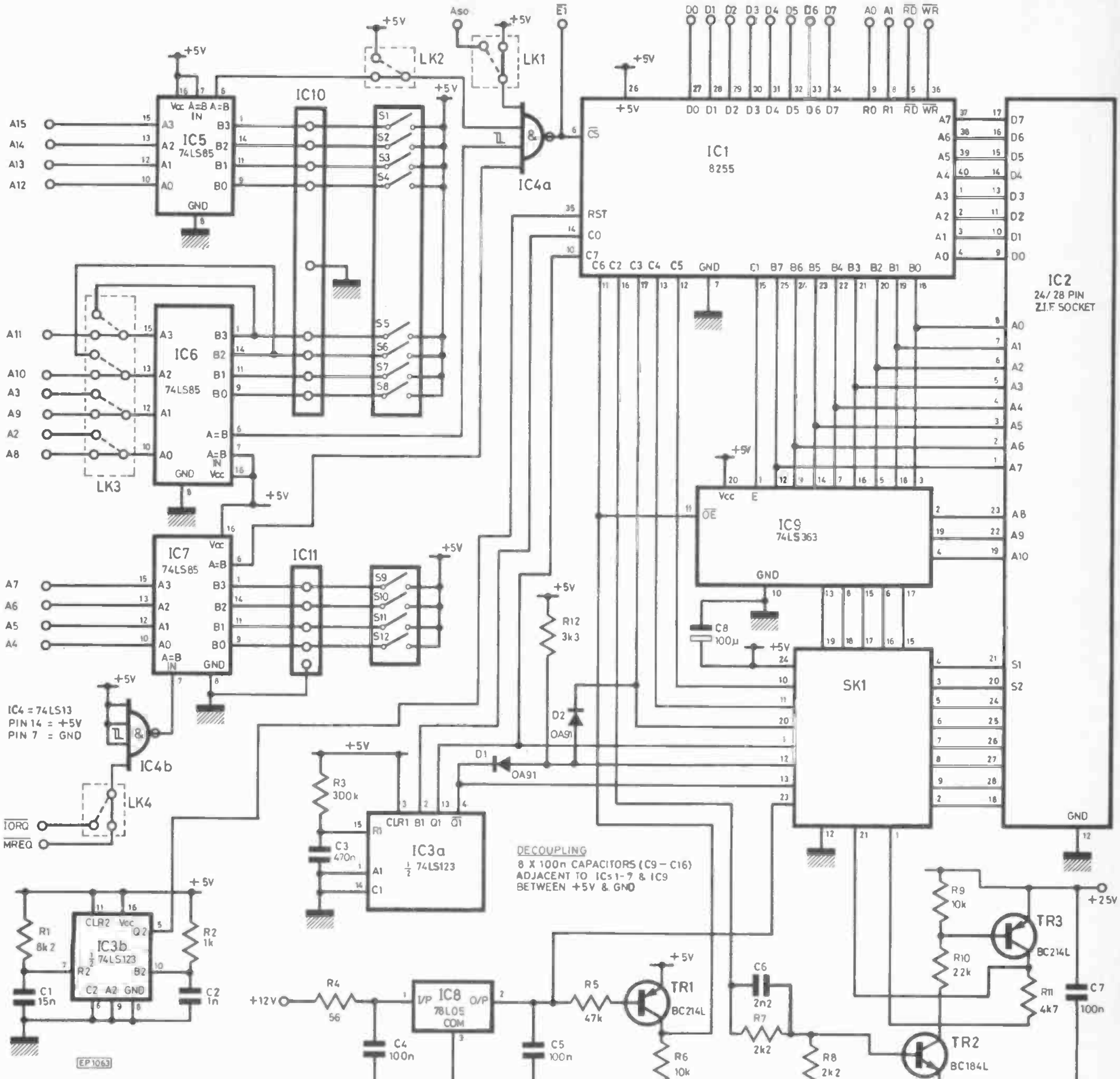


Fig. 4.1. Circuit diagram of ULTIMUM's Universal PROM Programmer

HALF-MEGABIT EPROMs WELCOME!

operation. The latch (IC9) can be tested by latching data with the line C1 which should be pulsed high then held low, checking that the data on eight outputs (see Fig. 4.1) are correct. This done, the setting up is complete.

WIRING FOR PROM TYPES

Table 4.3 gives the various header options for IC10. Table 3(a) shows the lines connected to this header. Each PROM type requires a different header. The connections in Table 4.3 make use of the current limited supply.

The correct sequence for programming any PROM is as follows:

With the power off . . .

1) Choose and insert the appropriate header for IC10.
2) Power up the board, without the PROM inserted. This allows the 8255 and monostable to settle to their safe state.
3) Insert the PROM and program.
4) Remove the PROM.
5) Power down.

Follow this sequence, or you will run a slight risk of mis-programming one or more locations.

