608

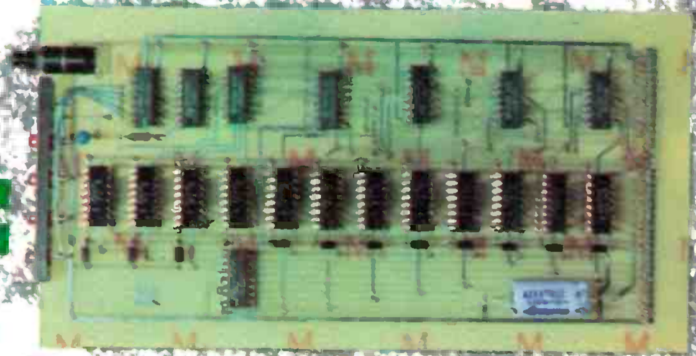
Australia $1.50 New Zealand $1.60 Malaysia $4.95 IR £1.30 (inc. VAT)

PRACTICAL ELECTRONICS

SEPTEMBER 1983

90p

A MORE RELIABLE MEMORY...



Computer Soft Error Correction Board

GUITAR ACTIVE TONE CONTROLS

UK SATELLITE TV SYSTEM Explained

Used Computer and Test Gear Bargains

SAVE ON THE PRICE OF YOUR COLOUR PRINTS!

with the Practical Electronics Colour Print Service

While prices go up elsewhere, Practical Electronics makes a bargain offer in its Colour Print Service. Now you can have as many films printed as you like, including Giant Superprints, at only 12p a print. There is no developing charge and just 25p towards postage and packing.

At this new price, the magazine Colour Print Service, already used by hundreds of thousands of readers, is as fast and efficient as ever. Here's all you have to do to enjoy its advantages.

Send any make of colour print film, including disc film, inside the envelope enclosed with this issue. Or fill in the coupon below and send with your colour print film in a strong envelope to: **Practical Electronics Colour Print Service, FREEPOST, READING RG1 1BR. No stamp is required.**

SEND NO MONEY

We are so confident in the reliability of our service and the quality of our prints (each one date-stamped with the month and year of developing) that you don't pay until you've seen them.

LUXURY COLOUR PRINTS

You will be amazed at the beautiful colours and sheen finish of these prints. They have elegant rounded corners and are borderless to give you maximum picture area. And with the Giant Superprints, you get 30 per cent more picture area than the standard enprints *at no extra cost!*

UNBEATABLE VALUE

All you pay for the Colour Print Service is 12p for each good print received plus 25p towards postage and packing. The most you would pay us for processing and printing a 24-exposure film for example is £3.13. Compare that with the price you would pay in the shops.

FREE ALBUM PAGES

With each film we process, you receive an album page voucher. Collect and return three vouchers, and you receive a set of FREE album pages to fit into our specially designed album for any size of print up to 4in. by 6in.

HOW YOU BENEFIT

You benefit in three ways. Firstly, you pay nothing for the actual processing—only for prints and postage and packing. Secondly, you enjoy a personal service with every care taken over each individual order. And thirdly, you pay only for what you get—with no credit vouchers as with many other companies. An invoice comes with your prints, so it is a straight business transaction.

48 HOURS IN-LAB SERVICE

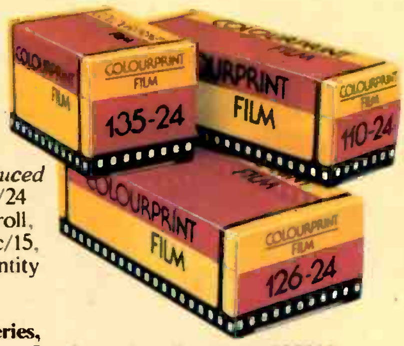
Your films will be processed within 48 hours* of receipt, but please allow for postal delays.

The price of this offer is limited to the U.K.

*C41 Process cassette and cartridge film only.

FILMS AT REDUCED PRICES

Always keep your camera action-ready. Order replacement films *at our specially reduced prices:* 110/24, 126/24 or 35/24 at £1.20 a roll, or three for £3; disc/15, £1.30 each (no quantity discount).



Offer excludes Black & White, transparency, sub-miniature, C22 & Agfa CNS film.
Superprints can only be produced from Kodacolour II, C41 cassette, cartridge and disc film not half frame. Prices correct at time of going to press.

If you have any queries, contact our Customer Service on Reading (0734) 597332.

Use this label if you have no envelope, or pass it to a friend. It is used to pack your prints.

To: Practical Electronics Colour Print Service
FREEPOST, Reading RG1 1BR

● Please print my film Superprint size ☐
Standard Enprint size ☐

If film is being ordered ● Please send me ______
of 110/24 ☐ of 126/24 ☐ of 35/24 ☐ of disc/15 ☐

● Tick box(es) as required.

From: Practical Electronics Colour Print Service
FREEPOST, READING RG1 1BR

Mr/Ms ______

Address ______

______

______ Postcode ______

PRACTICAL
ELECTRONICS

VOLUME 19 No. 9 SEPTEMBER 1983

CONSTRUCTIONAL PROJECTS

GENERAL FEATURES

NEWS AND COMMENT

SPECIAL SUPPLEMENT

OUR OCTOBER ISSUE WILL BE ON SALE FRIDAY, SEPTEMBER 2nd, 1983
(for details of contents see page 10/6 of Micro-file)

WATFORD ELECTRONICS

33, CARDIFF ROAD, WATFORD, HERTS WD1 8ED, ENGLAND
Tel. Watford (0923) 40588. Telex: 8956095 WAELEC

ALL DEVICES BRAND NEW, FULL SPEC. AND FULLY GUARANTEED. SEND CASH, P.O.'s OR CHEQUE WITH ORDER. GOVERNMENT AND EDUCATIONAL INSTITUTIONS OFFICIAL ORDERS ACCEPTED (ACCESS ORDERS BY TEL. PHONE 0923-50234). TRADE AND EXPORT INQUIRY WELCOME. P & P ADD 50p TO ALL CASH ORDERS. OVERSEAS POSTAGE AT COST.

VAT Export orders no VAT. U.K. customers please add 15% VAT to total cost incl. p&p. We stock thousands more items. It pays to visit us. We are situated behind Watford Football Ground. Open Monday to Saturday, 9.00 am to 6.00pm. Ample FREE Car parking.

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 **15p**; 47 **12p**; 68 **16p**; 100 **19p**; 220 **26p**; 1000 **70p**; 2200 **99p**; **50V:** 68 **20p**; 100 **17p**; 220 **24p**; **40V:** 68 **15p**; 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**.

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**.

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

SLIDER POTENTIOMETERS
0.25W log and linear values 60mm track
5KΩ-500KΩ Single gang **70p**

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

SILVER MICA (pf)
2, 3.3, 4.7, 6.8, 8.2, 10, 12, 18, 22, 27, 33, 39, 47, 50, 56, 68, 75, 82, 85, 100, 120, 150, 180 **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**.

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

	RANGE	Val.	1-99	100+
0.25W	2Ω2-4M7	E24	3p	1p
0.5W	2Ω2-4M7	E12	3p	1p
1W	2Ω2-10M	E12	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, 6K8, 10K, 22K, 47K, 100K **26p.**

TRANSISTORS

AC125/6	35
AC127/8	35
AC141/2	30
AC176	28
AC187/8	32
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
BD695A	125
BD696A	125
BF180	38
BF194/5	12
BF198/9	18
BF200	30
BF224	25
BF244A	28
BF244B	29
BF256B	35
BF257/8	32
BF259	35
BF336	30
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
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	55
MPSU52	65
MPSU55	60
MPSU56	60
OC23	170
OC28/36	220
OC41/42	75
OC44	29
OC70	40
OC76	50
OC81/82	50
OC83/84	40
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	80
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
ZTX320/26	30
ZTX451	23
ZTX500/1	14
ZTX502/3	18
ZTX504	25
ZTX531	25
ZTX550	25
2N696	23
2N697	23
2N698	40
2N699	48
2N706A	19
2N708	19
2N914/5	19
2N918	35
2N930	20
2N1131/2	24
2N1303/4/5	
2N1307/8	65

2N1613	30
2N1671B	160
2N2160	295
2N2219A/20A/21A/22A	25
2N2369A	18
2N2646	45
2N2846	80
2N2904A/05A/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
2N3906/5	15
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	200
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
8037CJ	850
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	420
AY-3-8912	450
AY-5-1230	450
AY-5-1317A	630
CA3011	130
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	376
CA3123	165
CA3130	90
CA3140	40
CA3160	95
CA3161E	160
CA3162E	450
CA3189	200
CA3240	110
HA1366	175
HA1388	255
ICL7106	690
ICL7107	975
ICL7204	550
ICL7611	99
ICL7660	248
ICL8038CC	300
ICL8211	175
ICM7204	550
ICM7205	1150
ICM7207	475
ICM7215	1050
ICM7216A	£22
ICM7217A	750
ICM7224	785
ICM7240	300
ICM7555	80
ICM7556	150
LA3350	220
LA4031P	240
LA4032	295
LA4400	295
LA4422	275
LC7120	350
LC7130	340
LC7137	395
LF347	150
LF351	48
LF353	95
LF355	85
LF356	95
LF357	110
LF398	475
LM10	325
LM301A	24
LM307	45
LM308	95

LM311	55
LM318	150
LM319	195
LM324	30
LM334Z	90
LM335	128
LM339	47
LM348	60
LM349	115
LM358	60
LM377	175
LM379	480
LM380	75
LM381N	145
LM382	115
LM384	160
LM386	90
LM387	120
LM389	95
LM392	60
LM393	45
LM394CH	290
LM725CN	325
LM733	70
LM2917	195
LM3302	75
LM3900	50
LM3909	85
LM3911	125
LM3914	200
LM3915	200
LM3916	225
LM13600	110
LS7220	280
M706B1	125
M51513L	230
M51515L	320
MB3712	220
MB3756	440
MC1303	98
MC1304P	260
MC1310P	150
MC1445	250
MC1455	35
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
NE556DB	45
NE558	140
NE560	325
NE561	395
NE562B	410
NE564	420
NE565A	120
NE566	155
NE567	140
NE570	410
NE571	400
NE5532	145
NE5534	105
OM335	750
RC4136D	60
RC4558	45
S566B	225
SAB3209	426

SAB3210	325
SAB3271	485
SAB4209	595
SG3402	295
SL490	350
SL6270	150
SN76013N	350
SN76033	350
SN76477	420
SN76488	480
SP8629	299
TA7120	125
TA7130	125
TA7204	195
TA7205	175
TA7222	150
TAA900	395
TAB1042	110
TAD100	159
TBA120S	70
TBA540	275
TBA550Q	330
TBA641	290
TBA651	190
TBA800	80
TBA810S	95
TBA820	80
TBA920Q	200
TBA990	350
TCA270	350
TCA280A	220
TCA940	175
TCA965	145
TDA1004	290
TDA1010	198
TDA1022	499
TDA1024	115
TDA1034	350
TDA1490	350
TDA2002	325
TDA2003	198
TDA2004	495
TDA2006	330
TDA2020	320
TDA2030	295
TDB0791	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
TL430C	90
TL507	110
UA2240	100
UA78540	230
UAA170	180
UAA180	180
UGN3020T	160
ULN2001	80
ULN2003	75
ULN2004	75
ULN2068	290
ULN2802	200
ULN2804	150
ULN2283	100
UPC575	165
UPC1025H	265
UPC1032	95
UPC1182	270
UPC1156H	225
UPC1366	195
XR2206	300
XR2207	375
XR2211	475
XR2216	675
XR2266	360
ZN414	80
ZN419CE	180
ZN423E	130
ZN424E	130
ZN425E-8	345

ZN426E-8	300
ZN427E-8	590
ZN428E	410
ZN429E-8	210
ZN459	325
ZN1034E	200
ZN1040E	665
ZNA234E	850

COMPUTER IC's

1702	350
1802CP	650
2114L-200n	95
2147-3	425
2532-3	300
2564	£6
2708	250
2716-5V	250
2732	295
2764	425
27128/250n	£25
3242	590
4116-150	100
4118-250	325
4164-200	400
4532-3	275
4816-100ns	225
5101	220
6116-150ns	340
6116L-120ns	550
6117-100n	490
6167-6	795
6502 CPU	325
6502A	450
6520	100
6522 VIA	285
6530 RRIOT	£11
6532 RIOT	570
6545 CRTC	899
6551 ACIA	650
6592 PC	£20
6800	220
6802	250
6803	850
6804	160
6805	670
6808	520
6809	630
6810	115
6820	100
68B21	220
6821	100
6840	375
6843	00
6845	650
6847	650
6850	110
6852	250
6854	599
68B54	890
6875	500
68000 New msk	£68
8080A	275
8085A	280
8088	£18
81LS95/96	80
81LS97/97	80
8118-10	225
8123	125
8155	350
8156	350
8202	£25
8205	£20
8212	160
8214	425
8216	100
8224	180
8226	250
8228	220
8243	270
8250	850
8251A	250

8253	400
8255	225
8256A	£35
8257A	400
8259	395
8271	£36
8272	£00
8279	410
8282	450
8283	450
8284	350
8285	365
8287	£17
8288	£10
8T26A	99
8T27	150
8T28A	120
8T31	350
8T95N	90
8T97N	90
9364AP	550
9602	220
AM26LS31C	125
AM26LS32A	125
AM26LS33A	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
DP8304BN	250
DS3691N	320
DS8820	110
DS8830	110
DS8831	125
DS8832	250
DS88LS120N	275
E9365	£38
E9366	£35
FD1691	£15
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	725
MC3446	295
MC3447P	315
MC3486	225
MC3487	225
MK3886-2M	£7
MM5280D	695
MM5303	635
MM5307	1275
MM5387A	475
MM58174	700
RO-3-2513L	650
RO-3-2513U	650
SFF96364E	800
SP0256AL2	£15
TMS2716-3	725
TMS6011	365
TMS4164-15	475
TMS4416-2	475
TMS9927	£14
TMS9928	£20
TMS9929	£20
TMS5100	£10
TMS6011	365
TMS4164-15	475
ULN2003	75
UPD7002	425
Z80CPU 2.5	285
Z80ACPU4M	300
Z80CTC	250
Z80ACTC	300
Z80B	875

Z80DART	495
Z80ADART	698
Z80ADMA	896
Z80DMA	675
Z80P10	260
Z80AP10	275
Z80S10-1	850
Z80AS10	900

74S Series

74S00	24
74S02	24
74S04	30
74S05	60
74S08	60
74S10	40
74S11	50
74S20	40
74S22	50
74S30	40
74S32	70
74S37	60
74S74	75
74S85	295
74S86	70
74S112	90
74S113	90
74S114	90
74S124	300
74S132	110
74S133	60
74S138	115
74S139	115
74S140	60
74S151	180
74S153	182
74S157	225
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	450
74S374	365
74S470	325
74S471	620
74S472	1150
74S474	400
74S475	800
74S571	620
74S573	950

75 Series

75107/8/9	95
75110	90
75150	125
75154	125
75159	125
75182/3	99
75188/9	55
75322	140
75450	86
75451/2	52
75454	70
75491/2	65

TTL 74

7400	11
7401	11
7402	11
7403	12
7404	13
74L04	85
7405	15
7406	20
7407	20
7408	16
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	28
7476	25
7480	40
7481	120
7482	65
7483	38
7484	70
7485	60
7486	20
7489	170
7490	20
7491	25
7492	25
7493	25
7494	25
7495	25
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	25
74141	65

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	54
74174	54
74175	55
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	46
74192	46
74193	45
74194	40
74195	46
74196	46
74197	40
74198	80
74199	84
74221	54
74246	120
74247	120
74248	120
74249	120
74251	65
74259	150
74265	55
74273	150
74276	100
74278	100
74279	50
74283	50
74284	155
74285	155
74290	125
74293	80
74297	236
74298	100
74351	195
74365	30
74366	30
74367	30
74368	30
74390	75
74393	80
74490	95

74C

C244	195
C245	196
C373	240
C374	245
C922	400
C923	500
C925	400

74LS

LS00	11
LS01	11
LS02	11
LS03	12
LS04	12
LS05	12
LS08	12
LS09	12
LS10	12
LS11	12
LS12	12
LS13	15
LS14	26
LS15	12
LS20	12
LS21	12
LS22	12
LS26	12
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	30
LS133	24
LS136	25
LS138	25
LS139	28
LS145	70
LS147	100
LS148	70
LS151	40
LS153	40
LS154	135
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	80
LS173	50
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	50
LS245	68
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	37
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
LS674	550

CMOS

4000	10
4001	10
4002	12
4006	50
4007	14
4008	32
4009	24
4010	24
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	25
4049	25
4050	25
4051	45
4052	60
4053	50
4054	85
4055	85
4056	85
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	13
4075	13
4076	50
4077	13
4078	15
4081	13
4082	13
4085	50
4086	60
4089	125
4093	20
4094	70
4095	80
4096	70
4097	190
4098	75
4099	75
4160	95
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	35
4504	75
4505	185
4506	38
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
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	595

Step-by-step fully illustrated assembly and fitting instructions are included together with circuit descriptions. Highest quality components are used throughout.