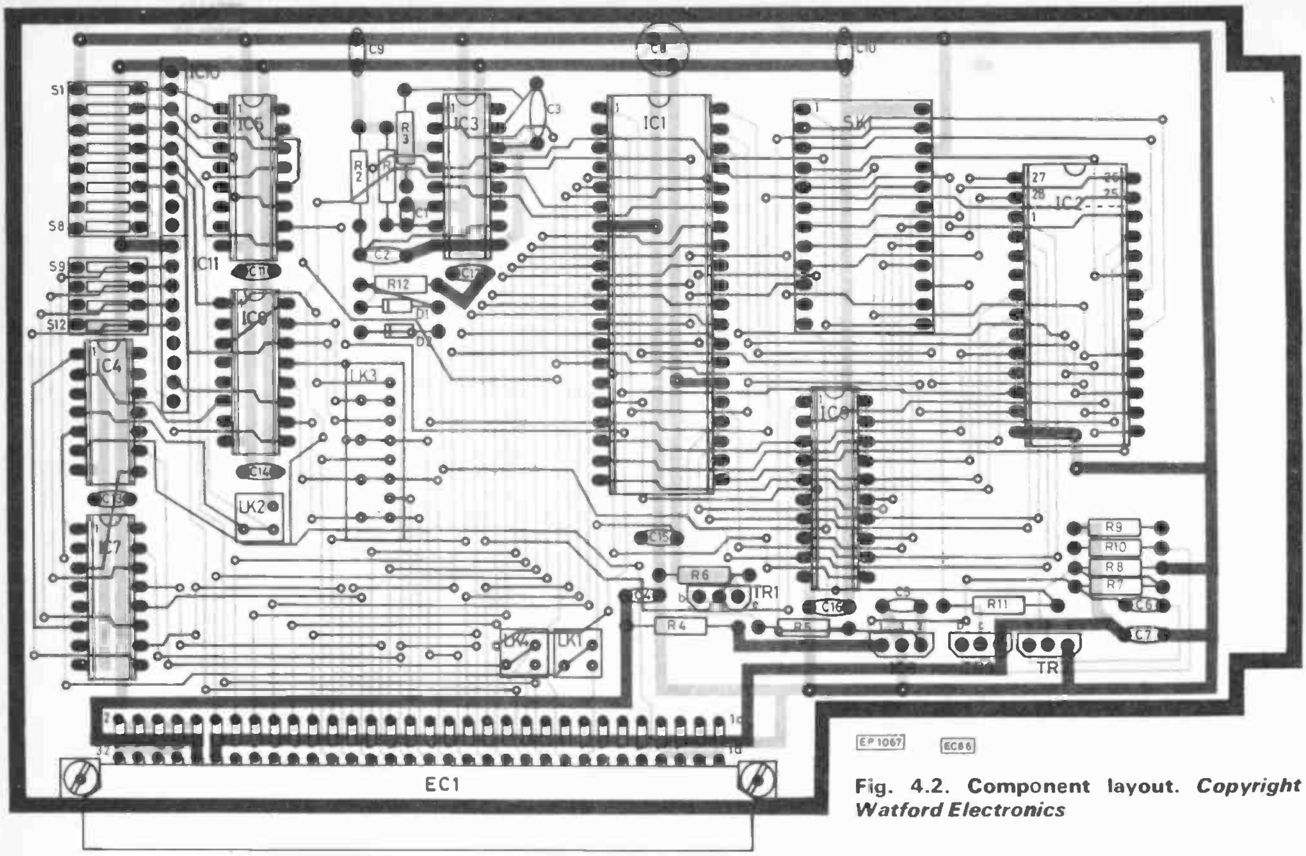


Fig. 4.2. Component layout. ***Copyright Watford Electronics***

Compatibility range:

- Acorn Atom
- Apple II
- Atari
- BBC
- Commodore PET
- Dragon 32
- Jupiter Ace
- Oric I
- RML 380Z
- Spectrum
- Superboard
- Superbrain
- S100 Bus machines
- UK101
- Video Genie
- ZX81

U L T I M U M

LK1	IC4 to +5V (default position)	= Permanently mapped in
	to Aso	= May be dynamically mapped
LK2	IC4a to IC5 (default position)	= Memory map option
	to +5V	= I/O option
LK3 & LK4	Default position	= Memory map option
	Alternative	= I/O option

SWITCHES

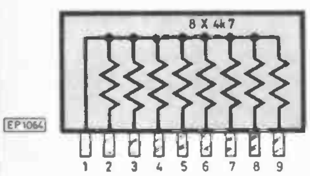
S1	A15
S2	A14
.	.
.	.
.	.
S12	A4

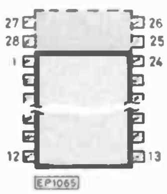
The switches set the required position in memory, in binary. For example, S2 set and all others open would give 4000 hex (16384 decimal)

Table 4.1. The link options

Daughter card range:

- Ram card
- Rom/Battery backup Ram card
- EPROM programmer card
- Romulator card
- Floppy disc controller card
- Printer and general port car
- Analogue I/O card
- Sound card
- Speech card
- Terminal card
- Processor card
- Prototyping card





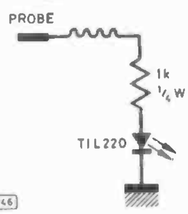


Fig. 4.3 (right). A simple logic probe circuit

COMPONENTS . . .

Resistors

R1	8k2
R2	1k
R3	300k 1%
R4	56
R5	47k
R6, R9	10k (2 off)
R7, R8	2k2 (2 off)
R10	22k
R11	4k7
R12	3k3

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

Capacitors

C1	15n
C2	1n
C3	470n 5%
C4, C5, C7	100n (3 off)
C6	2n2
C8	100µ/16V
C9–C16	100n disc ceramic (8 off)

Transistors and Diodes

D1, D2	OA91 (2 off)
TR1, TR3	BC214L (2 off)
TR2	BC184L

Integrated Circuits

IC1	8255
IC2	PROM to be programmed
IC3	74LS123
IC4	74LS13
IC5–IC7	74LS85 (3 off)
IC8	78LO5
IC9	74LS363
IC10, IC11	8x4k7 s.i.l. resistor pack (2 off)

Miscellaneous

SK1 24-pin socket for header
24/28 pin z.i.f. socket for PROM
D.i.l. switches 8 x s.p.s.t. (2 off)
Printed circuit board WEO3 PRG
PL1 2 x 32 'A+C' DIN Euro Plug (Right-angled pins)
24 pin d.i.l. personality header
14 pin d.i.l. socket
16 pin d.i.l. socket (4 off)
20 pin d.i.l. socket
40 pin d.i.l. socket