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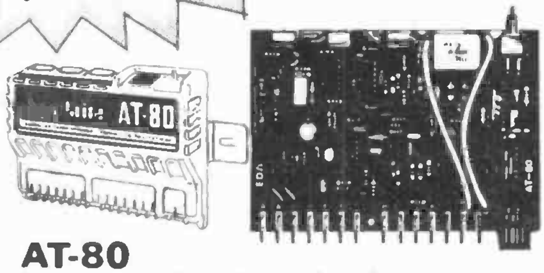

AT-80
Electronic Car Security System

- Arms doors, boot, bonnet and has security loop to protect fog/spot lamps, radio/tape, CB equipment
- Programmable personal code entry system
- Armed and disarmed from outside vehicle using a special magnetic key fob against a windscreen sensor pad adhered to the inside of the screen ● Fits all 12V neg earth vehicles
- Over 250 components to assemble

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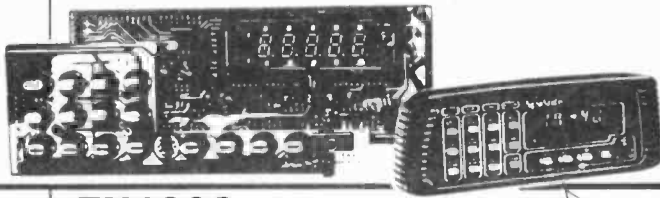
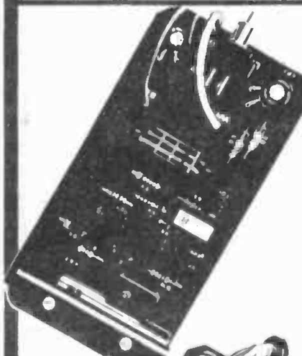
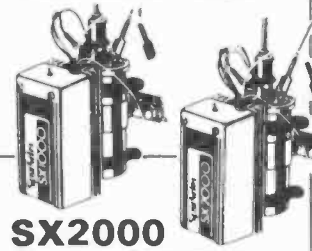
● A most sophisticated accessory ● Utilises a single chip mask programmed microprocessor incorporating a unique programme designed by EDA Sparkrite Ltd ● Affords 12 functions centred on Fuel, Speed, Distance and Time ● Visual and Audible alarms warning of Excess Speed, Frost/Ice, Lights-left-on ● Facility to operate LOG and TRIP functions independently or synchronously ● Large 10mm high 400ft-L fluorescent display with auto intensity ● Unique speed and fuel transducers giving a programmed accuracy of + or − 1% ● Large LOG & TRIP memories 2,000 miles, 180 gallons 100 hours ● Full Imperial and Metric calibrations ● Over 300 components to assemble
A real challenge for the electronics enthusiast!





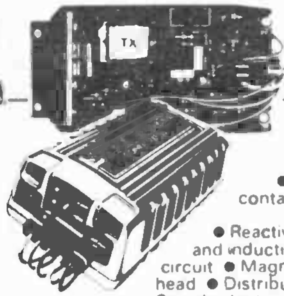
SX1000
Electronic Ignition

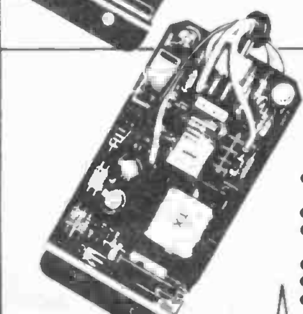
- Inductive Discharge
- Extended coil energy storage circuit
- Contact breaker driven
- Three position changeover switch
- Over 65 components to assemble
- Patented clip-to-coil fitting
- Fits all 12v neg. earth vehicles



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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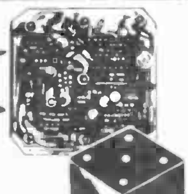

MAGIDICE
Electronic Dice

- Not an auto item but great fun for the family
- Total random selection
- Triggered by waving of hand over dice
- Bleeps and flashes during a 4 second tumble sequence
- Throw displayed for 10 seconds
- Auto display of last throw 1 second in 5
- Muting and Off switch on base
- Hours of continuous use from PP7 battery
- Over 100 components to assemble

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FULL KIT £137 Also available in 3 parts.

(Published in P.E.)

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Two Channel touch Sensitive unit plus variable angle L.F.O., phaser, Internal and external triggering.

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THREE PIECE BACKING BAND
Generates the sounds of three Instrumentalists to back Soloists

DRUMS + BASS + KEYBOARDS
Over 3,000 chord changes (60 scores) on 132 different chords – extendable to 200 scores. Master Rhythm also required.
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TDE/K	Extension kit for 2-way switching for TD300K	£ 2.50
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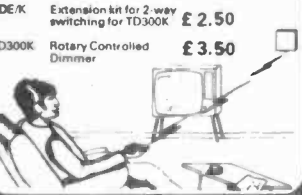

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This KIT contains a purpose designed lock IC, 10-way keyboard, PCBs and all components to construct a Digital Lock, requiring a 4-key sequence to open and providing over 5000 different combinations. The open sequence may be easily changed by means of a pre-wired plug. Size: 7 x 6 x 3 cms. Supply: 5V to 15 V d.c. at 40uA. Ouput: 750mA max. Hundreds of uses for doors and garages, car anti-theft device, electronic equipment, etc. Will drive most relays direct. Full instructions supplied. **ONLY £10.50**

Electric lock mechanism for use with latch locks and above kit **£13.50**

"OPEN-SESAME"

The XK103 is a general purpose infra-red transmitter/receiver with one momentary (normally open) relay contact and two latched transistor outputs. Designed primarily for controlling motorised garage doors and two auxiliary outputs for drive/garage lights at a range of up to 40 ft. The unit also has numerous applications in the home for switching lights, TV, closing curtains, etc. Ideal for aged or disabled persons.

The Kit comprises a mains powered receiver, a four button transmitter, complete with pre-drilled box, requiring a 9V battery and one opto-isolated solid state switch kit for inter-facing the receiver to mains appliances. As with all our kits, full instructions are supplied.

ONLY £23.75

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Based on ZN414 IC, kit includes PCB, wound aerial and crystal earpiece and all components to make a sensitive miniature radio. Size: 5.5 x 2.7 x 2cms. Requires PP3 9V battery. IDEAL FOR BEGINNERS. **£5.00**

♫ 3-NOTE DOOR CHIME ♫

Based on the SAB0600 IC the kit is supplied with all components, including loudspeaker, printed circuit board, a pre-drilled box (95 × 71 x 35mm) and full instructions. Requires only a PP3 9V battery and push-switch to complete. AN IDEAL PROJECT FOR BEGINNERS. Order as XK 102. **£5.00**

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Uses LM3911 IC to sense temperature (80°C max) and triac to switch heater (1KW). Mains powered. £4.00

MK2 SOLID STATE RELAY
Switches 240V ac motors, lights, heaters from logic/computer circuits. Zero voltage switching, opto isolated. Supplied without triac £2.60

MK4 PROPORTIONAL TEMPERATURE CONTROLLER
Uses "burst fire" technique to maintain temperature to within 0.5°C. Ideal for photography, incubators, wine making, etc. Max load 3KW (240V ac). Temp range up to 90°C. £5.56

MK5 MAINS TIMER
Mains powered timer enabling a load up to 1KW at 240V ac to be switched on (or off) for a variable time from 20 mins to 35 hrs. Longer or shorter periods possible with minor component changes. £5.00

MK15 DUAL LATCHED SOLID STATE RELAY
Comprises two MK2s with latch circuit enabling the MK12 kit to control two mains loads independently. Two output triacs not supplied. (See remote control kits.) £4.50

NEW! MK19 DC CONTROLLED AUDIO AMPLIFIER
May be used with virtually any stereo audio amplifier to control bass, volume, treble and balance remotely either using a wire link or the MK11 infra red receiver. A 1 of 10 decoder with LEDS is also included for remote input selection/display. (See remote control kits.) £10.70

COMPONENTS
a wide range in stock including:

LINEAR ICs

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556	40
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748	35
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CA3140	43
ICL7106	7.00
ICL7107	9.00
ICL7126	8.00
ICL8038	3.10
CMOS555	79
LF351	44
LF353	80
LF356	90
LM324	35
LM3342	90
LM3352	1.20
LM339	50
LM348	63
LM358	45
LM377	1.45
LM380	80
LM381	1.15
LM382	1.00
LM386	75
LM1458	35
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LM3909	60
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LM3914	2.10
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ML929	1.40
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ULN2004	85
ZN414	98
ZN425	3.40
ZN427	5.70
ZN428	4.10
ZN1034E	1.80

TRIACS

400V Plastic	
1.6A	42
4A	49
8A	58
12A	85
16A	95
25A	1.90
C4006L1	85
MOC3020	1.10
Diac	18

REGULATORS

78L05	12
15	26
79L05	12
15	60
7805	12
15	35
7905	40
LM317T	1.80
LM338K	4.60
LM723	40

CMOS

4000	11
4001	11
4002	11
4007	12
4011	11
4012	12
4013	20
4015	39
4016	20
4017	29
4019	24
4023	15
4025	15
4026	72
4027	20
4028	38
4040	39
4043	38
4046	46
4049	21
4050	21
4060	42
4069	13
4070	13
4071	13
4077	16
4081	12
4093	20
4501	24
4511	55
4514	1.15

MEMORIES

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6810	1.25
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Rectangular	55p

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J5	DOT MAN	£3.90

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Now you can run your central heating, lighting, hi-fi system and lots more with just one programmable timer. At your selection it is designed to control four mains outputs independently, switching on and off at pre-set times over a 7 day cycle, e.g. to control your central heating (including different switching times for weekends). Just connect it to your system programme and set it and forget it—the clock will do the rest.

FEATURES INCLUDE:-

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Now only £39.00

(Kit includes all components, PCB, box, assembly and programming instructions)
Order as CT6000

XK114 OPTIONAL RELAY KIT
Kit includes one relay, PCB to accommodate up to four relays, terminal blocks etc to fit inside CT6000 box. Provides up to four 3amp 240V AC changeover contacts **£3.90**

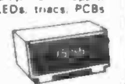
Additional relays £1.65 each

COMPONENT PACKS

PACK 1 650 Resistors 47 ohm to 10 Mohm — 10 per value £4.00
PACK 2 40 × 16V Electrolytic Capacitors 10μF to 1000μF — 5 per value £3.25
PACK 3 60 Polyester Capacitors 0.01 to 1μF/250V — 5 per value £5.55
PACK 4 45 Sub-miniature Presets 100 ohm to 1 Mohm — 5 per value £2.90
PACK 5 30 Low Profile IC Sockets 8, 14 and 16 — pin — 10 of each £2.40
PACK 6 25 Red LEDs (5mm dia.) £1.25

24 HOUR CLOCK/ APPLIANCE TIMER KIT

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



CT1000K Basic Kit	£14.90
CT1000K with white box (56/131 × 71mm)	£17.40
(Ready Built)	£22.50

DISCO LIGHTING KITS

DL 1000K
This value for money kit features a bi-directional sequence, speed of sequence and frequency of direction change being variable by means of potentiometers and incorporates a master dimming control. **£14.60**

DLZ1000K
A lower cost version of the above, featuring unidirectional channel sequence with speed variable by means of a pre-set pot. Outputs switched only at mains zero crossing points to reduce radio interference to a minimum **£8.00**

Optional opto input DLA1
Allowing audio ("beat") — light response **60p**

DL3000K
This 3 channel sound to light kit features zero voltage switching, automatic level control and built in mic. No connections to speaker or amp required. No knobs to adjust — simply connect to mains supply and lamps. (1Kw channel) **Only £11.95**

LCD 3½ DIGIT MULTIMETER

16 ranges including DC voltage (200 mv-1000 v) and AC voltage, DC current (200 mA-10 A) and resistance (0-2 M) + NPN & PNP transistor gain and diode check. Input impedance 10M. Size 155x88x31 mm. Requires PP3 9v battery.
Test leads included **ONLY £29.00**

HOME CONTROL CENTRE

This kit enables you to control up to 16 different appliances anywhere in the house from the comfort of your armchair. The transmitter injects coded pulses into the mains which are decoded by receiver modules connected to the same mains supply and used to switch on the appliance addressed. The transmitter also includes a COMPUTER interface so you can programme your favourite micro (eg ZX81) to switch lights, heating, electric blanket, make your morning coffee, etc., automatically without rewiring your house. JUST THINK OF THE POSSIBILITIES. The kit includes all PCBs and components for one transmitter and two receivers, plus a pre-drilled box for the transmitter.

Order as XK112. **£42.00**

Additional Receivers XK111 £10.00

REMOTE CONTROL KITS

FOR A DETAILED BOOKLET ON REMOTE CONTROL — send 30p + 6" × 9" S.A.E.

MK6 SIMPLE INFRA RED TRANSMITTER
Supplied with hand-held plastic box. Requires 9V (PP3) battery £4.20

MK7 INFRA RED RECEIVER
Mains powered with triac output to switch up to 500W at 240V ac. Range approx. 20 ft. on off or momentary control £9.00
IRC 500K — special price for MK6, MK7 £12.50

MK9 4-WAY KEYBOARD
For use with MK 18, MK 12 transmitter receiver where only 4 channels are required £1.90

MK10 16-WAY KEYBOARD £5.40

MK11 10 channel + 3 analogue o/p receiver
A mains powered I.R. receiver providing control signals to 10 on/off and 3 analogue circuits. May be used for controlling the volume of an amplifier, brightness of a lamp etc. £12.00

MK12 16-CHANNEL I.R. RECEIVER
A mains powered I.R. Receiver providing up to 16 outputs for switching £11.95

MK18 based on the SL490. This kit includes all components to make a coded transmitter. Requires a PP3 battery and keyboard (MK9, MK10 or MK13) size 8 × 2 × 1.3cm. Range approx. 60 ft. £6.20

MK13 11 way keyboard for use with MK18 and MK11 kits £4.35

DVM/ULTRA SENSITIVE THERMOMETER KIT

This new design is based on the ICL7126 (a lower power version of the ICL7106 chip) and a 3½ digit liquid crystal display. This kit will form the basis of a digital multimeter (only a few additional resistors and switches are required—details supplied), or a sensitive digital thermometer (-50°C to +150°C) reading to 0.1°C. The basic kit has a sensitivity of 200mV for a full scale reading, automatic polarity indication and an ultra low power requirement—giving a 2 year typical battery life from a standard 9V PP3 when used 8 hours a day, 7 days a week

Price £15.50

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Please do not wait until the last moment to inform us. When you write, we will tell you how to make your claim and what evidence of payment is required.

We guarantee to meet clais from readers made in accordance with the above procedure a soon as possible after the Advertiser has been declared bankrupt or insolvent.

This guarantee covers only advance payment sent in direct response to an advertisement in this magazine not, for example payment made in response to catalogues etc. received as a result of answering such advertisements. Classified advertisements are excluded.

PE VOLUME 19 No. 9 SEPTEMBER 1983

TOO GOOD

YOU have never had it so good, a comment that is almost guaranteed to put backs up even before any clarification. However, this was felt recently when we needed to order some items. Perhaps it would be more accurate to say things are not good in other areas and this makes us thankful for the distributors and retailers in the electronics industry.

What was it we were ordering? Not a special gear wheel for a sewing machine made in Outer Mongolia but simply some control knobs for a current Thorn/EMI domestic appliance. Similar to the sort we fit every week to our projects, but of course the spindle size just had to be different and we wanted the knobs to match existing ones. Therefore it was no good ordering from one of our advertisers. Had we been able to the knobs would have cost about £1 each, we could have ordered with a credit card over the 'phone, or even by computer via a modem, and the order would probably have arrived after a few days. Not a bad service considering that many retailers stock more than 5000 items, most of which are worth less than about £2. Postage would have been about 50p maximum.

LUCK

Just contrast this with the Thorn/EMI story: First we asked about replacement parts in the local appliance showroom — a large independent retail chain — a very helpful assistant informed us that it would be best and quickest to contact the manufacturer direct. The assistant supplied an address but did not have a phone number. He wished us luck; we later found out why! Back at the office a call to directory enquiries resulted in two phone numbers, for different factories, and a local Thorn/EMI department number. Now the story begins:

Dial the first number, a lady quickly answers, we inform her we want to order some replacement knobs. "You have to go to your local 'electric' to order them".

"But we were told to phone you direct, it would be quicker."

"Everyone knows we don't deal direct anymore" she says, ending the conversation.

We decide to try the other number — no reply. We try the local department instead. They are helpful and tell us to phone the second number, for a price and how to order, but since it is after 4.00 on Friday they will be closed.

Monday morning, we dial the number, engaged, try again — engaged, try later — engaged, try again . . . Anyway, Tuesday we get through, we even get to the right department (after being cut off once). "Yes Sir we can supply. The price is £3·28, how many do you want?"

"Only one set of four."

"No Sir, that is £3·28 *each* — plus VAT of course."

"Why are they so expensive? They are only simple knobs!"

"Don't know Sir, but the price is correct. Just send us a cheque."

Still amazed at the price we ring off and send the cheque, with a letter asking why they are so expensive. Ten days, £15·08 (we could buy *five* Z80 microprocessors for that!), four phone calls and a letter later the knobs arrive—they are not gold plated! The following printed note is attached: '. . . it should be remembered that recent inflation has upset the relationship between parts prices and the original cost of appliances'.

Technical *and* **Editorial** *queries and letters (see note below) to:*
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We regret that lengthy technical enquiries cannot be answered over the telephone

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

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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, postal orders and international money orders should be made payable to IPC Magazines Limited. Payment can also be made using any credit card and orders placed via Teledata Tel. 01-200 0200.

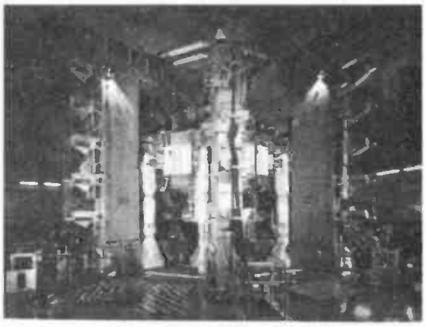
JET START-UP

The JET (Joint European Torus) experiment which was the subject of a feature in the June issue of PE was operated for the first time at Culham in Oxfordshire during the weekend of 25/26 June 1983, having been completed on time and within a few per cent of the cost estimates made in 1975 (taking inflation into account). This marks the culmination of a five-year construction programme, costing £175 million at current prices, which has been carried through by an international team drawn from the 11 European countries participating in the Project.