Constructors' Note

Kits for all parts of the ULTIMUM system are (or will be) available from **Watford Electronics**, 33 Cardiff Road, Watford, Herts WD1 8ED. Send SAE for price list of boards now available.

```
10 P = programming port address
20 POKEP + 3, 136
30 POKEP, 85:POKEP + 1, 85:POKEP + 2, 85
40 POKEP, 85170:POKEP + 1, 170:POKEP + 2, 170
50 GOTO30
```

Table 4.2. 8255 check program in BASIC

	2716	2732	2532	2764 (Hitachi)	2764 (Mostek)	2564 (Texas)
Vpp TIE	+5V	GND	+5V	+5V	GND	+5V
18	PGM	PGM/CS	A11	GND	PGM/CS	A11
20	OE	Vpp	PGM/CS	OE	Vpp	PGM/CS
21	Vpp	A11	Vpp	A11	A11	A12
24	+5 Lim	+5 Lim				
25				PGM		GND
26				+5 Lim	+5 Lim	+5 Lim
27				Vpp		Vpp
28				A12	A12	GND
	OE Low for read. High for pgm. High for pdn	PGM Hold low for read.	PGM Hold low for read.	OE Low for read. High for pgm.	PGM Hold low for read.	PGM Hold low for read.

A0–A7	O/P	D0–D7
B0–B7	O/P	A0–A7
(B0)–(B7)	O/P	A8–A15
C0	O/P	mono fire
C1	O/P	latch fire
C2	O/P	Vpp Sw
C3	O/P	$\overline{OE}$
C4	I/P	uncommitted
C5	I/P	uncommitted
C6	I/P	Vcc sense
C7	I/P	PGM sense

Table 4.3. Header options for IC10

NOTE: For machines like Superbrain, where the whole of the address space is taken up by RAM, by changing Links 2–4 the Programmer becomes an I/O mapped device.

Table 4.3(a). Header connections

Vpp Tie	1	24	+5
pin 18	2	23	+5 Lim.
20	3	22	GND
21	4	21	Vpp
24	5	20	$\overline{OE}$
25	6	19	Q7
26	7	18	Q6
27	8	17	A13
28	9	16	A12
C5	10	15	A11
$\overline{C4}$	11	14	$\overline{PGM}$
PGM/$\overline{CS}$	12	13	$\overline{PGM}$

Table 4.4. Simple program for 2732 PROMs

```
1Ø  P = programming port
      address
2Ø  Q = RAM start
3Ø  POKE P + 3, 155            ; set all I/P, mode Ø
4Ø  A = PEEK (P + 2)           ; read port C
5Ø  IF ((A< 128) AND (A > 63)) ; bit 6 set, chip in backwards
      OR (A > 191) THEN 4ØØ
6Ø  POKEP, Ø:POKEP + 1,
      Ø:POKEP + 2, Ø
7Ø  POKEP + 3, 136             ; set high C I/P, reset O/P,
                                 mode Ø
8Ø  L = Ø, H = Ø, N = Ø        ; counters; addr high & low,
                                 data locations
9Ø  POKEP + 3, 5               ; programming power on
1ØØ POKEP + 3,                 ; initialise high address
      3:POKEP + 3, 2
11Ø POKEP, PEEK (Q + N)        ; load data
12Ø POKEP + 1, L               ; load low address
13Ø POKEP + 3,                 ; trigger program pulse
      1:POKEP + 3, Ø
14Ø IF PEEK (P + 3) > 127      ; wait until end
      THEN 14Ø
15Ø N = N + 1                  ; increment count
16Ø IFN > 4Ø95 THEN 3ØØ        ; finished ?
17Ø L = L + 1                  ; increment low address
18Ø IF L < 256 THEN 11Ø
19Ø H = H + 1:L = Ø            ; increment high address
2ØØ GOTO 11Ø
300 POKEP + 3, 4               ; programming power off
310 PRINT "DONE"
320 STOP
400 PRINT "EPROM
      INSERTED
      INCORRECTLY"
410 END
```

PROGRAMMING PROMS

The programs to program PROMs can be of many levels of sophistication. Table 4.4 is a simple program for 2732 PROMs (the most commonly used), which illustrates the general principle. You could design programs to cater for all PROMs (possibly menu driven) checking for correct insertion, and making sure they are blank before programming. The board is supplied with data on the 8255, so that more sophisticated programs may be produced.

NEXT MONTH: ROM Emulator card.

Strictly Instrumental

by K. Lenton-Smith

KONOSUKE Matsushita was born in 1894 in a small village 35 miles south of Osaka, the commercial capital of Japan. The English translation of his name is "Lucky man under the pine tree" and indeed he spent his childhood under a matsu (Japanese pine).

He was apprenticed to a bicycle merchant in Osaka at the age of ten, bicycles being an exotic rarity in Japan at the time. After seeing a tramcar for the first time, he was convinced that the electric industry had a bright future and in 1910 joined the Osaka Electric Light Company.

By 1918 he had become the youngest inspector on the payroll and decided to set up in business on his own. With his wife and brother in law, he manufactured a device he had patented: this was an Edison screw, adaptor designed to fit a light socket.

Matsushita built his first office and factory in 1922, extended his sales operations and had by now 50 employees. Bicycle lamps, heaters and radios were among the products made in the decade that followed.

Matsushita Electric Industrial Co. came into being in 1935 with a capital of 10M Yen and nine subsidiary companies. The group's products were mainly domestic appliances, including experimental TV receivers made in 1938.

Seeing the conditions prevailing in post-war Japan, the company's founder set himself the task of re-vitalising his country: his slogan was "P.H.P."—Peace and Happiness through Prosperity. In 1951 Konosuke Matsushita visited the USA and Europe and on his return urged all employees to work together to build the company on international lines.

An exchange of technical expertise was arranged with Philips of the Netherlands in 1952, and Matsushita Electronics Corporation was established to produce a wide range of electronic components. These included semiconductors and electronic tubes.

PANASONIC

The concern continued to expand and in 1959 opened its first overseas venture, Matsushita Electric Corporation of America, which sold its products under the brand name of Panasonic. 1961 saw the first overseas manufacturing concern established—the National Thai Company.

Ten years later, Matsushita Electric stock was offered on Wall Street and was instantly oversubscribed; six further leading markets were listing its stock two years later.

Konosuke Matsushita left the company's Chair in 1973. He had certainly lived up to his name as "The Lucky Man . . ." but also proved himself as both a patriot and hard-working man of vision. Outside Japan he will best be remembered by the thousands of products with brand names of National, Panasonic, Quasar and Technics.

With an excellent reputation for sound reproduction equipment and as a component manufacturer—especially of complex integrated circuits—entry into the electronic music field was almost a natural progression.

In 1980 I attended the launching of a new series of organs, when the trade was introduced to the "U" organs, and told that Technics' engineers had been back to the drawing board and had completely re-designed the range of instruments. Among the new features at that time was the Program Chord Computer, a "first" for Technics, which allowed the SX-U60 to be programmed to remember 100 chords of eight basic types.

Technics have continued to update the series, the latest model being an improvement on the SX-U90, namely the SX-U90P.

SX-U90P

This de luxe instrument has a space-age appearance, its console being finished in silver-grey and mounted on columns. It is priced at £5999·99 (in case you can't afford £6000!) and, although described as portable, is supplied with a pair of silver-grey extension speaker cabinets and was probably designed for professional use.

For practicing, two 10W speakers are built in to each side of the console: these are indispensible in judging expression when using remote cabinets. Two 4-octave manuals and their control buttons and tabs are housed between the monitor's speakers under the metallic hooding of the console. Below are 13 pedals and the expression control.

The various buttons and tabs are colour coded and many of them illuminated. Although I do not favour consoles that look like a pin-ball machine, I must admit that the complexity of modern instruments is such that the performer needs all the help the manufacturer can offer in finding things quickly, especially when reading music at the same time. The controls are fitted above the upper manual and on the cheeks, and laid out logically.

The Orchestra Conductor section has 12 illuminated buttons which allow the player to select various departments: these are Tab Voices, Orchestral Presets, Percussion, Solo Synth., Organ, String Ensemble and Vocal Ensemble which, apart from Orchestral Presets, are available on both manuals.

Tab Voices cover the organ tones. These include the complete range of Flutes (equivalent to those found on drawbar organs), Brass, Oboe and String on the Upper Manual, whilst the Lower Manual has Flutes 8', 4', 2' and 1' with Diapason, Horn, Cello and String. Pedal Tabs include those for Bass Guitar and String Bass.

Two types of synthesizer are employed. Upper Orchestral presets allow polyphonic playing, where there are eight effects to choose between. Solo Synthesizer presets allow single note melodies on either manual, and there are some odd effects here, such as Cosmic Fuzz, or Whistle and Synthe Chopper!

FEATURES

One of the outstanding features of the SX-U90P is the Rhythm Unit. It has a stereo output and can also be programmed to suit the user. Its information is based on pulse coded modulation and it produces the recorded sounds of actual instruments and is thus considerably lifelike. In non-programmed mode there is a choice between 12 patterns, each with a variation, and it will produce intros. and fill-ins. It can be made to trigger an accompaniment of piano, banjo or guitar.

Percussion can be applied to the Upper Manual at 5–1/3', 4', 2–2/3' and 2' pitches and there are also Upper/Lower Percussive Presets—Piano, Harpsicord, Vibraphone etc. Harmonic Couplers can be used from either manual and there is also the intriguing Upper Click control: this applies the very same effect that many engineers have burned midnight oil trying to eliminate and was largely responsible for the original success of the Hammond with jazz organists!

Celeste may be applied selectively to sections of the organ and the Voice Setting Computer allows the player to store four favourite voice combinations in memory for six weeks if the instrument is unused.

Although probably best suited to club or studio work, Technics have not forgotten the beginner's aids. Auto Play Chord (one-finger, fingered and memory) and Program Chord Computer still are featured, the latter remembering two 50-chord programs which can be edited if mistakes occur. Walking Bass can be applied to the pedals and Arpeggios played on Harp or Strings.

In all, the SX-U90P is an exciting and complex instrument which should be seen to be appreciated as it is impossible to cover all its many features here.

The silicon chip has been a boon to Matsushita and its contemporaries—and if we still had to rely on valves the organ would need a complete room to house what the SX-U90P encompasses!

MICRO PROMPT

The hardware and software exchange point for PE computer projects

UK101 SINGLE KEY BASIC

The UK02 Monitor ROM is a vast improvement over the original UK01 ROM but it leaves the computer still lacking the ability to produce complete BASIC words by pressing just one or two keys. A short program to remedy this is given below and can be used with either monitor by changing the first line of the program to the appropriate input routine address ($FFBA for UK01, $FBAC for UK02). Unfortunately when used with the UK02 Monitor, the Editor is completely disabled when the program is running, but this may be overcome as follows—

1) Enter the program using the m/c monitor.

2) Reset, enter Cold Start and then type in the following BASIC lines;

1 POKE 536,64:POKE 537,2:END
2 POKE 536,172: POKE 537,251:END

To activate the Single Key Basic, type RUN. Before calling the Editor type RUN 2 and then edit in the normal way, after which RUN may be used to return to Single Key Basic. Reset W can be used instead of RUN 2 although this will of course clear the screen. The POKEs given in line 1 above are also used to activate the program when used with the UK01 monitor.

BASIC words are called by using CTRL plus another key as listed below. It was considered unnecessary to include words of three letters or less as it is almost as fast to type these out in full. However these are presented for completeness along with some other infrequently used words together with the OFFSET and may be included if required by adding them to the table.