JET is the largest and most ambitious tokamak in the world and has been constructed mainly with funds from the European Communities, as part of the EURATOM Fusion Programme. Completion of the construction enables the start of a 7 year programme of experiments to determine the feasibility of using nuclear fusion to provide a long term energy source. Several further steps beyond JET will be required to reach a commercial nuclear fusion power station in the next century.

The conditions obtained during the start-up operation of JET were very modest compared to the ultimate performance expected. A current of 60 thousand amperes was passed through a low density hydrogen gas for a period of one tenth of a second, converting the gas to a plasma. In the envisaged JET experimental programme this current will be progressively increased to around 5 million amperes. In later years massive additional heating equipment (25MW) will be added to the machine with the aim of raising the hydrogen plasma to a temperature around 50 million degrees for periods of about 10 seconds. If this is successful then towards the end of the project deuterium and tritium gas instead of hydrogen will be introduced into the machine to produce fusion reactions, when it is hoped that the self-heating effect will further raise the temperature to the required 100 million degrees centigrade, hotter than the centre of the sun, releasing bursts of high energy neutrons. In a future fusion reactor these neutrons will be the source of heat for producing electricity. Of the various fusion experiments in the world only JET and the American TFTR tokamaks have been designed to operate with deuterium and tritium plasmas. Neither JET nor TFTR have, however, been designed to utilize the energy from these neutrons.

The successful completion of the JET device is a major step forward in the development of nuclear fusion as a new source of energy for Europe. If the outcome of the experiments on JET is positive then it will still be necessary to build another machine to study and solve the engineering and technological aspects of fusion before a demonstration reactor can be built. It will therefore be well into the next century, ie 2020 – 2030, before a commercial nuclear fusion power station could be built.



CASE HARDENED

Crofton Electronics have just launched a replica of the case for the BBC Micro in sheet steel. Although the case is heavier than the original it is strong enough to support disk drives and a monitor.

Fitting the case is quite straightforward and only requires a few simple hand tools. The keyboard surround, back label and input/output labels are merely taken off the original case and refitted to the new one by means of double sided Sellotape.

Crofton also intend to produce an alternative top cover with an integral floppy disk housing with a platform large enough to support a 14" colour monitor.

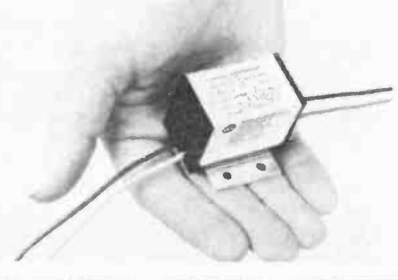
The retail price of the standard case is £39·50 inclusive. Crofton Electronics Ltd., 35 Grosvenor Road, Twickenham, Middlesex TW1 4AD (01-891 1923).

BATTERY MONITOR

A new device has been developed by S&W Battery Charging Systems Limited to prevent premature battery failure and to reduce the costs of battery maintenance. This unit may be simply inserted between the charger and the battery.

No larger than a matchbox, the unit is designed to constantly monitor battery voltage without interrupting the system. Once the cells are fully charged, the controller will pass only sufficient current to maintain the battery in a fully charged condition without overcharge.

The controller which can easily be fitted into existing charging systems can be adjusted externally to give a variety of voltages, thereby making one unit suitable for a wide range of lead acid or nickel cadmium batteries.



The unit is priced at £19·95 including VAT and p&p. S&W Battery Charging Systems Ltd., Nailsea Trading Estate, Southfield Road, Nailsea, Bristol (0272 855161).

Software Library

A program library is being formed to keep up the supply of software for OSI/UK101 computers.

Programs will be available, several to a tape, for a small charge to cover professional duplication, post and packing.

The library is looking for anyone who can

MARKET PLACE

donate programs (a major ex-dealer has generously offered to donate his entire program range already) or help in any other way.

Tape 1, to get things moving, is available now for £2·50. Contents include games, novelties and BASIC Remember and tape file programs, all of which run under CE GMON, preferably with an enhanced screen. All cheques to the 'OSI/UK Program Library' please, to the address below.

For further details see the OSI/UK User Group Newsletter or contact Mr F. J. Leonhardt, 2, Birchmead Avenue, Pinner, Middlesex HA5 2BG (01-866 7010) weekends.

PAN 2001

The Pantec Pan 2001 is a high quality multimeter which is available by mail order from Electronic & Computer Workshop Ltd., priced at £99·00 plus £1·00 p&p and VAT.

The unit will measure d.c.–a.c. voltages from 100µV to 1000V in 5 ranges; d.c.–a.c. current from 1µA to 10A in 6 ranges; resistances from 0·1 ohms to 20Mohms in 6 ranges and capacitance from 1pF to 20µF in 5 ranges. An optional temperature measuring facility gives a –50°C to +150°C measuring range.

Specifications include a 3½ digit 19mm l.c.d., automatic polarity, overload indication and battery test, a 10Hz to 30Hz frequency range, with protection on all ranges up to 250V a.c./d.c. Power consumption is low with battery life in excess of 200 hours' continuous operation.

Electronic & Computer Workshop Ltd., 171 Broomfield Road, Chelmsford, Essex (0245 62149).

P.c.b. Services

Unless it is otherwise stated in the components list p.c.b.s for projects in PE can be obtained from the following suppliers:

Proto Design, 14 Downham Road, Ramsden Heath, Billericay, Essex CN11 1PU (0268 710722)

Bradley Printed Circuits, 9 Harcourt Terrace, Headington, Oxford (0865 60741)

Magenta Electronics Ltd., 135 Hunter St., Burton-on-Trent, Staffs DE14 2ST (0283 65435)

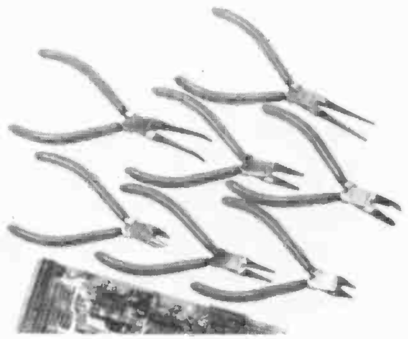
Payne Electroprint Ltd., Marcus Road, Dunkeswell, Honiton, Devon EX14 0RA (040 489 646)

Stanfield, 96 Woodend, Handsworth Wood, Birmingham (021 357 7621)

TOOL RANGE

A range of seven precision instrument pliers have been added to the Draper selection of high quality hand tools for the electronics market.

The tools are intended to give lifelong trouble free service under everyday working conditions and are all manufactured in induction hardened chrome vanadium steel with blue PVC coated handles.



The range includes both short, straight and bent needle nose pliers. Flat nose pliers and plain, thin jaw and angle head cutting pliers. All are ideal for miniature electronic assembly, model making and precision engineering applications.

They are priced between £5·26 and £6·85 each (plus VAT). Draper Tools Ltd., Hursley Road, Chandler's Ford, Eastleigh, Hants. SO5 5YF (04215 66355).

4½ DIGIT DMM

Keithley Instruments have announced a 4½ digit DMM with a current measuring capability to 20A. The unit, model 179A, has a large l.e.d. display with a full scale of 20,000 counts (4½ digits). It can measure a.c./d.c. voltages from 10µV to 1000V full scale, resistance from 0·1 ohms per digit to 20MΩ and a.c. and d.c. current from 10µA up to 20A. The a.c. conversion technique is TRMS which provides accurate readings of complex waveforms over the frequency range of 45Hz to 20kHz.

Hi-Lo ohms is fitted as standard for easy in circuit resistance measurements.

The 179A which is priced at £229·00 excluding VAT and p&p can be connected as a talker to a controller using the model 1793 IEEE interface. A BCD interface and rechargeable battery pack is also available. Keithley Instruments Limited, 1 Boulton Road, Reading, Berkshire RG2 0NL (0734) 861287.

Silicon News Corner

Bulletins announcing new semiconductor devices arrive at PE daily, so it is possible only to describe them briefly. Details of how to obtain further information are included, however.

Motorola ▶ The H11AA1 and H11AA2 are two new dual l.e.d. opto-couplers with back-to-back (a.c. mode) IR l.e.d.s. Isolation is to 7500V and they are directly interchangeable with GE H11AA1/2.

▶ The LM137 series regulators are 3-terminal, adjustable negative voltage units with internal current limiting, thermal shut-down and safe area compensation. They are virtually blow-out proof, remaining so even if the adjustment terminal goes o/c.

▶ A 7-bit high speed parallel ADC employing ECL process. Comprises 128 parallel latched comparators across a high quality input reference network. Overrange output allows paralleling of the ADCs. These 15MHz devices are called MC10315L and MC10317L. Input from –2V to +2V.

▶ MOS power transistor range with breakdown voltages up to 900V. Eight types, each 3A Id: MTM3N55 to MTM2N90 (TO3), and MTP3N55 to MTP2N90 (TO-220). Motorola Ltd., York House, Empire Way, Wembley, Middlesex.

Marconi ▶ Unique rugged glass-wall diode with 2500GHz cut-off frequency, called the DC1346. Has low capacitance and resistance. Marconi Electronic Devices Ltd., Doddington Road, Lincoln LN6 0LF.

Mitsubishi ▶ A mass produced 64K Mask ROM capable of high speed reading (250ns access). Consumes 40mA (10mA standby), is TTL compatible, organised as 8192 x 8 bits, and is called the M5M2364P. Mitsubishi Electric Corp.

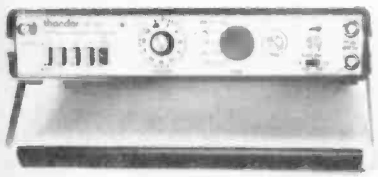
RCA ▶ 10A Versawatt SCR added to sensitive-gate family. The S4060 has µA gate sensitivity with working voltages up to 800V, and current surges up to 120A. Thermal resistance is only 2°C/W. Comes in plastic TO-220AB package. RCA, Lincoln Way, Windmill Road, Sunbury-on-Thames, Middlesex.

Hitachi ▶ DMA controller called HD68450 is first of a new family of intelligent 68000 support chips. Transfer rates of 2 megawords/Sec possible. Four channels/chip, each with 16MByte memory addressing. Can mix 8 and 16 bit operation, and can monitor system and then *automatically* adjust data rates to maximum efficiency. Hitachi Electronic Components (UK) Ltd., Hitec House, 221 Station Road, Harrow, Middlesex.

FUNCTION GENERATOR

The TG101 is mains operated 0·02Hz to 200kHz function generator with selectable waveforms of sine, square, triangle and d.c. from a variable amplitude 600Ω output. A TTL output is also provided.

Frequency is selected by a five position range switch and a calibrated vernier or can be controlled by the sweep input which enables the generator frequency to be adjusted or modulated by an external control voltage. Both vernier and sweep input can give >1000: 1 frequency change within the selected range. Typical external sweep range is 10,000: 1.



A single vernier plus two position switched attenuator control the level of the 600Ω variable output over a >80dB range up to a maximum of 10V peak to peak. D.C. offset is switch selectable and the vernier provides adjustment of up to ±5V.

The TG101, which is priced at £99 plus VAT, is housed in a ABS case measuring 255×150×50mm and weighs 1200gms. It will operate from a 50/60Hz supply of 100–120V a.c. or 200–240V a.c.

Thandor Electronics Limited, London Road, St Ives, Huntingdon, Cambs PE17 4HJ (0480 64646).

Robot Race

Teenagers in 21 schools are tuning up their computers for Britain's first "race of the robots."

At stake is more than £2,000 prize money offered by BP Oil in their Buildarobot Competition in which schools have been challenged to design and build their own classroom robots.

Although the full details of the microchip marvels are remaining strictly under wraps until the competition finals in October, one school has already revealed that its robot could be used for finding lost golf-balls, while another could be adapted to serve afternoon tea.

The competition itself, run as part of the oil company's "Challenge to Youth" series, has actually set less daunting tasks. Teams have been given two options — to design a robot which will retrieve and return a cube, or to make a robot to carry out a specific task of their choosing.

The winners will be decided at the Royal Electrical and Mechanical Engineers' Arborfield Garrison on 23 and 24 October.

Boys at Shrewsbury School are using an immensely powerful microchip, and parts salvaged from a 20-year-old mainframe computer to build their self-contained robot in the "free choice" section. In the competition, its job will be to search out a route and then locate an object.

"We've tried it out in the school courtyard, and found that it could be programmed to bring me a gin and tonic without knocking over any ornaments, or else serve me with afternoon tea in my garden," said the school's head of computing, Mr Roscoe.

Meanwhile, both the Royal Latin School, in Brookfields, Bucks, and the Rednock Comprehensive School in Dursley, Gloucestershire, are building robots for the cube-retrieval section of the competition.

Five boys at the Royal Latin School are using two miniature radar transmitters to home their robot in on the cube, guided by a special program they have written for the school's BBC computer.

Two Rednock schoolboys are using stereo ultrasonics for the miniature "guidance system" which will steer their robot close to the cube before arms fitted with sensors shoot out and grab it.

To prevent the competition from taking on too much of a "hi-tech" atmosphere, the organisers are planning an "It's a Knockout" interlude in which the schools will take on teams from REME, the judging panel, and BP in sports ranging from snooker to swimming.

More than 200 schools originally entered the competition, and the 21 who have reached the finals have each been given £100 to complete their robots. BP's "Challenge to Youth" series also includes competitions for young people to design and build their own cars, motorcycles and hovercraft, as well as providing grass-roots coaching in sports such as rugby and squash.

Table Tennis Challenge

The technical successes and popularity of the "Micromouse" competition has enthused Dr. John Billingsley, of the department of Electrical & Electronic Engineering, Portsmouth Polytechnic, to throw down the gauntlet to the robotics fraternity. This time, build robots that can play table tennis (modified ping-pong, really), and do it in readiness for 1986. Perhaps computerised mice can extricate themselves from a fiendish maze too easily, but the contending robots of ping-pong will need sophisticated vision systems if they are to avoid the humiliation of a comical defeat.

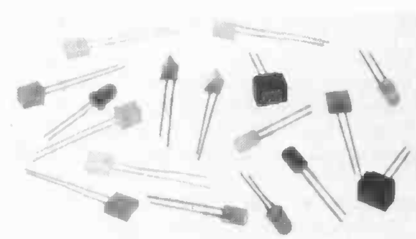
A number of rules have been decided upon: No mainframe link-ups. No laser vision systems, in deference to the ocular health of the spectators. The bat size is not to exceed a diameter of 12·5cm, but it needn't look like a conventional bat. The projecting force could come from a spring-loaded mechanism within the bat, as opposed to a swing of the robot arm.

Doctor Billingsley points out that the fastest net-skimming return from a low ball takes just under 0·5 seconds from bat to bounce, and has a vertical velocity on bouncing of just over two metres per second—*"Within the performance of the servo's of any self-respecting high-speed plotter!"* A lob may allow more time for the opposing robot to respond, but will impart double the vertical ball velocity. The table is especially designed to accommodate a ball-serving mechanism, along with physical barriers to the robot competitors themselves, who must perform within specified boundaries. The scoring system will probably be based on the lengths of rallies, or number of returned shots. For more information, interested parties should contact Dr. Billingsley at Portsmouth Poly', Anglesea Road, PO1 3DJ.

COMPATIBLE l.e.ds

Stotron are now able to supply a range of standard and flat plane viewing l.e.d. lamps at competitive prices. Miniature and standard sized l.e.d. indicators are available, with red, green or yellow diffused lenses. These are all compatible with TTL, CMOS and MOS circuits.

Round l.e.d. lamps with a flat plane viewing surface are also available with the above three colour options, and triangular, rectangular and square lamps are available with orange lenses.



One rectangular series with a lighted area of 0·220" × 0·125" is stackable in X or Y direction and is supplied complete with mounting grommet.

Stotron Ltd, 72 Blackheath Road, Greenwich, London SE10 8DA (01-691 2031).

MARKET PLACE

Briefly...

BICC, the British cable manufacturer and Corning Canada, an optical fibre company, have formed a partnership to produce fibre optic cables. The two companies have set up a new firm called Optical Fibres and have built the World's first purpose-built factory for the production of optical fibres in Deeside, North Wales.

● ● ● ●

The latest technology has come to the aid of the visually handicapped writer, in the shape of a device called the Microbrailler MB2400. This 1Mbyte braille word processor is manufactured by Erleybridge Communications, and is interfaced to that company's speech terminal.

To assist the partially sighted, Wormald International Sensory Aids has produced an information handling system called the Viewscan Text System (VTS) that can receive information from public data bases. Viewscan comprises a display screen capable of presenting extra bright characters of up to three inches in height, and is linked to a miniature hand-held camera for reading the printed text.

Blind, and partially sighted DP professionals, of which there are about 200 in Britain, are able to keep abreast of developments by way of courses documented in braille. The British Computer Association of the Blind organises two courses each year (courses which maintain very high standards) through the RNIB—this latter organisation being responsible for placement.

● ● ● ●

The chemical giant ICI is investing £10 million over the next three years in the creation of an electronics group dedicated to technological advances, rather than the exploitation of existing markets. ICI's new venture will orbit around its 400,000 unmarketed chemicals; chemicals which might have applications in resists, display dyes and data storage, to an estimated value of £100 million by the end of the decade.

● ● ● ●

Scientists at the Texas Agricultural and Mechanical University have brought nearer the day when vehicles can be economically run on hydrogen extracted from water. Using electrolysis to separate water into its constituent components, hydrogen and oxygen, was previously only possible at an efficiency between one and five percent, but the new technique has passed the 12 per cent mark. This breakthrough is considered very exciting because hydrogen, being a light element, is potentially suitable as an aircraft fuel. The exhaust created upon combustion is water, so hydrogen also has ecological advantages.

● ● ● ●

Clive Sinclair is sinking £2 million into a Cambridge based research establishment, to be called MetaLab. This will be a think-tank and spawning ground for high risk ideas. MetaLab is intended to regurgitate actual commercial launches in fields ranging from battery technology to robotics.

● ● ● ●

Graduates of French polytechnics can now circumvent conscription into national service for 12 months, by providing a term of computer training to the country's unemployed youngsters. 12,000 graduates have already given computer education to youths in this novel scheme which President Francois Mitterrand hopes will help to close socialist France's technology shortfall. It remains to be seen whether, or not, mere two-month crash courses will burgeon a Gallic workforce of competent computer technologists.

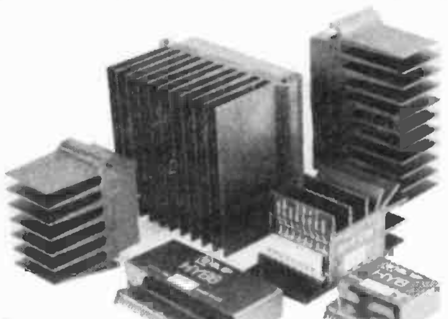
Countdown...

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.

Acorn Exhibition Aug. 25–28. Cunard Int. Hotel, Hammersmith, London. **J3**
BARTAG Rally (radio teleprinter) Aug. 29. Sandown Park, Esher, Surrey. **E2**
Light Aviation Show Sept. 1–3. Cranfield Institute, Bedfordshire. **Z1**
Electro West Sept. 6–8. Bristol Exhibition Centre. **Q**
CAST (Cable And Satellite Television) Sept. 11–14. NEC. **F5**
Weldex Sept. 12–16. NEC B/ham. **I**
Testmex Sept. 13–15. Grosvenor House, Park Lane, London. **E**
Home Entertainment Spectacular Sept. 17–25. Olympia. **I2**
Peterborough R & ES Mobile Rally Sept. 18. Wirrina Stadium, Bishops Rd., Peterborough. **L2**
Personal Computer World Show Sept. 28–Oct. 2. London. **M**
Laboratory London Oct. 12–15. Barbican Centre. **E**
Drives/Motors/Controls Oct. 12–14. Leeds University. **E**
Analyticon (ex. & conf.) Oct. 12–14. Barbican Cntr., London. **L4**
Computer Graphics Oct. 18–20. Wembley. **O**
PARC (computers in architecture, conf.) Oct. 18–20. Wembley. **O**
International Business Show Oct. 18–26. NEC. **T**
Business Efficiency Exhibition Oct. 22–26. Earls Court, London. **Z**
Electronics Hobbies Fair Oct. 27–30. Alex Pavilion, London. **Z1**
Electronic Displays Nov. 1–3. Kensington Ex. Centre, London. **D4**
Brainwave (computing/video) Nov. 4–6. NEC Birmingham. **G2**
Home Tech Nov. 11–13. Ex. Cntr., Bristol. **F3**
Test (and Environmental Test). Nov. 15–17. Wembley Conf. Cntr. **T**
Compec Nov. 15–18. Olympia, London. **Z1**
Intron Nov. 22–24. RDS Hall, Dublin. **V**
Northern Computer Fair Nov. 24–26. Belle Vue, Manchester. **Z1**
Automatic Testing/Test/Instruments. Dec. 13–15. Metropole, Brighton. **D4**
BEX Bournemouth 84 (Business Equipment). Feb. 8–9. Pavilion. **K**

D4	Network ✆ 02802 5226
E	Evan Steadman ✆ 0799 22612
E2	BARTG 89 Linden Gdns., Enfield, Middx.
F3	Tomorrow's World ✆ 0272 292156
F5	Cable & Satellite ✆ 01-487 4937
G2	Clapp & Poliak ✆ 01-747 3131
I	Industrial Trade Fairs ✆ 021 705 6707
I2	Alan Taylor ✆ 01-486 1951
J3	Computer Marketplace ✆ 01-930 1612
K	Douglas Temple ✆ 0202 20533
L2	D. T. Wilson, 4 Conway Ave., Peterborough
L4	Scientific Inst. Manufacturers' Assn. ✆ 01-437 0678
M	Montbuild ✆ 01-486 1951
O	Online ✆ 09274 28211
Q	Exhibitions for Industry ✆ 08833 4371
T	Trident ✆ 0822 4671
V	SDL Exhibitions ✆ Dublin 763 871
Z	BETA Exhibitions ✆ 01-405 6233
Z1	IPC Exhibitions ✆ 01-643 8040

GET BIG POWER



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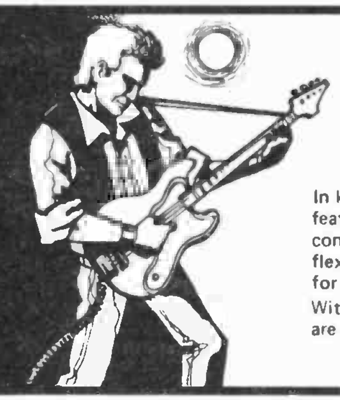
the third generation

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



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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	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	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	[illegible]
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.

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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 8 Ω.
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.

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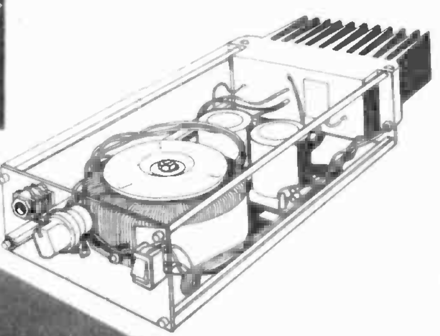
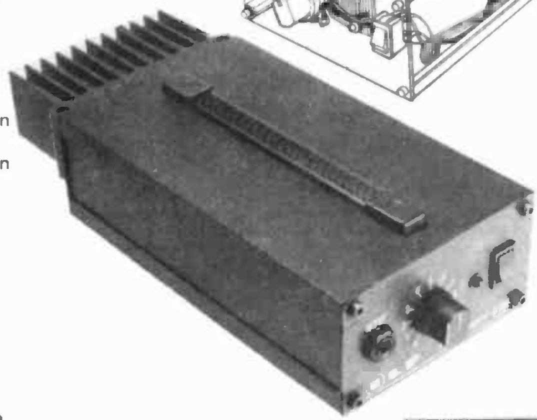
Each Unicase kit contains all the hardware required down to the last nut and bolt to build a complete unit without the need for any special tools.

Because of ILP's modular approach, "open plan" construction is used and final assembly of the unit parts forms a compact aesthetic unit. By this method construction can be achieved in under two hours with little experience of electronic wiring and mechanical assembly.





Hi Fi Separates

UC1 PRE AMP UNIT: Incorporates the HY78 to provide a "no frills", low distortion, (<0.01%), stereo control unit, providing inputs for magnetic cartridge, tuner, and tape/monitor facilities. This unit provides the heart of the hi fi system and can be used in conjunction with any of the UP Unicase series of power amps. For ultimate hum rejection the UC1 draws its power from the power amp unit.

POWER AMPS: The UP series feature a clean line front panel incorporating on/off switch and concealed indicator. They are designed to compliment the style of the UC1 pre-amp. Performance for each unit which includes the appropriate power supply, is as specified on the facing page.

Power Slaves

Our power slaves, which have numerous uses i.e. instrument, discotheque, sound reinforcement, feature in addition to the hi fi series, front panel input jack, level control, and a carrying handle. Providing the smallest, lowest cost, slave on the market in this format.

UNICASES

HIFI Separates					Price inc. VAT
UC1	Preamp				£29.95
UP1X	30 + 30W/4–8Ω	Bipolar	Stereo	HiFi	£54.95
UP2X	60W/4Ω	Bipolar	Mono	HiFi	£54.95
UP3X	60W/8Ω	Bipolar	Mono	HiFi	£54.95
UP4X	120W/4Ω	Bipolar	Mono	HiFi	£74.95
UP5X	120W/8Ω	Bipolar	Mono	HiFi	£74.95
UP6X	60W/4–8Ω	MOS	Mono	HiFi	£64.95
UP7X	120W/4–8Ω	MOS	Mono	HiFi	£84.95
Power Slaves					
US1X	60W/4Ω	Bipolar	Power	Slave	£59.95
US2X	120W/4Ω	Bipolar	Power	Slave	£79.95
US3X	60W/4–8Ω	MOS	Power	Slave	£69.96
US4X	120W/4–8Ω	MOS	Power	Slave	£89.95

Please note X in part number denotes mains voltage. Please insert '0' in place of X for 110V, '1' in place of X for 220V (Europe), and '2' in place of X for 240V (U.K.) All units except UC1 incorporate our own toroidal transformers.

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555 741 TESTER

STEPHEN IBBS

AMONGST the most common i.c.s used by hobbyists must be the humble 555 and 741. Many books have been written on how to use these versatile devices, but what if they go wrong? There is no easy way of telling if an i.c. has ceased to function by looking at it unless it quite literally does go up in smoke, so the author decided to build a very simple little tester. This unit gives a functional check to each device and whilst it doesn't claim to check many of the parameters, it should help to sort out the good from the bad. It uses the case given free by PE some time ago and which is available from the editorial offices at Poole (50p inclusive). It is very cheap to build, and even easier to use. Two wire-wrap sockets stand proud of the p.c.b. and project through the top panel of the case to enable suspect devices to be inserted quickly.

HOW IT WORKS

The circuit diagram for the Tester is shown in Fig. 1. The test 555 is connected as an astable multivibrator whose frequency is determined by R1, C1 and R2, and with the component values stated it should oscillate at approximately 1Hz. The output (pin 3) drives D1, current limited by R5, and is also connected via S2a to one of the inputs of the test 741. The other input is connected via S2b to the potential divider formed by R3 and R4, biasing the pin at approximately half supply voltage. The effect of S2 is to alter the 741 from being an inverter to a buffer and vice-versa. The output of the 741 drives D2, current limited by R6 which will flash either in phase, with the 741 as a buffer, or out of phase, with the 741 as an inverter.

CONSTRUCTION

This can be either on Veroboard or a p.c.b., a suggested design for a p.c.b. is given in Fig. 2 with the component layout shown in Fig. 3. Mount the components, including the wire-wrap sockets which are soldered with a space of 10mm above the p.c.b. Cut a piece of black plastic to fit behind the case aperture, and mount the two switches and l.e.d.s in the panel before gluing it into position. Care must be taken to choose miniature toggle switches, otherwise they might foul the p.c.b. Two holes need to be cut in the top panel to allow the sockets to project through. Mount the p.c.b. using self-tapping screws, connect the battery and after the usual search for solder joins across tracks, track breaks etc, insert two working devices and check that the

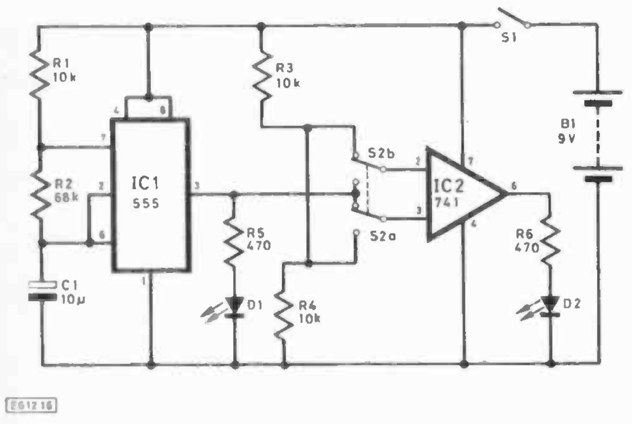


Fig. 1. Circuit diagram

COMPONENTS . . .

Resistors

R1, R3, R4	10k (3 off)
R2	68k
R5, R6	470 (2 off)

All resistors ¼W 5% carbon

Capacitors

C1	10µ 16V tant.

Diodes

D1, D2	min red l.e.d. (2 off)

Switches

S1	S.p.s.t. toggle switch
S2	D.p.d.t. toggle switch

Miscellaneous

P.c.b.
2 wire-wrap 8-pin d.i.l. sockets
Case
Battery connector

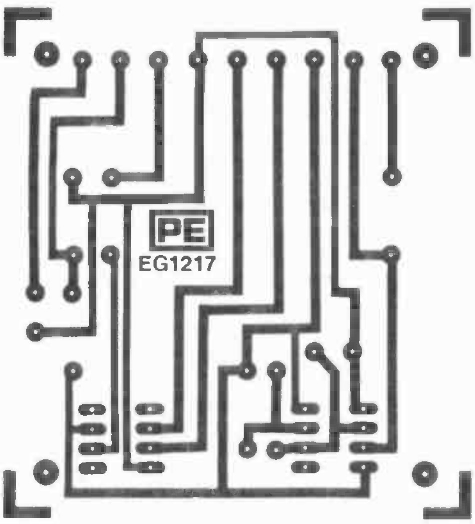
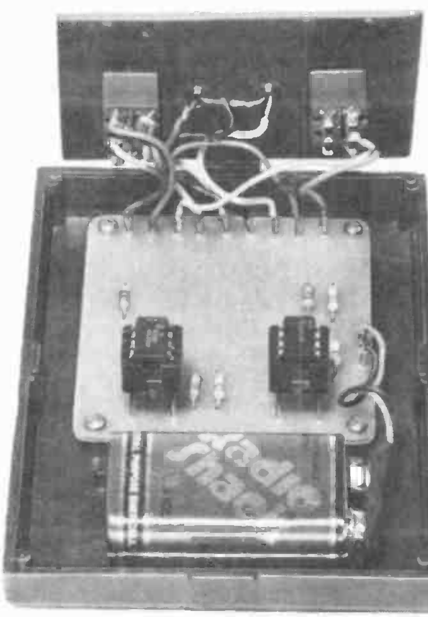


Fig. 2. P.c.b. design



Internal view

unit functions properly. It is likely that l.e.d. D2 will glow slightly. This is normal and can be ignored, it also serves to show that the unit has been left on.

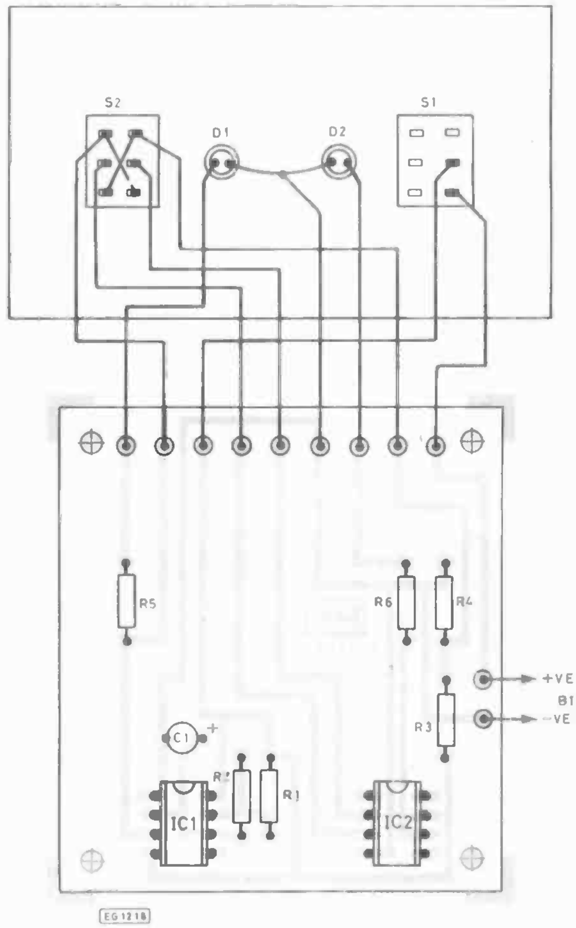


Fig. 3. Component layout

In use, two working devices are kept in the sockets, and then replaced with a suspect device for testing as and when necessary. There is no reason why other op-amps . . . e.g. CA3140, cannot be tested in the same way, providing the pin-out is the same. ★

VERNON TRENT *at Large!*

V.T.'s views and opinions are entirely his own and not necessarily those of PE

I RECKON it was Cleopatra who started this women's lib lark. The trouble was that she botched it up and, consumed with remorse, stuffed an asp down her cleavage. And that was the end of her.

Another front runner was Queen Boadicea who felt a natural feminine indignation about the tyranny of Roman rule. So she fixed blades to the wheels of her chariot and simply mowed down any cohorts she came across. Nothing very feminine about that.

Coming to modern times there's Germaine Greer who is said to have burnt her bra as a demonstration of her beliefs. In so doing she not only lost a lot of support, but did little to further what could have been a well-founded cause.

Tina Knight, whom I met recently over avocado, steak and kidney and a selection of cheeses, is, to my mind, though she scorns the suggestion, a women's libber of a sort. But as far as I know she has never provided personal accommodation for a snake, there are no blades on the wheels of her BMW and I am prepared to believe that not so much as a shoulder strap has ever been ignited.

Tina is the managing director of Global Specialties Corporation (UK) Ltd., a British-based autonomous offshoot of a company in the United States. As PE readers will know, Global enjoys a firm reputation with hobbyists and a growing popularity with industrial companies in the field of solderless breadboards and low-cost instrumentation.

"I am not a liberationist," says Tina, "but a fervent believer in equal opportunities. Yet—and this may sound like a paradox—I maintain that a woman still has the right to all those little courtesies and spoilings, like having the door opened for her, having a man stand up when she comes into the room and so on.

"Really, it boils down to a matter of good manners. And a woman's manners should be just as good as a man's. I've tried to bring the quality of good manners into my business, along with the old fashioned contention that the customer is always right. Apart from politeness, it's good common sense. A man buys a £3 breadboard and feels he's been treated as a customer should, may well turn out to be a major client. Even if he doesn't he still merits consideration and good service."

How did a young and attractive person like Tina get mixed up with the masculine-dominated, tough world of electronics?