With regard to the Table, pressing CTRL and another key gives the ASCII value of that key plus #$CO. Thus the required value for the KEYBD column in the Table can be easily calculated; e.g. CTRL 4 gives 34+CO=F4 (Hex.). The following keys cannot be used; M, SPACE, SHIFT, (also E and L for UK02 Monitor). It is essential to end the Table with a 00 Byte.

Once the Machine Code has been entered, a BASIC loader may be produced using the m/c to BASIC converter given in P.E. July 1981.

PROGRAM LISTING

```
0240   20BAFF   JSR   $FFBA
0243   84FE     STY   $FE
0245   85FF     STA   $FF
0247   A0FF     LDY   #$FF
0249   C8       INY
024A   B97D02   LDA   $027D,Y
024D   F029     BEQ   $0278
024F   C8       INY
0250   C5FF     CMP   $FF
0252   D0F5     BNE   $0249
0254   B97D02   LDA   $027D,Y
0257   A8       TAY
0258   E046     CPX   #$46
025A   B018     BCS   $0274
025C   B984A0   LDA   $A084,Y
025F   48       PHA
0260   297F     AND   #$7F
0262   9513     STA   $13,X
0264   E8       INX
0265   20E5A8   JSR   $A8E5
0268   C8       INY
0269   68       PLA
026A   10EC     BPL   $0258
026C   C9A4     CMP   #$A4
026E   D004     BNE   $0274
0270   A928     LDA   #$28
0272   D006     BNE   $027A
0274   A900     LDA   #$20
0276   F002     BEQ   $027A
0278   A5FF     LDA   $FF
027A   A4FE     LDY   $FE
027C   60       RTS
```

TABLE	KEYBD	OFF SET		
027D	03	CC	CTRL C	CHR$(
027F	04	0A	CTRL D	DATA
0281	0F	2D	CTRL O	GOSUB
0283	07	1D	CTRL G	GOTO
0285	09	0E	CTRL I	INPUT
0287	06	D0	CTRL F	LEFT$(
0289	F1	61	CTRL 1	LIST
028B	F2	DB	CTRL 2	MID$(
028D	0E	06	CTRL N	NEXT
028F	10	BB	CTRL P	PEEK
0291	0B	54	CTRL K	POKE
0293	12	16	CTRL R	READ
0295	CD	32	CTRL CR	RETURN
0297	08	D5	CTRL H	RIGHT$(
0299	13	80	CTRL S	STEP
029B	F3	C2	CTRL 3	STR$(
029D	01	6D	CTRL A	TAB(
029F	14	79	CTRL T	THEN
02A1	00		END OF TABLE	

OTHER BASIC WORDS WITH OFFSET VALUE

ABS	97	NEW	6A
AND	89	NOT	7D
ASC	C9	NULL	41
ATN	B8	POS	A0
CLEAR	65	REM	38
CONT	5D	RESTORE	26
COS	AF	RND	A6
DEF	51	RUN	21
DIM	13	SAVE	4D
END	00	SGN	91
EXP	AC	SIN	B2
FOR	03	SPC(	75
FRE	9D	SQR	A3
INT	94	STOP	3B
LEN	BF	TAN	B5
LOAD	49	USR	9A
LOG	A9	VAL	C6
		WAIT	45

NOTE: Many of the three letter words require brackets which the single key basic program will not supply, the exception being SPC.

L. J. Dolman,
Norwich.

WORKSPACE MOVE

Sir—You may be interested in the following for Microprompt.

In Compukit 101 or Superboard BASIC, the ability to reserve a block of RAM for machine-code routines by givng a number in response to MEMORY SIZE? or POKEing 133 and 134 is useful if the routines are written to reside at the top of RAM. It is, however, often desirable to use a machine-code program at the same time as BASIC, which resides in low memory. For example, an extended monitor (mine runs from Ø28Ø to ØD5Ø). It is possible by means of a couple of POKEs to move BASIC's workspace fromØ3ØØ to XXØØ—wherever you want it. To move it to nnØØhex, the command is:

POKE 122,nn:POKE nn*256,Ø:NEW

having put nn into decimal. The POKE 122 changes the main base pointer. The second POKE is essential to prevent BASIC crashing. The "new" command changes all BASIC's vectors to the appropriate new positions. So to reserve memory up to ØFFF hex, giving free space from Ø222 to ØFFF hex, use

POKE 122,16:POKE 16*256,Ø:NEW

Once set, reset has no effect on the vectors, so the memory stays in the new configuration until BASIC is Cold-started again.

Michael Punnett,
Swanley,
Kent.

UPDATE!

Sir — The program "Text String Search" published in PE *Oct. '82 Microprompt was originally written by myself for the Synmon monitor. Since then, Newmon has become the standard and because of different usage of zero page and low memory, the program as published will not function properly with this monitor. Points to note for conversion are:*

1. The first free byte in Newmon is $0228 and not $0222 and the program needs relocating to this new start address.

2. References to $EØ to $E5 must be changed to other zero page locations. Some of the later bytes from the input buffer ($13 to $5A) can probably be used instead.

3. References to other zero page bytes and Basic routines $A000 onwards still apply and do not need changing.

Peter Beckett
Blackpool

PIXEL GRAPHICS

Sir—With a desire to improve the graphics capability of the UK 101 I set out to design a system that was cheap, simple, and gave higher resolution.

I decided not to use any more than the 1K of video RAM already on the UK 101. This limited the resolution to 64 x 96, 32 x 192, 128 x 48 or some other such combination. The system I intended to use was one where each point is represented by a bit in the video memory.

However there are two methods of performing this. One is a true method, whilst the other only appears to perform the function.