"I started work in a bank," she told me. "Mum thought that was nice and respectable. I was supposed to be a junior shorthand-typist, but all I seemed to do was pick up paper clips. So I told the bank they'd have to try and get along without me. And I joined the ill-fated John Bloom empire. It was a pity about him, for he had a fine product, but not enough business flair. And when the crash came I took a job as secretary to the boss of a cash-and-carry greetings cards operation. At his invitation, and expense, I did a management course and picked up many a wrinkle."

At the age of 19 Tina shoved another iron in the fire by becoming the manageress of an employment and accommodation bureau. It was there she met her husband, Mick, who was pad-hunting.

"It was what romantic novelists call a whirlwind romance and like a lot of euphoric newly-weds I saw the future as one of roses round the door, coffee mornings, marching round Sainsbury's and, who knows, the patter of little feet in the fullness of time. But fate had other plans up her sleeve. Mick works on a newspaper and one day a strike blew up. It promised to be a protracted one. So I found a job with a shipping company first and then moved on to a firm of investment brokers.

"This brought me into close contact with a management consultancy. They asked me whether I'd like to take on the task of setting up an office in London for a Greek shipowner. This meant finding accommodation, arranging the decoration and furnishing and recruiting staff. I revelled in it. In fact I achieved something of a coup in getting offices in the Stock Exchange building, hitherto reserved exclusively for stockbrokers. The thing positively snowballed, for in no time at all I was doing the same for Arabs."

The real turning point in her career came when she was asked to take over the UK operation for Global. They were so impressed with her capabilities that they gave her a free hand to locate their UK activity wherever she wanted. She chose Saffron Walden in rural Essex. Tina calls it England's mini silicon valley, with firms like ITT and Pye-Unicam at Harlow and Cambridge respectively. Global then did something that was clearly written in the cards. They asked Tina to boss the outfit for them.

Now, from her Saffron Walden HQ, she covers the whole world except the Americas. Some 60 per cent of her business is in exports. She travels extensively in Europe and this year is off to Australia and South Africa.

At Saffron Walden she has a modest staff of only 18 people—13 of them women. Right now she's looking for her 19th. He has to be a versatile Man Friday, able to handle the exhibition side, take on some of the travelling and turn his hand to servicing. Any takers?

We sat and talked in the chintzy living room of her 13th (or most of it) century cottage a mile or two from her office. "Actually, I'm a reluctant career woman at heart," she said. "What I like most is to sit here in the evening in front of a log fire (you could stage a CND rally in the space it takes up) listening to music or watching the box. Or perhaps reading—the English classics like Trollope, Austen, Delderfield. Russian classics, too. Or maybe doing a bit of needle point."

Friends: "We've lots of close friends, though we don't get the time to do as much entertaining as we'd like. Some of my dearest pals live with me. There are the two Persians (they were lolling on the settee as though they owned the place) and then there's Jemima. She's a wild duck who dropped in one day in the garden and has been coming back at intervals ever since. She must like the cuisine. A while back she got herself pregnant and now all her little ones come back with her. Talk about getting the bird."

Marketing: "Some Americans are the finest marketing men in the world. They really get out there and sell with energy, enthusiasm and dedication. Far too many business men spend far too much of their time at meetings, gassing, investigating and drawing up four-year plans and suchlike. Where do they find the time to put what they've decided upon into effect? Of course you've got to have statistical information if you want to operate effectively and profitably. But don't get into a state where you can't see the end-product wood for the organisational trees."

Complaints: "An absolute essential is to deal with a customer's complaint fairly, swiftly and cheerfully. As I said over the avocado, the man who's spending his money with you is entitled to consideration and service. In any case, by complaining he could be doing you a favour in bringing to light some weakness in your working methods. I know that, as a customer, I've never been reluctant to complain. If a steak's tough or a soup cold, it's my duty to let the chap at the selling end know, if only in the interests of other customers."

These extracts from a long and highly-entertaining conversation, which tend, I fear, to sound like clips from the thoughts of Chairman Knight, are not only intended to illustrate the philosophy which guides a successful company, but also to show the kind of attitude that has enabled a woman to make it in a man's world.

You might pose the question: Where does this clever, quick-witted lady go next? I'd stick my neck out and say that the world is her Whitstable native. After all, how did Margaret Thatcher start? Weighing up sugar in her dad's grocery shop. You can't have a humbler beginning than that!

But even if she moves not a whit away from Global and the tranquil atmosphere of Rab Butler country, she has already made her point. That is, the hand that applies the eye-shadow is also pretty nifty at making a fairly high-technology business pay and prosper. And getting one in the eye of any man who thinks that Tina Knight and her gender are properly restricted to wielding a Hoover and making the odd, exciting excursion into sessions of pickled walnut bottling at the local Women's Institute.

One thing we haven't talked about is energy. When it was given out Tina was there at the front of the queue with a large sack. The evening before we met she'd been lashed to her desk, working out some complicated business deal, until 10.30. But as I left her and her husband at the cottage, she apologised for not coming personally to the station to see me off because she'd booked a game of squash.

How do you beat a woman like that?

SEMICONDUCTOR CIRCUITS

TOM GASKELL B.A.(Hons)

LIGHT SPOT DRIVER (UAA 170)

THERE are a number of ways of displaying quantitative information electronically, from the simple analogue meter up to sophisticated alphanumeric readouts. Each of these techniques has its own specific advantages and disadvantages which affect suitability for any given application. As a rule, moving bars, pointers, or lights are most suitable for displaying information that varies for much of the time; they are good at indicating trends. 'Digital' displays such as alphanumeric readouts tend to be better for displaying fixed or static values, since they become difficult to comprehend when the measured parameter changes too rapidly.

For simple or non-critical measurements, a moving spot of light is often the ideal display system. Although it has a resolution which is limited by the finite number of lights used, trends can be shown very easily, and the circuitry can be made simple and inexpensive. The LM 3914 and LM 3915 i.c.s are very popular devices which can illuminate up to ten l.e.d.s, either as a spot (one lit) or as a bar (ten up to lit) in response to an analogue input signal. In many applications, however, ten l.e.d.s is not enough, yet cascading two devices to produce twenty l.e.d.s is far more than required, and is a considerable 'overkill'.

A recently introduced, but less frequently seen i.c. is the Siemens UAA 170. This is a Light Spot Driver with some unusual features which make it a better choice in some applications; namely, the capability of driving up to sixteen l.e.d.s from a sixteen pin package, and the ability to adjust the type of transition of illumination from one l.e.d. to the next between 'smooth' and 'abrupt'.

L.E.D. DRIVING

Fig. 1 shows the pinout and specifications of the UAA 170, and Fig. 5 an applications circuit; for the moment, let us concentrate on the l.e.d. driving side of Fig. 5 only.

It can be seen that the l.e.d.s are driven as a matrix; they are arranged in four groups of four to reduce the total number of i.c. pins needed to connect to them from sixteen to eight. The lowest analogue input voltage illuminates l.e.d. D1, and the highest illuminates D16. Because of the matrixing used to drive the l.e.d.s, a little care has to be taken when connecting up the display. Those used in each group of four should have the same characteristics, i.e. D1 to D4 should all be the same type, D5 to D8 should all be the same (not necessarily the same as D1 to D4, though), etc. Hence, if the display was to be part green and part red, the colour change should be done between one group of four and the next, not within a group. Within each group the forward voltage drop of the l.e.d.s (V_f) should match within 0·5V. (Most l.e.d.s will easily achieve this.)

The type of circuit arrangement used to drive these l.e.d.s is the determining factor in the requirement for a relatively high supply voltage needed for the i.c.; see Fig. 1. This is typically either 12 or 15 volts. When connecting up the l.e.d. driving pins of the UAA 170, beware of the rather odd way that the pins connect, especially the 'reversal' of pins 4 and 5; it's very easy to get it wrong! If only four, eight or twelve l.e.d.s are required, simply omit the highest relevant groups of four. If only one, two or three l.e.d.s from a given group of four are to be used, each missing l.e.d. must be replaced by its electrical equivalent, so use three ordinary diodes (1N 4148) in series to replace each omitted l.e.d. If two or more i.c.s are cascaded, beware that the top or bottom l.e.d.s of each i.c. glow continuously when the input voltage goes out of the relevant range (see Figs. 2 and 3) so these will need to be replaced by groups of three diodes as appropriate.

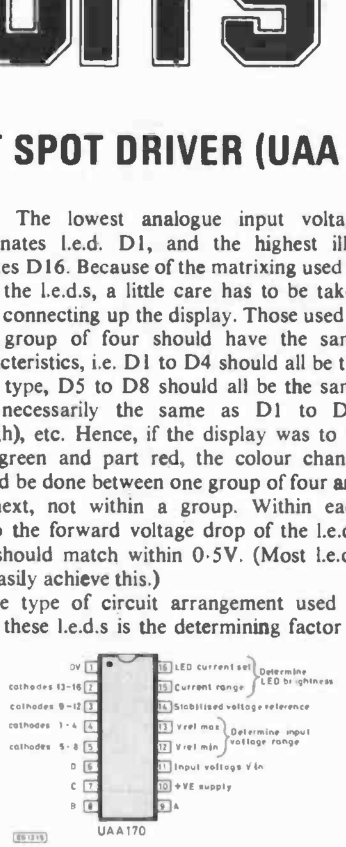


Fig. 1. UAA 170 pin-out with specification

Characteristic	Notes	Minimum	Typically	Maximum	Units
Supply voltage	All specs measured at +12V supply	11*		18	V
Quiescent current	No l.e.d.s driven, no load on pin 14	2	4	10	mA
Temp. range		−25		85	°C
Input voltage (V_{in})		0		6·0	V
V_{ref} min		0		4·6	V
V_{ref} max		1·4		6·0	V
Stabilised V_{ref}	300µA load 5mA load	 4·5	5·0	6·0	V V
Current from stab. V_{ref}				5·0	mA
Voltage difference	(V_{ref} max—V_{ref} min)	1·4		6·0	V
L.e.d. current		0		50	mA
Permissible variation of V_F of l.e.d.s				0·5	V
Input currents	Pins 11, 12 and 13	2			µA

* For l.e.d. $V_F > 1{\cdot}5V$, this lower limit will rise

SMOOTH OR ABRUPT TRANSITIONS

Most conventional 'bargraphs' or 'light spot' meters illuminate their l.e.d.s in an abrupt way; one l.e.d. turns off at the moment that the next one turns on. This is often a valid

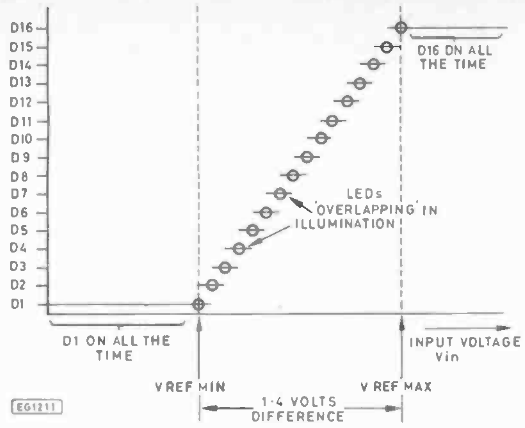


Fig. 2. 'Smooth' or overlapping l.e.d. illumination

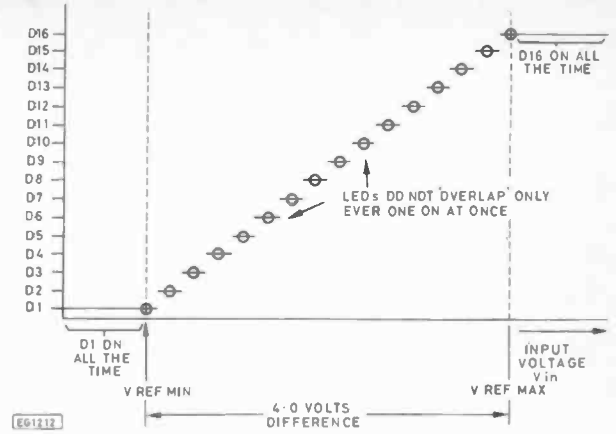


Fig. 3. 'Abrupt' or non-overlapping l.e.d. illumination

requirement, as it makes the display very positive and unambiguous. However, if the adjacent l.e.d.s are made to 'crossfade' (one fading down as the other fades up in brightness), the light spot seems to move more smoothly, resembling a purely analogue meter, or one with a much higher resolution. This makes it ideal for displaying rapidly changing information. In the UAA 170 we have the facility for choosing just how smooth or abrupt we want the display to be; see Figs. 2 and 3.

The analogue input voltage to the i.c. (V_{in}) should vary between two voltage reference inputs, V_{ref} minimum and V_{ref} maximum. Often, V_{ref} min will be set to 0V, but both are variable over the range indicated in the specifications (Fig. 1) to allow flexibility in operation. Input voltages below V_{ref} min cause D1 to be illuminated all the time, and voltages above V_{ref} max cause D16 to be lit all the time. (Note that V_{ref} min, V_{ref} max, and V_{in} should not exceed 6V.)

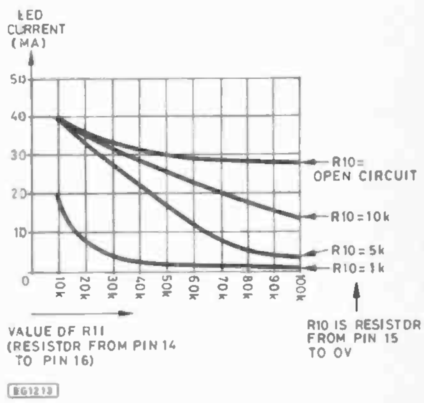
The difference between V_{ref} min and V_{ref} max determines the type of action of the display; 1·4V represents 'smooth' changes, with the l.e.d.s fading into each other, i.e. overlapping, and 4V represents 'abrupt' changes, with the l.e.d.s turning on and off rapidly, and with no overlap. This effect changes proportionally for voltages between 1·4 and 4V. Since the difference between V_{ref} min and V_{ref} max represents the range of input voltages which are accepted, the design of any input circuitry will have to take into account the type of l.e.d. display changes required. For convenience, a stabilised voltage reference of nominally 5V is provided on pin 14, and this can be used directly, or via a potential divider, to provide the V_{ref} max voltage.

DISPLAY BRIGHTNESS

The brightness of the display can be adjusted in rather a complex way by using pins 15 and 16; see Figs. 4 and 5. R11, between the stabilised voltage reference and pin 16, determines the l.e.d. drive current. The variation of current with R11 value is determined by another resistor, R10, from pin 15 to 0V. As can be seen from Fig. 4, for a low value of R10, the current can range from 0 to 20mA. For high values of R10 the range is 20mA to 40mA or thereabouts.

With the values shown in Fig. 5, the l.e.d. current is approximately 9mA. The reason

Fig. 4. Effects of resistance variation on l.e.d. current



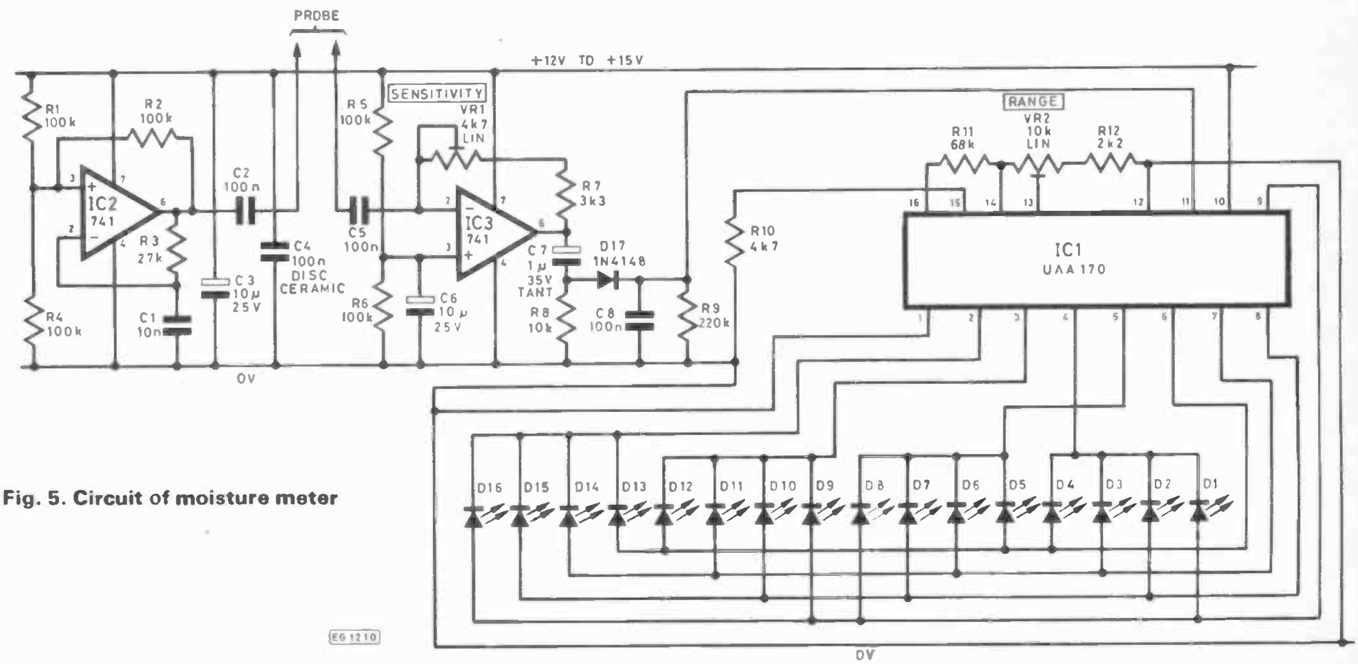


Fig. 5. Circuit of moisture meter

for this rather unusual design of brightness adjusting circuitry is to allow a phototransistor to be used to automatically adjust l.e.d. brightness to suit ambient conditions. R11 is replaced by an *npn* phototransistor in series with a 10k resistor. (Collector to pin 14, base open circuit, emitter to 10k resistor, 10k resistor to pin 16.) Another resistor, typically 18k, is connected between the emitter and collector of the phototransistor, and R10 is made a suitable value, chosen from the graph in Fig. 4.

APPLICATIONS CIRCUIT

Fig. 5 shows a simple moisture meter for determining the water content of soil or similar substances. IC2 is a 741 (or similar) op-amp connected as a square wave oscillator with a frequency of approximately 2·8kHz. This is a.c. coupled via C2 to one half of the probe. The other half is again a.c. coupled via C5 to the virtual earth input of IC3, a 741 (or similar) op-amp connected as an inverting amplifier. The a.c. coupling is used to prevent electrolysis of the probe metal. The resistance of the material between the two halves of the probe, which is dependent on the moisture content, tends to act as the input resistor for IC3. The output of IC3 is therefore a square wave of amplitude determined by the resistance across the probe. R5, R6, and C6 ensure that IC3 is biased up to half the voltage of the supply rail. IC3 is then a.c. coupled via C7 to the network of D17, C8 and R9. This network acts as a simple means of rectifying and smoothing the signal, so that the voltage at pin 11 of IC1 is a d.c. signal of an amplitude dependent on the magnitude of signal

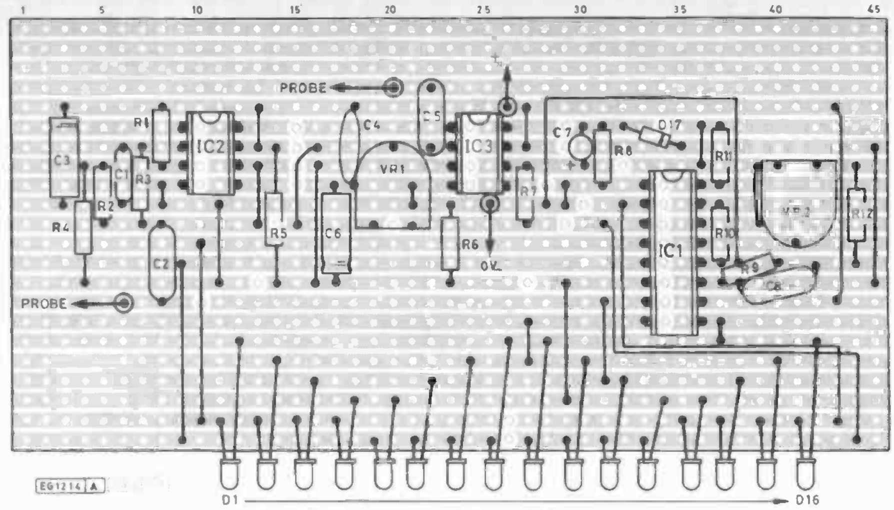


Fig. 6. The assembled moisture meter

at the output of IC3. The a.c. coupling of C7, and ground referencing of R8, ensure that this d.c. signal varies between 0V, and +6V maximum. IC1, of course, is connected as a Light Spot Driver, as already described.

VR1 adjusts the gain of IC3, and therefore determines the sensitivity of the system. V_{ref} min of IC1 is set at 0V, and V_{ref} max is set by VR2. Thus, the type of l.e.d. change, and the 'range' of the display can be adjusted by VR2. C3 and C4 provide supply decoupling for the +12 to +15V supply. This need not be regulated.

The probe can easily be made from a pair of stiff copper or brass wires set approximately 25mm apart. (Old ballpoint pen cases can be used to mount the wires in.) When used in soil, these should be pushed in by 25mm or so. VR1 and VR2 can then be set accordingly, to suit the particular requirements in question.

The UAA 170 is also available with a logarithmic, rather than a linear, characteristic, and is known as a UAA 170L. However, Siemens do not suggest that it is used for new designs, so it has a somewhat limited market lifetime. For your next project using a light spot type of display, the UAA 170 offers an interesting and novel alternative to the more popular proprietary i.c.s, yet is very cheap and readily available.

The UAA 170 is available from **Watford Electronics**, and many other suppliers.

BAZAAR

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WANTED data and service sheets for Russian scope type C.15. D. Beecher, 73 Gurnards Ave., Fishermead, Milton Keynes, Bucks. Tel: 0908 662903.

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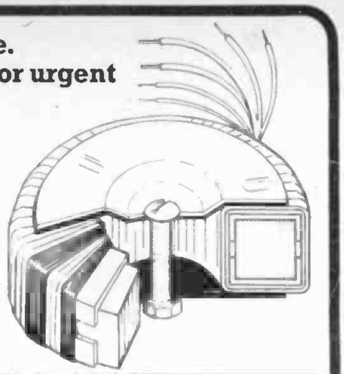

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TYPE	SERIES No	SECONDARY Volts	RMS Current	PRICE
15 VA	0x010	6+6	1.25	
62 x 34mm	0x011	9+9	0.83	
0.35Kg	0x012	12+12	0.63	£5.12
Regulation	0x013	15+15	0.50	+ p & p £0.78
19%	0x014	18+18	0.42	+ VAT £0.89
	0x015	22+22	0.34	TOTAL £6.79
	0x016	25+25	0.30	
	0x017	30+30	0.25	

(encased in ABS plastic)

TYPE	SERIES No	SECONDARY Volts	RMS Current	PRICE
30 VA	1x010	6+6	2.50	
70 x 30mm	1x011	9+9	1.66	£5.49
0.45Kg	1x012	12+12	1.25	+ p & p £1.10
Regulation	1x013	15+15	1.00	+ VAT £0.99
18%	1x014	18+18	0.83	TOTAL £7.58
	1x015	22+22	0.68	
	1x016	25+25	0.60	
	1x017	30+30	0.50	
50 VA	2x010	6+6	4.16	
80 x 35mm	2x011	9+9	2.77	
0.9Kg	2x012	12+12	2.08	
Regulation	2x013	15+15	1.66	£6.13
13%	2x014	18+18	1.38	+ p & p £1.35
	2x015	22+22	1.13	+ VAT £1.12
	2x016	25+25	1.00	TOTAL £8.60
	2x017	30+30	0.83	
	2x028	110	0.45	
	2x029	220	0.22	
	2x030	240	0.20	
80 VA	3x010	6+6	6.64	
90 x 30mm	3x011	9+9	4.44	
1Kg	3x012	12+12	3.33	£6.66
Regulation	3x013	15+15	2.66	+ p & p £1.72
12%	3x014	18+18	2.22	+ VAT £1.26
	3x015	22+22	1.81	TOTAL £9.64
	3x016	25+25	1.60	
	3x017	30+30	1.33	
	3x028	110	0.72	
	3x029	220	0.36	
	3x030	240	0.33	

TYPE	SERIES No	SECONDARY Volts	RMS Current	PRICE
120 VA	4x010	6+6	10.00	
90 x 40mm	4x011	9+9	6.66	
1.2Kg	4x012	12+12	5.00	
Regulation	4x013	15+15	4.00	£7.42
11%	4x014	18+18	3.33	+ p & p £1.72
	4x015	22+22	2.72	+ VAT £1.37
	4x016	25+25	2.40	TOTAL £10.51
	4x017	30+30	2.00	
	4x018	35+35	1.71	
	4x028	110	1.09	
	4x029	220	0.54	
	4x030	240	0.50	
160 VA	5x011	9+9	8.89	
110 x 40mm	5x012	12+12	6.66	
1.8Kg	5x013	15+15	5.33	
Regulation	5x014	18+18	4.44	£8.43
8%	5x015	22+22	3.63	+ p & p £1.72
	5x016	25+25	3.20	+ VAT £1.52
	5x017	30+30	2.66	TOTAL £11.67
	5x018	35+35	2.28	
	5x026	40+40	2.00	
	5x028	110	1.45	
	5x029	220	0.72	
	5x030	240	0.66	
225 VA	6x012	12+12	9.38	
110 x 45mm	6x013	15+15	7.50	
2.2Kg	6x014	18+18	6.25	
Regulation	6x015	22+22	5.11	£9.81
7%	6x016	25+25	4.50	+ p & p £2.05
	6x017	30+30	3.75	+ VAT £1.78
	6x018	35+35	3.21	TOTAL £13.64
	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	

TYPE	SERIES No	SECONDARY Volts	RMS Current	PRICE
300 VA	7x013	15+15	10.00	
110 x 50mm	7x014	18+18	8.33	
2.6Kg	7x015	22+22	6.82	
Regulation	7x016	25+25	6.00	£10.88
6%	7x017	30+30	5.00	+ p & p £2.05
	7x018	35+35	4.28	+ VAT £1.94
	7x026	40+40	3.75	TOTAL £14.87
	7x025	45+45	3.33	
	7x033	50+50	3.00	
	7x028	110	2.72	
	7x029	220	1.36	
	7x030	240	1.25	
500 VA	8x016	25+25	10.00	
140 x 60mm	8x017	30+30	8.33	
4Kg	8x018	35+35	7.14	£14.38
Regulation	8x026	40+40	6.25	+ p & p £2.40
4%	8x025	45+45	5.55	+ VAT £2.52
	8x033	50+50	5.00	TOTAL £19.30
	8x042	55+55	4.54	
	8x028	110	4.54	
	8x029	220	2.27	
	8x030	240	2.08	
625 VA	9x017	30+30	10.41	
140 x 75mm	9x018	35+35	8.92	
5Kg	9x026	40+40	7.81	£17.12
Regulation	9x025	45+45	6.94	+ p & p £2.55
4%	9x033	50+50	6.25	+ VAT £2.95
	9x042	55+55	5.68	TOTAL £22.62
	9x028	110	5.68	
	9x029	220	2.84	
	9x030	240	2.60	

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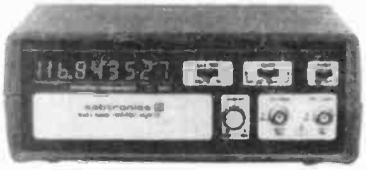

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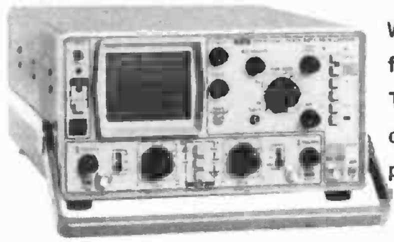

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INDUSTRY NOTEBOOK

By Nexus

Status Quo

So far as trade and industry are concerned the General Election killed uncertainty and it is quite clear that the socialist solution to economic problems if not completely discredited, then was certainly not trusted.

As I have often pointed out, all administrations when coming to power find themselves captive of influences outside their control. It is doubtful, had Labour won, that it would have been possible to implement their manifesto. In the event the prospect of implementation scared off the voters.

The popular vote did not in fact completely endorse the Conservative manifesto although, because of the electoral system, the Conservatives won the greatest number of seats. What the popular vote did demonstrate was that few people want more nationalisation in industry, withdrawal from the EEC, more power to the trade unions, spending our way out of recession, or unilateral nuclear disarmament. In fact the Labour manifesto was decisively rejected. A good result for industry.

Swop-Shop

Before the invention of money as a medium of exchange, trade existed through barter. It still exists. A private swop of, say, a hi-fi for a good SLR camera is common enough. No cash changes hands, no tax is payable, both parties are satisfied.

Today, with so many nations virtually bankrupt, barter is growing in international trade with perhaps as much as 20 per cent of trade conducted in this primitive form. Recent swops have included motor vehicles and steel for coffee, tractors for fish, cars for bauxite. All these swops are in the multi-million pound bracket.

So far I have not heard of electronics goods being involved. It is conceivable that it will come. How about a computer network in exchange for a shipload of bananas? Or whatever? Watch this column.

Telecom

Privatisation is once again on the agenda now the Conservatives are back in power. The biggest sell-off, if it ever happens, will be British Telecom. The new rival trunk network, Mercury, is already in place but with restricted service. The appearance of Mecury and the threat of privatisation has already worked miracles in BT under the leadership of Sir George Jefferson. The organisation is much more efficient than before both through new technology and vigorous marketing of services. There is possibility, indeed, probability, of further improvement but the Telecommunications Bill, lost in the General Election, has been revived in the new Parliament. This time it will be introduced by the new minister, Cecil Parkinson, and despite the huge government majority it is likely to have a turbulent passage.

Naturally, the Post Office Engineering Union will fight tooth and nail and threaten confrontation. But some user groups, formerly bitter critics of BT, are none too happy. Their change of heart may have come about from seeing that BT is pulling itself together or it may be cold feet at the prospect of the unknown. Either way the Bill will not have universal support. Getting it through the House may be easy. Implementing the Bill may prove much more difficult and may take a long, long while in a step-by-step procedure. That's why it may never happen in total though it is bound to happen in part. Selling 51 per cent of shares in BT worth up to £4 billion is still quite a problem.

Finding the Slot

Small companies can best succeed by finding a slot in the general market as yet undiscovered by big firms or considered too small in volume to warrant serious attention. I notice, for example, that at the International Audio and Video Fair to be held in Berlin in September, a German company has spotted the rising popularity of collecting early 78 r.p.m. gramophone records. Modern stylii for use with microgroove recordings are unsuitable so the firm of Dreher and Kauf, who normally have supplied only diamond needles in the past, have added to their range "old-fashioned" needles to fill the need.

On show, too, though you need a microscope to see it adequately, is a Philips chip containing all the stages of a UHF radio receiver. The export slot is to Japan who have taken the chip in large quantities, proving once again that the Japanese market is not impenetrable.

Buying In

The fast way to get into electronics is by acquisition, popular with outsiders wishing to broaden their business into fast-growth areas. An example is Lex Service in motors who import Volvo cars to the UK. Some 18 months ago the company acquired Hawke Electronics and now they have increased their stake in electronics by buying Jermyn Holdings, thus gaining control of the Jermyn Group. Both Hawke and Jermyn are component distributors. The purchase price for Jermyn was a little over £15 million. For that they get all the Jermyn activities in the UK, France and Germany. Senior directors remain in place with three-year service contracts.

Before bringing the deal to a conclusion Lex studied all the market statistics and concluded that semiconductor sales in the UK would grow at an average of 19·5 per cent per year over the next five years but those sold through distributors would grow at 24·5 per cent per year. At present distributors are estimated to sell 30 per cent of all semiconductors in the UK. In the USA the figure is 40 per cent, so there appears to be room for further growth in market share for Jermyn and others within the total increased volume.

Pirates

A big problem with innovative products is the "pirating" of designs. There is, of course, protection by patent but litigation can be lengthy and expensive. Such difficulties are often overcome by offering licences involving royalties to be paid to the patent holder.

In the ordinary way the public is unaffected by inter-company squabbles on possible infringement but I note with more than ordinary interest the public warning issued by Racal-Decca Navigator Ltd on unauthorised receivers now being offered for sale.

Decca Navigator "chains" which give navigational position to mariners are privately owned and thus not a public service. Recently, technical changes to the transmissions have been made to improve the service and Racal-Decca say that although their receivers and others manufactured with approval by Racal-Decca are unaffected, "pirate" receivers can give false readings. Naturally, official "Notices to Mariners" have been issued by the UK Hydrographer of the Navy to warn navigators of the possibility of error because safety-at-sea is of fundamental importance.

The unlicensed receivers, apparently of foreign manufacture, continue to be offered for sale. It seems to me that cheating is bad enough in itself but when safety-at-sea could be involved it is despicable conduct.

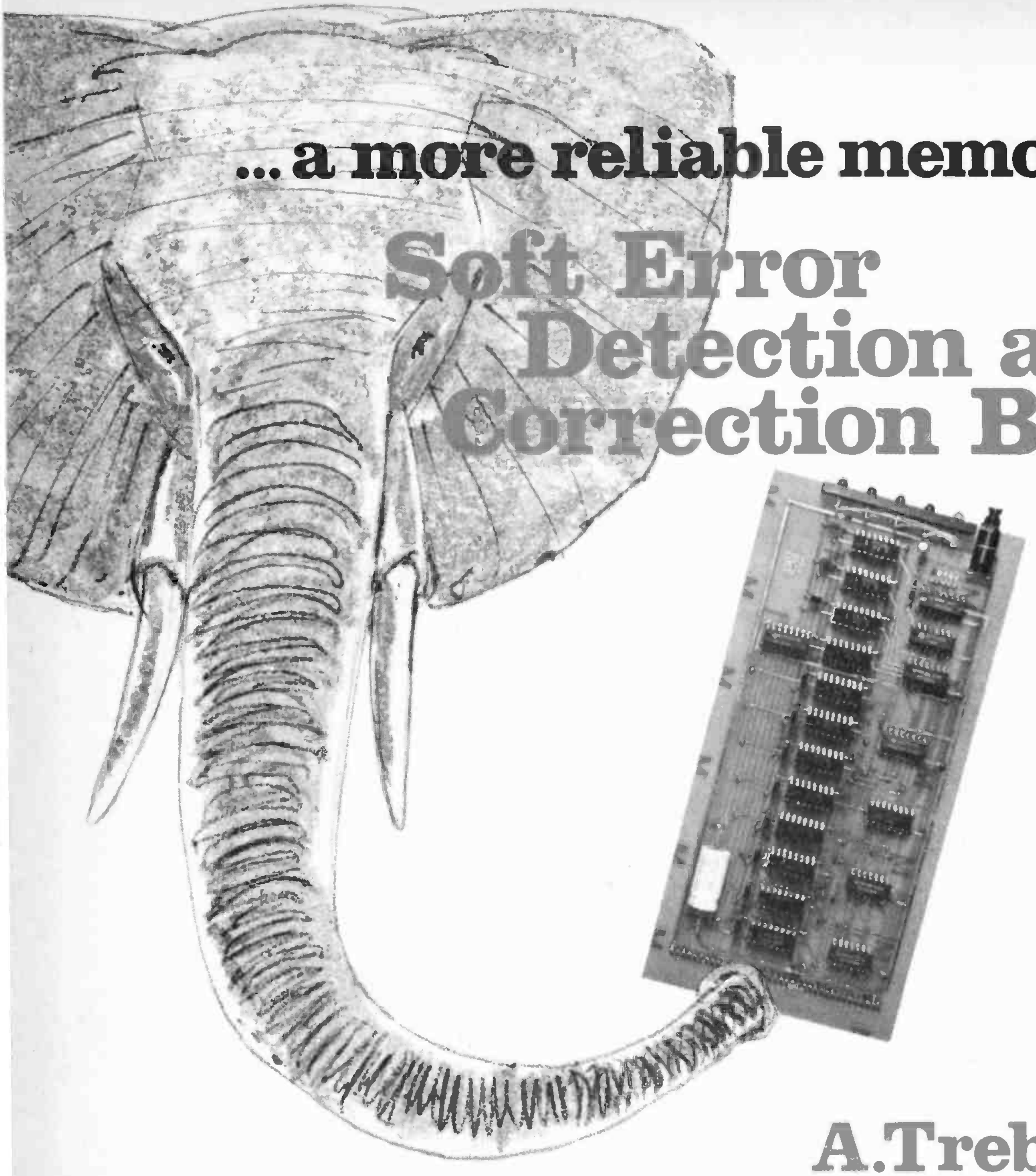
Hoppers

Frequency-hopping tactical radios which are resistant to message interception and jamming had a high profile a couple of years ago. There was then an ominous silence during, presumably, a lengthy evaluation period by signals staffs. Now the orders are starting to filter through. Of course some armies keep quiet about new equipment but Marconi have announced orders for their Scimitar range from Portugal, Sweden and Finland with other countries still evaluating.