The second method is to "switch off" the main character generator and "switch on" an alternative character generator. In this second character generator an alternative character set is held with the characters arranged in such a way so that it appears that each bit represents a point. Using this method a second character generator must be programmed as well as having the auxiliary chips (i.e. address decoding etc.) and despite the ever decreasing price of 2716 EPROM's, this is still a costly process.

The first method is both cheaper and information from the RAM is used directly, giving a resolution of 60 rows by 96 columns with one line of text at the bottom. This can be used for scores for games etc. Having this line of text is why the resolution is slightly lowered.

As shown in Fig. 2, what was a character position is now eight pixel positions with bit 0 representing the top left point etc. A one in this bit position will produce a white square in this location. By means of the machine code subroutines given, each point in the 60 by 96 array of points may be set, reset or examined.

The circuit itself is quite simple and can be divided into three separate parts. Firstly the address decoding 1's and 0's are decoded using NAND and NOR gates with the result that the output of the 4-input NAND gate is low only if address 61823 (F17F Hex) is present on the address bus. The four AND gates decode the top four address lines so that the character generator is switched back on if the bottom line of the VDU RAM is accessed.

The second part of the circuit is simply a hold-follow latch constructed so that if the lower input to 7402a is 0, then the data on DO is held in the latch and produced on the output. This is ORed with the data from the VDU address decoding and so turns the Character Generator on (requires a one to turn it on) if either the latch has been latched to one or the bottom line of the VDU is being displayed. The pixel logic is automatically turned off when the Character Generator is on and vice versa.

The pixel logic itself is very simple. IC1 is a dual 1 of 4 data selector. Depending on C9 and C10 (which normally are address inputs to the CHR GEN) either VD0 and VD4 or VD1 and VD5 or VD2 and VD6 etc. are produced on the outputs. This in effect divides the normal character position into 8 blocks as required. IC2 is to isolate IC1 from the Shift Register inputs and prevents the Shift Register inputs being connected to each other as would otherwise happen.

C. M. Taggart, St. Albans

Watford Electronics' new 4K monitor WEMON uses the top 4K of memory (including address F17F). Those who have this ROM should use the alternative address coding shown in Fig. 1.

To turn the pixel graphics on: POKE 61823,0 (or POKE 58239,0 when 4K monitor is present).

To turn the pixel graphics off: POKE 61823,1 (or POKE 58239,1 when 4K monitor is present).

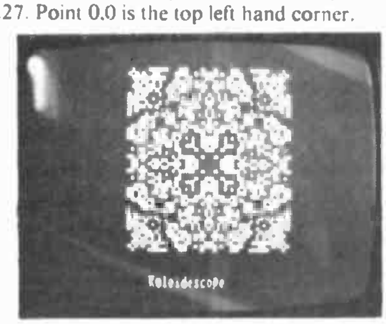
Since the first address in the screen memory that can be seen on the TV varies with the version of UK 101, the routines work as follows:

Horizontal position of pixel point is POKE'd into address 226.

Vertical position of pixel point is POKE'd into address 227.

X=USR(X) should then be performed.

To set a pixel point on the screen :POKE 11,150:POKE 12,31. The pixel point's position should be then put into addresses 226 and 227. Point 0,0 is the top left hand corner.



E.g. to set point 64,31:

POKE 61823,0 to turn the pixels on.

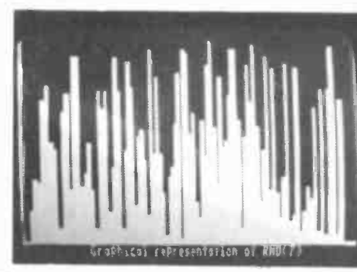
POKE 11,150:POKE 12,31 to use set routine.

POKE 226,64: POKE 227,31: X=USR(X) The pixel's position is specified and this point is set i.e. made white.

To reset a point, i.e. make it black, this routine should be used with POKE 11,158 instead of POKE 11,150.

To find out whether a point is black or white POKE 11,168 and after the routine has been used address 228 will be zero if the point is black and non-zero if it is white. When the routines have been loaded 8082 should be answered to MEMORY SIZE?

All these addresses are for an 8K UK101. For a 4K machine the routines should be put into memory from 0F96 to 0FFF. The set, reset, and examine routines should be used as before except that POKE 12,15 must precede the X=USR(X) instead of POKE 12,31. Also addresses 0F98,0FA0,0FAA,0FE5,0FFE should be 0F rather than 1F. Finally 3986 should be answered to MEMORY SIZE? rather than 8082.