But rival Racal, who were the first to introduce frequency-hopping, have one order on which they have been allowed to publicly put a price-tag—a hefty £20 million contract with the Sultanate of Oman. Racal also claim 13 countries are already using their Jaguar-V frequency hoppers.

... a more reliable memory

Soft Error Detection and Correction Board



A.Trebar

SMALL business and personal computers often have the same configuration, they use the same microprocessors with the same performances, and yet the small business computers are often far more expensive when compared with personal computers; why such a difference? The answer is reliability, the small business computers are built for professional use and are designed to be as reliable as possible. The hardware is much more sophisticated and incorporates additional circuits for diagnostics which enables fault location, which in turn makes repair easier and faster. Every minute the system is not operable means a loss of money to the system user and should be kept at a minimum. On the other hand personal computers are intended for educational purposes and entertainment. With some additional hardware we can enhance the reliability of a personal computer to a degree that it can be used to do more sophisticated tasks where a long term error free operation is a must.

One of the most error prone parts of a computer is the computer memory. Usually it is built with high density integrated circuits such as 16K and 64K RAMs, which can be affected by two types of errors: 'Hard' errors and 'Soft' errors.

Hard errors are caused by permanent damage of a memory chip or a part of it. They are mostly a stuck-to-zero or a stuck-to-one type of error. The erroneous location in memory cannot be overwritten with new data. They can easily be detected by a software memory checking program by writing some pattern to the memory and then reading it back. The same operation should be performed again with a complement pattern. Such a routine can be used as part of a power-up self test program.

Soft errors cannot be located so easily. There are several causes for soft errors: alpha radiation from packaging material, the noise can push the chip beyond limits of its normal operation, which can result in a loss of charge on storage capacitors. It is possible to observe from Table 1 that the soft errors appear more often than hard ones. The error rates of memory devices are given by manufacturers and are evaluated in an ideal testing environment. In real applications memory devices are exposed to interference and temperature variations, and this is why the error rate of a memory system is generally higher than evaluation from reliability data.

The most efficient method of coping with soft errors is the error detection and correction technique (Error Checking and Correction-ECC). The method of ECC was first described by R. W. Hamming more than 30 years ago in the article *Error detecting and error correcting codes* published in the Bell System Technical Journal, and after all these years this method is still used by most computer manufacturers for storage protection.

Error rate	16K	64K
Soft %/1000h	0·1	0·45
Hard %/1000h	0·02	0·02

Table 1. Error rates of memory devices

CODE USAGE

Let's now take a look at how the Hamming code works. When the data is written into the memory, the control bits are generated and stored in a special part of the memory. The number of control bits needed depends on the number of bits in data word and on the number of errors we want to correct. The number of control bits required for single error detection and correction can be derived from the equation $2^n \geqslant k + n + 1$ where k designates the number of data bits and n the number of control bits.

Data words with 8 bits require 4 control bits which will together represent a memory word.

$$\underbrace{\overbrace{D_0D_1D_2D_3D_4D_5D_6D_7}^{\text{Data word}}\overbrace{C_1C_2C_3C_4}^{\text{Control word}}}_{\text{Memory word}}$$

The control word is generated as an exclusive OR (EXOR) combination of data bits as shown in Table 2.

	D_0	D_1	D_2	D_3	D_4	D_5	D_6	D_7
C_1	1	1	1	0	1	1	1	0
C_2	1	1	0	1	1	0	0	1
C_3	1	0	1	1	0	1	0	1
C_4	0	1	1	1	0	0	1	0

Table 2. Control word generation

Table 3 shows the system of equations which gives us control bits.

$C_1 =$	D_0	$\forall D_1$	$\forall D_2$		$\forall D_4$	$\forall D_5$	$\forall D_6$	
$C_2 =$	D_0	$\forall D_1$		$\forall D_3$	$\forall D_4$			$\forall D_7$
$C_3 =$	D_0		$\forall D_2$	$\forall D_3$		$\forall D_5$		$\forall D_7$
$C_4 =$		D_1	$\forall D_2$	$\forall D_3$			$\forall D_6$	

Table 3. Control bit equations ($\forall$ = for all values of)

When reading memory words from memory we must calculate the syndrome bits. This can be done in the following fashion: First we calculate control bits C_n' of data part of the memory word. A syndrome is an EXOR combination of control word and control bits calculated from the data part of a memory word. The relationship between syndrome bits (S_1, S_2, S_3 and S_4) and memory bits is shown in Table 4.

	D_0	D_1	D_2	D_3	D_4	D_5	D_6	D_7	C_1	C_2	C_3	C_4
S_1	1	1	1	0	1	1	1	0	1	0	0	0
S_2	1	1	0	1	1	0	0	1	0	1	0	0
S_3	1	0	1	1	0	1	0	1	0	0	1	0
S_4	0	1	1	1	0	0	1	0	0	0	0	1

Table 4. Syndrome/memory bit relationship

Since the D part of Table 4 corresponds to Table 2 the S_n bits can be calculated from the equations in Table 5.

$S_1 = C_1 \forall C_1'$
$S_2 = C_2 \forall C_2'$
$S_3 = C_3 \forall C_3'$
$S_4 = C_4 \forall C_3'$

Table 5. Syndrome bit equations

In the case that all syndrome bits are zero, we assume that there was no error in memory word. If the syndrome word is a non-zero combination there was an error. From the combination of ones and zeros in a syndrome word we can find out which bit is affected. From now on the correction of error is simple. All we have to do is to invert the bit in error and the data is correct again. If the combination of ones and zeros does not correspond to any column in Table 4 we have detected a multiple error. Such errors cannot be corrected, but we can suppress the execution of this instruction by the computer.

For example if we have the following data to be written into the memory:

$$D_0D_1D_2D_3D_4D_5D_6D_7$$
$$1\ 1\ 0\ 0\ 1\ 1\ 1\ 0$$

The control bits calculated from the equation in Table 3 will be:

$$C_1 = 1,\ C_2 = 1,\ C_3 = 0,\ C_4 = 0$$

The memory word will be:

$$D_0D_1D_2D_3D_4D_5D_6D_7C_1C_2C_3C_4$$
$$1\ 1\ 0\ 0\ 1\ 1\ 1\ 0\ 1\ 1\ 0\ 0$$

Let's assume that the error has affected one of the bits in the memory word. When reading from memory the memory word was:

$$D_0D_1D_2D_3D_4D_5D_6D_7C_1C_2C_3C_4$$
$$1\ 1\ 0\ 0\ 0\ 1\ 1\ 0\ 1\ 1\ 0\ 0$$

The syndrome bits calculated from the equations in Table 5 are: $S_1 = 1$, $S_2 = 1$, $S_3 = 0$, & $S_4 = 0$. From Table 4 we see that this syndrome corresponds to D_4. By inverting it we have correct data bits.

MULTIPLE ERRORS

Now it should be noted that some multiple errors can give us the same syndromes as single bit errors. This means that such errors will pass undetected, but fortunately it is not likely that two or more errors will occur simultaneously in the same memory word.

The method described above can give us the position of a single error in any bit of a memory word. Since only data bits are received by the processor, we do not correct the control part of the memory word in the case of an error.

A processor delivers 8-bit data to the memory unit and receives 8-bit data from the memory. All other functions are carried out automatically without the knowledge of the processor, so the ECC circuit can be regarded as transparent to the processor and thus applicable to different kinds of processors that are using an 8-bit data word system.

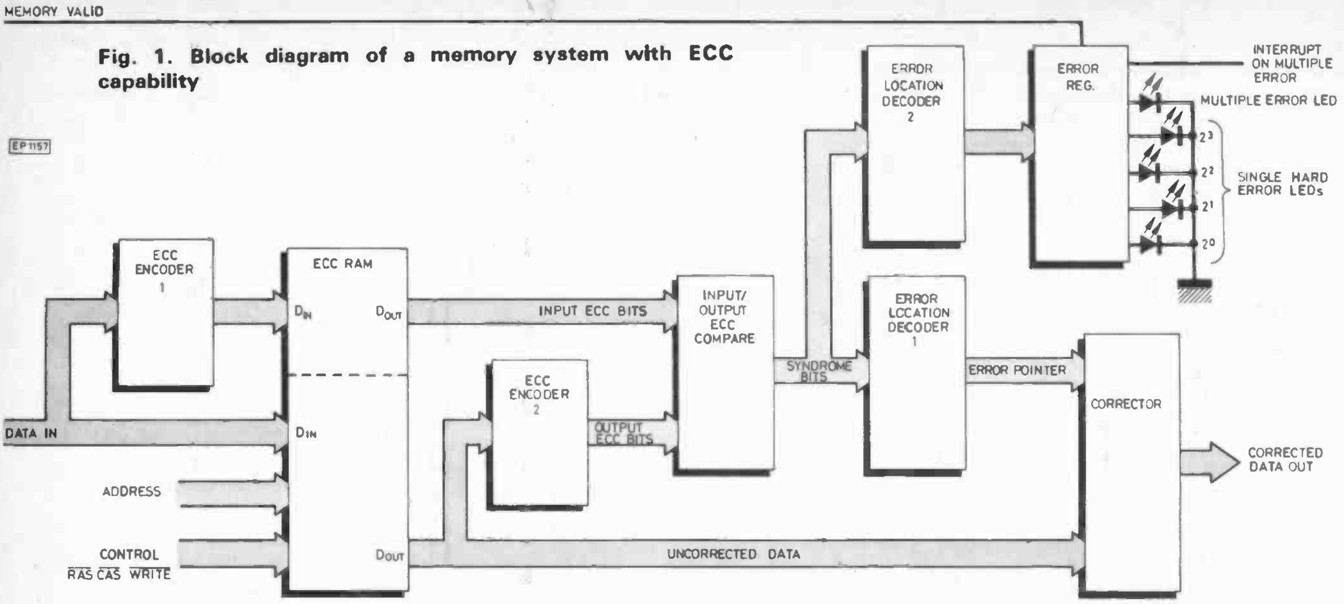


Fig. 1. Block diagram of a memory system with ECC capability

ECC IMPLEMENTATION

There are many single chip i.c.s presently available designed for detection and correction of a single bit in memory systems. These are very fast circuits that can detect and correct errors with propagation delay from 25 to 45ns. The major drawback for using these circuits in microprocessor based systems is their price which is prohibitively high for small quantities. Basically they are intended to be used in mini and medium size computers. The ECC circuit to be used with 8-bit data can be built with as few as 6 MSI chips.

Fig. 1 represents a block diagram of a memory system with ECC capability, five blocks are used for error detection and correction:

ECC ENCODER 1	generates control bits from data to be stored in memory.
ECC ENCODER 2	generates control bits from data read from the memory.
INPUT/OUTPUT ECC COMPARE	generates syndrome bits according to the equations in Table 5.
ERROR LOCATION DECODER	generates an error pointer from syndrome bits. The error pointer contains a single 1 at the place where the error occurred.
CORRECTOR	is a controlled inverter that inverts the erroneous data bit from the error pointer and thus corrects it.

The upper part of Fig. 1 represents a diagnostic circuit that points to the faulty memory chip in case of a hard error. The error position is decoded in ERROR LOCATION DECODER 2 and latched in ERROR REGISTER. L.e.d.s D1, D2, D3 and D4 show the chip in error.

Fig. 2 represents a detailed schematic diagram of the ECC circuit together with memory (IC1 to IC12). Data bits D_{0in} to D_{7in} enter memory chips (IC1 to IC8) and IC13 simultaneously. IC13 is a bipolar 256 × 4 PROM which serves as ECC ENCODER 1. For every combination of input data there is a distinct combination of control bits programmed in IC9. Its contents are shown in Table 6. Control bits are stored in IC9 and IC12. When data bits are read from the memory, a new set of control bits is generated in IC17 (ECC ENCODER 2) and is equal to IC13. Syndrome bits are calculated in IC18 and are EXOR combinations of stored control bits plus control bits generated from memory word that was read from the memory.

In case of error there will be a non-zero combination of syndrome bits. Syndrome will be 0, 0, 0, 0 if there is no error. Error location decoders are IC16 and IC19. These are 32 × 8 PROMS, both with the same contents. In the case of IC16 pin 14 is grounded. This means that only the lower part of the truth-table is selected ($A_4 = 0$). This part of PROM is programmed so that it gives us an error vector for syndromes tabulated in Table 7. The error vector is applied to

COMPONENTS . . .

Resistors

R1	6k8, ¼W, 5% carbon

Capacitors

C1, C2, C3, C4, C5, C6, C7, C8, C9, C10, C11,	2n2ceramic (12 off)
C12, C13	10µ/35V tant. bead (2 off)
C14	220µ/63V elect

Semiconductors

D1, D2, D3, D4	0·2 in red l.e.d.s (4 off)
D5	0·2 in green l.e.d.
IC1, IC2, IC3, IC4, IC5, IC6, IC7, IC8, IC9, IC10, IC11, IC12	4116 16K RAM or (4516 16K RAM)* or (4164 64K RAM)* (12 off)
IC13, IC17	MMI 6301 256 × 4 PROM (2 off)
IC14, IC15, IC18	74LS86 QUAD EXOR (3 off)
IC16, IC19	74S188 32 × 8 PROM (2 off)
IC20	74174 HEX D FLIP FLOP

Miscellaneous

S1	Push to make switch
Terminal pins	(39 off)
I.c. sockets	(Soldercon type) (300 off)
Printed circuit board	

*See Fig. 4.

Constructor's Note

All components including Soldercon pins are available from **Watford Electronics, 35 Cardiff Road, Watford, Herts.** (0923 40588.)

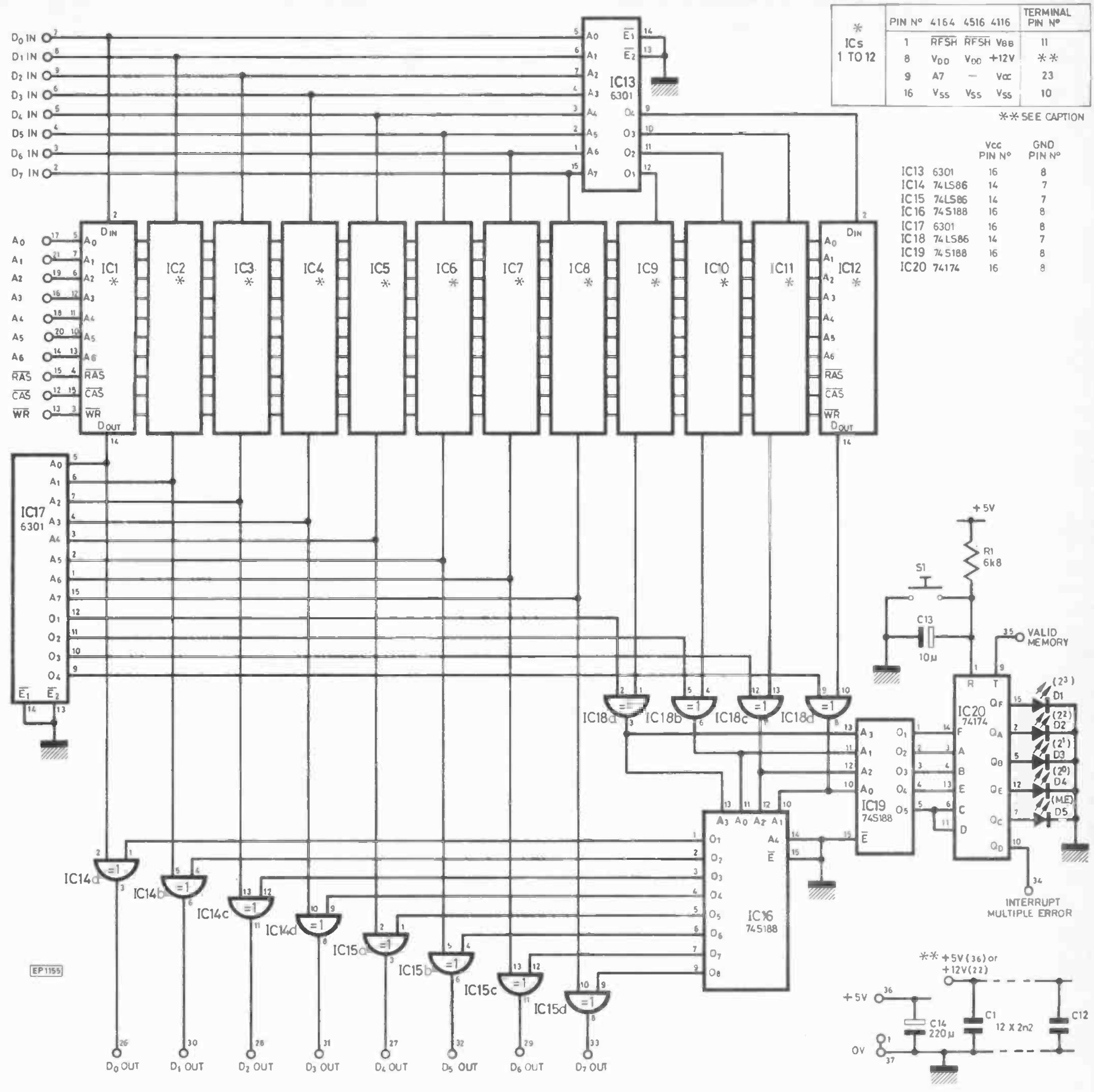


Fig. 2. Circuit diagram of the ECC circuit with memory array

IC14 and IC15 which are EXOR gates that serve as a controlled inverter. The data bit on position where error vector is 1 is inverted and thus corrected. The upper part of IC19 PROM ($A_4 = 1$) contains memory chip location that corresponds to syndrome bits tabulated in Table 4.