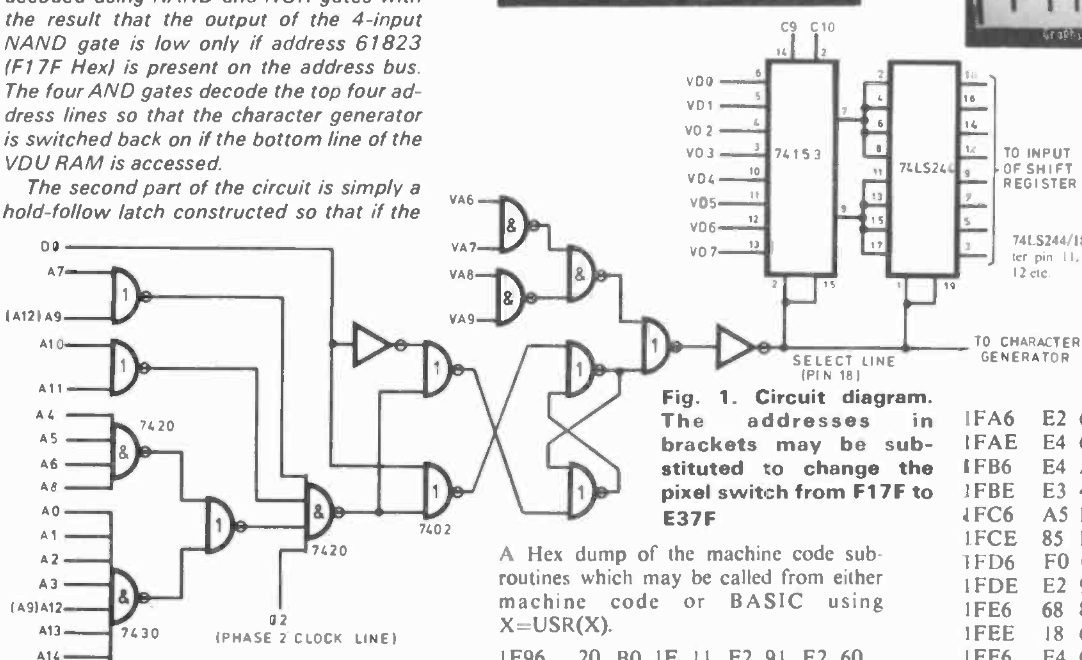


Fig. 1. Circuit diagram. The addresses in brackets may be substituted to change the pixel switch from F17F to E37F

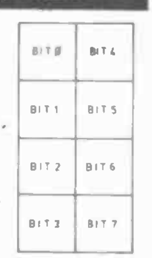


Fig. 2. Each original character position is divided into its eight pixel points

A Hex dump of the machine code subroutines which may be called from either machine code or BASIC using X=USR(X).

```
1F96  20 B0 1F 11 E2 91 E2 60
1F9E  20 B0 1F 49 FF 31 E2 91
1FA6  E2 60 20 B0 1F 31 E2 85
1FAE  E4 60 A5 E2 4A A8 0A 85
1FB6  E4 A5 E2 38 E5 E4 48 A5
1FBE  E3 4A 4A AA 0A 0A 85 E4
1FC6  A5 E3 38 E5 E4 48 A9 00
1FCE  85 E2 A9 D0 85 E3 E8 CA
1FD6  F0 0E A9 40 18 65 E2 85
1FDE  E2 90 02 E6 E3 4C D5 1F
1FE6  68 85 E4 68 F0 07 A9 04
1FEE  18 65 E4 85 E4 A9 01 E6
1FF6  E4 C6 E4 F0 04 0A 4C F7
1FFE  1F 60
```

COMPRESS

Sir—Using a BASIC program to produce DATA statements for the storage of machine code, for example, will result in DATA statements containing a large number of spaces. Consequently there will be a wastage of precious memory and the time to load the program from tape is considerably increased. This COMPRESS program will remove these spaces (spaces between quotes are unaffected).

The program takes up 157 bytes and is stored in the free space above the BASIC storage area. The program contains no Monitor subroutine calls and is therefore compatible with all Compukit monitors.

To use the program: load and run it, then NEW it. Load or write the program to be compressed, press Reset, M .0228G, CLEAR. CLEAR is necessary to reset all the program pointers.

You will be surprised at the amount of space wasted in what may look like a compact program!

Noel Caffrey,
Dublin.

BASIC LISTING

```
5 REM COMPRESS
6 REM NOEL CAFFREY JAN 1982
10 FORI=552TO709:READD:POKEI, D: NEXT
12000 DATA169,3,133,26,133,124,169,1,133,25,133
12010 DATA123,165,123,133,22,165,124,133,23,160,0
12020 DATA177,25,208,18,200,177,25,208,13,145,123
12030 DATA136,145,123,162,2,32,187,2,76,0,0
12040 DATA162,2,32,176,2,32,187,2,160,0,177
12050 DATA25,145,123,200,177,25,145,123,32,176,2
12060 DATA32,187,2,162,1,160,0,177,25,201,32
12070 DATA240,31,201,34,208,18,145,123,32,176,2
12080 DATA32,187,2,177,25,201,34,240,4,201,0
12090 DATA208,238,201,0,240,11,145,123,32,187,2
12100 DATA32,176,2,76,113,2,145,123,32,176,2
12110 DATA32,187,2,165,123,145,22,165,124,200,145
12120 DATA22,76,52,2,138,24,101,25,133,25,144
12130 DATA2,230,26,96,138,24,101,123,133,123,144
12140 DATA2,230,124,96
OK
```

ASSEMBLY LISTING

```
0228  A903    LDA  £$03      ;set up start addresses
022A  851A    STA  $1A       ;and program pointers.
022C  857C    STA  $7C
022E  A901    LDA  £$01
0230  8519    STA  $19
0232  857B    STA  $7B
0234  A57B    LDA  $7B       ;store new start address
0236  8516    STA  $16       ;for the current line.
0238  A57C    LDA  $7C
023A  8517    STA  $17
023C  A000    LDY  £$00      ;check for end of program.
023E  B119    LDA  ($19), Y
0240  D012    BNE  $0254

0242  C8      INY
0243  B119    LDA  ($19), Y
0245  D00D    BNE  $0254
0247  917B    STA  ($7B), Y  ;store end of program
0249  88      DEY            ;mark.
024A  917B    STA  ($7B), Y
024C  A202    LDX  £$02      ;increment end of program
024E  20BB02  JSR  $02BB     ;address.
0251  4C0000  JMP  $0000     ;jump to WARM START.
0254  A202    LDX  £$02      ;increment pointers.
0256  20B002  JSR  $02B0
0259  20BB02  JSR  $02BB
025C  A000    LDY  £$00      ;store line number.
025E  B119    LDA  ($19), Y

0260  917B    STA  ($7B), Y
0262  C8      INY
0263  B119    LDA  ($19), Y
0265  917B    STA  ($7B), Y
0267  20B002  JSR  $02B0     ;move to start of text.
026A  20BB02  JSR  $02BB
026D  A201    LDX  £$01
026F  A000    LDY  £$00
0271  B119    LDA  ($19), Y
0273  C920    CMP  £$20      ;space?
0275  F01F    BEQ  $0296     ;yes, then skip.
0277  C922    CMP  £$22      ;quotes?
0279  D012    BNE  $028D
027B  917B    STA  ($7B), Y  ;yes, then copy to end
                             ;of line, or end of quotes.
027D  20B002  JSR  $02B0
0280  20BB02  JSR  $02BB
0283  B119    LDA  ($19), Y
0285  C922    CMP  £$22
0287  F004    BEQ  $028D
0289  C900    CMP  £$00
028B  D0EE    BNE  $027B
028D  C900    CMP  £$00      ;end of line?
028F  F00B    BEQ  $029C
0291  917B    STA  ($7B), Y  ;store character.
0293  20BB02  JSR  $02BB
0296  20B002  JSR  $02B0
0299  4C7102  JMP  $0271     ;back to start of loop.
029C  917B    STA  ($7B), Y  ;store end of line mark.

029E  20B002  JSR  $02B0
02A1  20BB02  JSR  $02BB
02A4  A57B    LDA  $7B       ;store new link address.
02A6  9116    STA  ($16), Y
02A8  A57C    LDA  $7C
02AA  C8      INY
02AB  9116    STA  ($16), Y
02AD  4C3402  JMP  $0234
02B0  8A      TXA            ;subroutine to increment
02B1  18      CLC            ;pointers to old program.
02B2  6519    ADC  $19
02B4  8519    STA  $19
02B6  9002    BCC  $02BA
02B8  E61A    INC  $1A

02BA  60      RTS
02BB  8A      TXA            ;subroutine to increment
02BC  18      CLC            ;pointers to new program.
02BD  657B    ADC  $7B
02BF  857B    STA  $7B
02C1  9002    BCC  $02C5
02C3  E67C    INC  $7C
02C5  60      RTS
```

Noel Caffrey,
Dublin.

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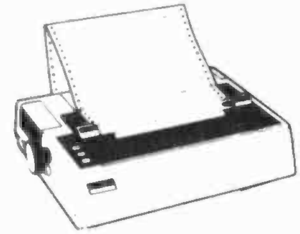

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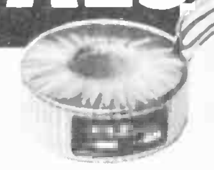

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18%	1x014	18 + 18	0 83	
	1x015	22 + 22	0 68	
	1x016	25 + 25	0 60	
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13%	2x014	18 + 18	1 38	
	2x015	22 + 22	1 13	
	2x016	25 + 25	1 00	
	2x017	30 + 30	0.83	
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Regulation	5x014	18 + 18	4 44	TOTAL £11 02
8%	5x015	22 + 22	3 63	
	5x016	25 + 25	3.20	
	5x017	30 + 30	2 66	
	5x018	35 + 35	2 28	
	5x026	40 + 40	2 00	
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	5x029	220	0.72	
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Regulation	6x015	22 + 22	5 11	TOTAL £12 88
7%	6x016	25 + 25	4.50	
	6x017	30 + 30	3 75	
	6x018	35 + 35	3 21	
	6x026	40 + 40	2 81	
	6x025	45 + 45	2.50	
	6x033	50 + 50	2 25	
	6x028	110	2 04	
	6x029	220	1 02	
	6x030	240	0 93	
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2 6 Kg	7x015	22 + 22	6.82	+ VAT £1 83
Regulation	7x016	25 + 25	6 00	TOTAL £14 00
6%	7x017	30 + 30	5.00	
	7x018	35 + 35	4 28	
	7x026	40 + 40	3 75	
	7x025	45 + 45	3 33	
	7x033	50 + 50	3.00	
	7x028	110	2 72	
	7x029	220	1 36	
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4 Kg	8x018	35 + 35	7 14	+ VAT £2 38
Regulation	8x026	40 + 40	6 25	TOTAL £18 26
4%	8x025	45 + 45	5 55	
	8x033	50 + 50	5 00	
	8x042	55 + 55	4 54	
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	8x029	220	2 27	
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5 Kg	9x026	40 + 40	7 81	+ VAT £2 79
Regulation	9x025	45 + 45	6 94	TOTAL £21 42
4%	9x033	50 + 50	6 25	
	9x042	55 + 55	5 68	
	9x028	110	5 68	
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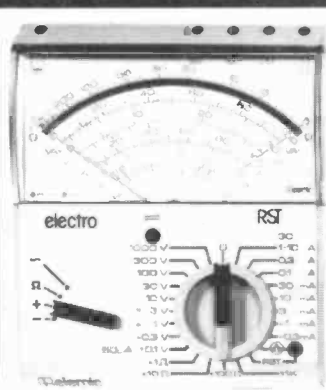

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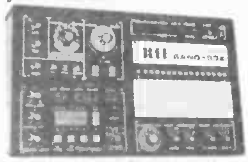

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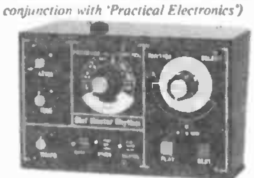

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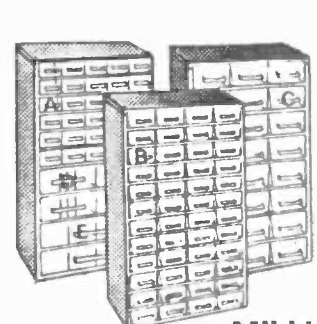

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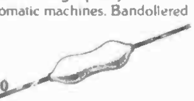

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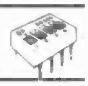

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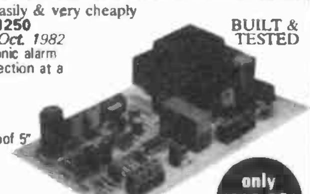

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