The decoded position is stored in IC20. This is the ERROR REGISTER. L.e.d.s D_1, D_2, D_3 and D_4 show the memory chip in error. D_5 is the indicator of multiple error. Error register IC20 is cleared at switch-on via R1 and C1 but can also be cleared by pressing pushbutton S1. Diagnostic data is written into the error register when memory word is valid. Otherwise we can get ambiguous information. When a multiple error is detected the signal at IC20 pin 10 (ME = high) can be used to stop the processor.

The p.c.b. was developed so that different kinds of memory i.c.s can be used: 4116, 4516, 4164 and their equivalents. The pinouts are shown in Fig. 3. The signal information needed to interface the ECC memory to the microcomputer is given in Table 8.

The ECC circuit will enhance the reliability of the microcomputer; however there are disadvantages to the scheme: The access time of memory will be longer for the propagation delay through the ECC circuit; that is why the higher speed memories are recommended. Another disadvantage is the high price of memory array, since four additional memory chips are needed.

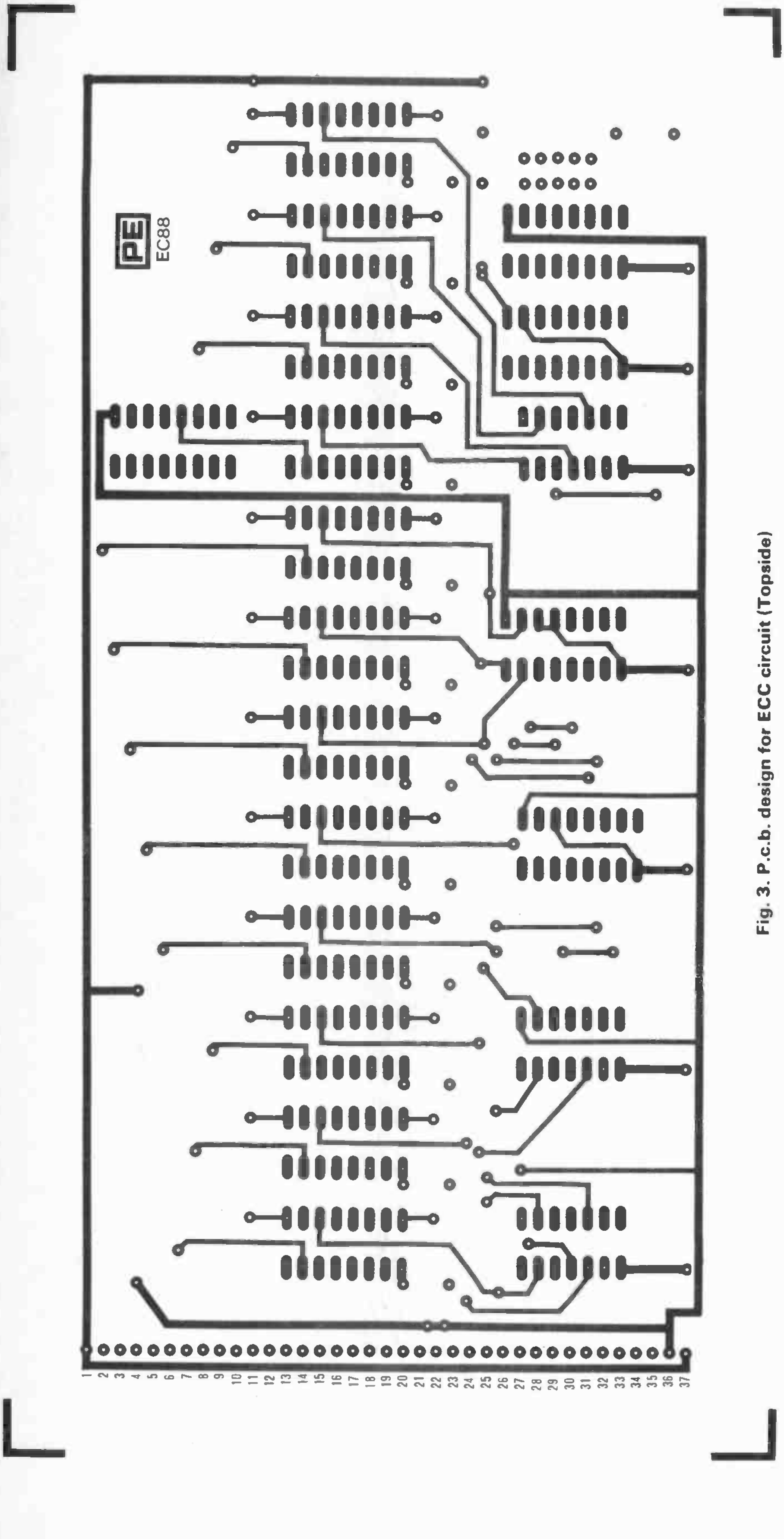
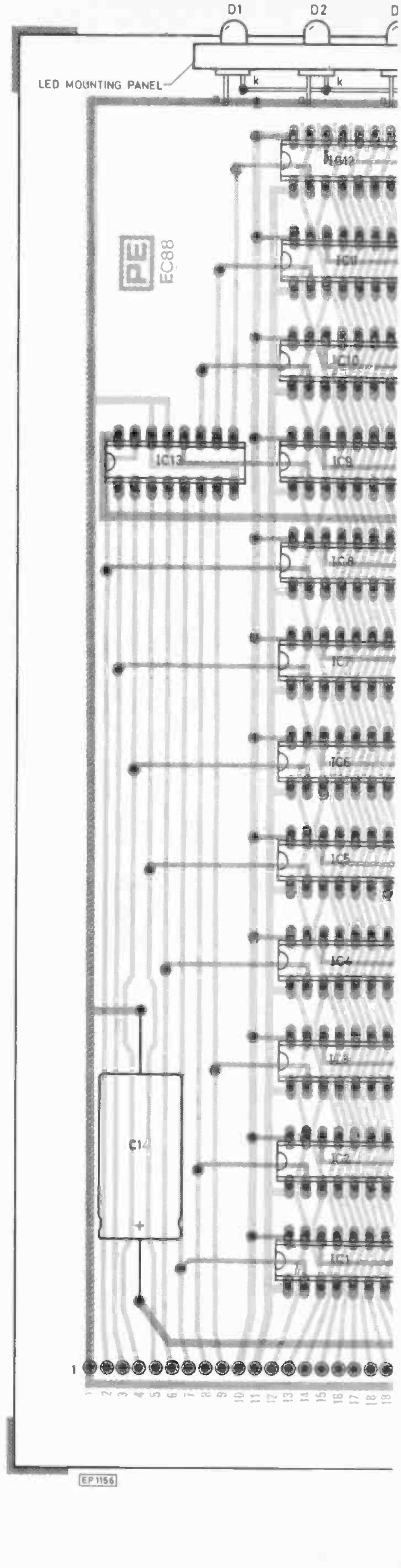


Fig. 3. P.c.b. design for ECC circuit (Topside)



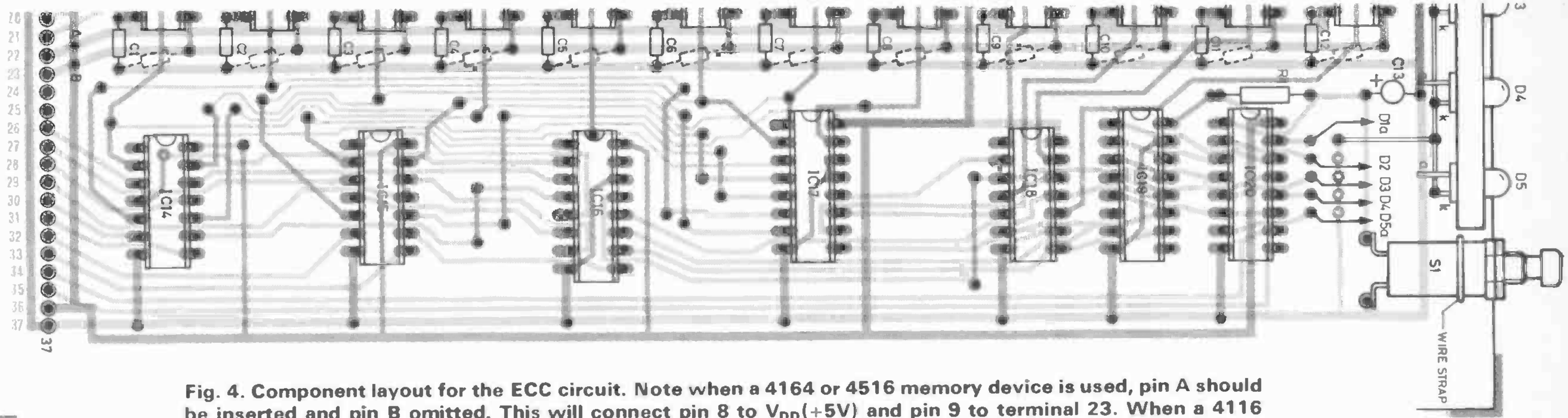


Fig. 4. Component layout for the ECC circuit. Note when a 4164 or 4516 memory device is used, pin A should be inserted and pin B omitted. This will connect pin 8 to V_{DD}(+5V) and pin 9 to terminal 23. When a 4116 device is used then pin B should be inserted and pin A omitted. This will connect pin 9 to +5V (Vcc) and pin 8 to +12V via terminal 22. The capacitors C1 to C12 are shown connected for 4164 and 4516 devices. If 4116's are used then C1 to C12 should be connected in the dotted position

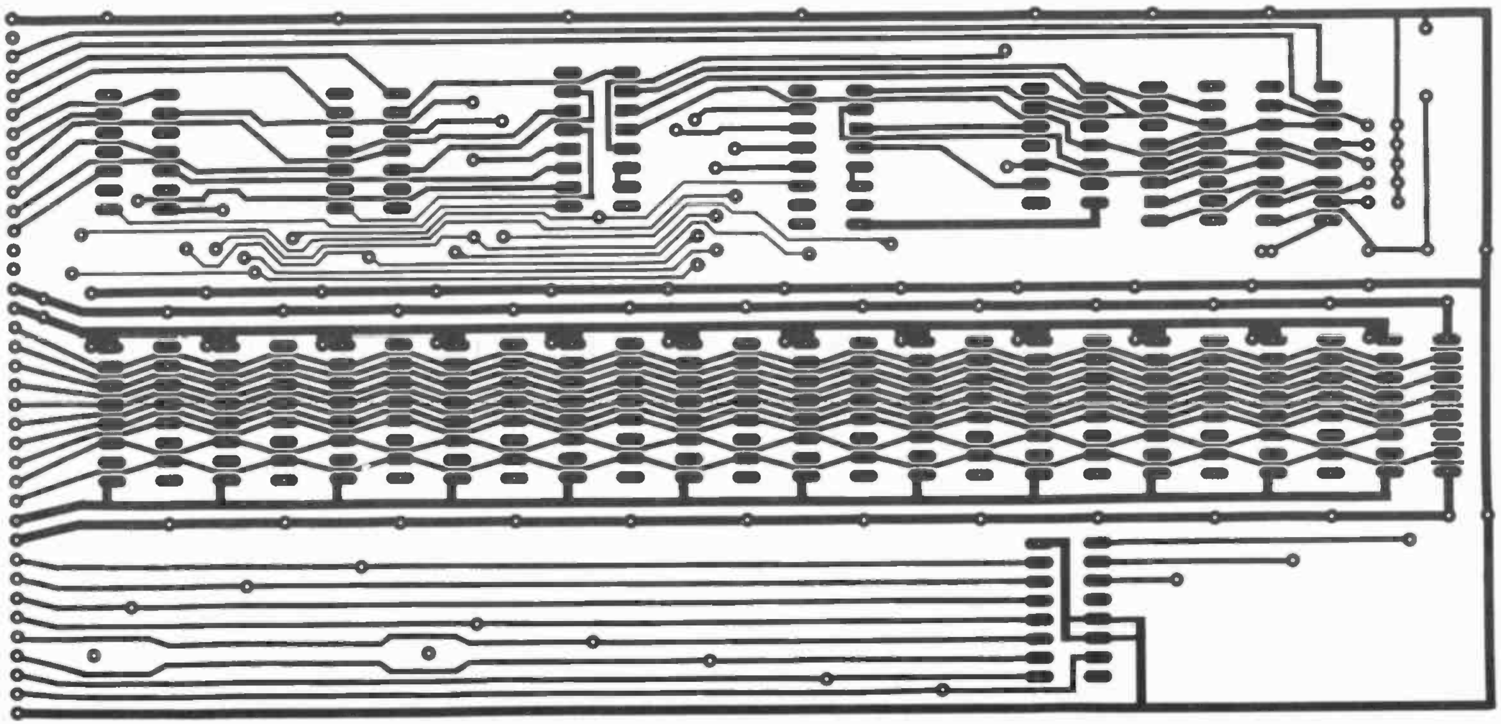


Fig. 5. P.c.b. design for ECC circuit (Underside)

	0	1	2	3	4	5	6	7	8	9	A	B	C	D	E	F
00	0	6	9	F	A	C	3	5	C	A	5	3	6	0	F	9
10	7	1	E	8	D	B	4	2	B	D	2	4	1	7	8	E
20	B	D	2	4	1	7	8	E	7	1	E	8	D	B	4	2
30	C	A	5	3	6	0	F	9	0	6	9	F	A	C	3	5
40	D	B	4	2	7	1	E	8	1	7	8	E	B	D	2	4
50	A	C	3	5	0	6	9	F	6	0	F	9	C	A	5	3
60	6	0	F	9	C	A	5	3	A	C	3	5	0	6	9	F
70	1	7	8	E	B	D	2	4	D	B	4	2	7	1	E	8
80	E	8	7	1	4	2	D	B	2	4	B	D	8	E	1	7
90	9	F	0	6	3	5	A	C	5	3	C	A	F	9	6	0
A0	5	3	C	A	F	9	6	0	9	F	0	6	3	5	A	C
B0	2	4	B	D	8	E	1	7	E	8	7	1	4	2	D	B
C0	3	5	A	C	9	F	0	6	F	9	6	0	5	3	C	A
D0	4	2	D	B	E	8	7	1	8	E	1	7	2	4	B	D
E0	8	E	1	7	2	4	B	D	4	2	D	B	E	8	7	1
F0	F	9	6	0	5	3	C	A	3	5	A	C	9	F	0	6

Table 6. The contents of ECC ENCODER 1 and 2 PROM

ADDR	DATA	ADDR	DATA
00	00	10	10
01	00	11	0C
02	00	12	0A
03	04	13	03
04	00	14	0B
05	08	15	04
06	01	16	01
07	80	17	08
08	00	18	09
09	02	19	02
0A	00	1A	10
0B	20	1B	06
0C	00	1C	10
0D	40	1D	07
0E	10	1E	05
0F	00	1F	10

Table 7. Correcting and diagnostic PROM contents

PIN	SIGNAL	PIN	SIGNAL
1	GND	21	A_1
2	D_7in	22	V_{DD}(4116)/ V_{CC}(4164,4516)
3	D_6in		
4	D_5in	23	V_{CC}(4116)/ A_7(4164)
5	D_4in		
6	D_3in	24	N.C.
7	D_0in	25	N.C.
8	D_1in	26	D_0out
9	D_2in	27	D_4out
10	V_{SS}(+5V)	28	D_2out
11	V_{BB}(4116)/ $\overline{RFSH}$(4164,4516)	29	D_6out
		30	D_1out
12	$\overline{CAS}$	31	D_3out
13	$\overline{WRITE}$	32	D_5out
14	A_6	33	D_7out
15	$\overline{RAS}$	34	INT
16	A_3	35	VALID MEM ADR
17	A_0	36	+5V
18	A_4	37	GND
19	A_2		
20	A_5		

Table. 8. Memory/micro interface information

CONSTRUCTION

The assembly of the p.c.b. is quite straightforward and the following points should be considered. The ECC circuit is on a double-sided p.c.b. the design of which is shown in Figs. 3 and 5 with the component layout shown in Fig. 4. In order to make the connections from the track-side to the component-side the i.c. sockets were soldered on both sides of the p.c.b; Soldercon i.c. pins were used. In all other positions tinned copper links or the component leads themselves were used to make the through connections.

On the prototype the l.e.d.s were mounted on a piece of plastic and fixed to the p.c.b. along with the pushbutton switch; the constructor may wish to mount these components in a position more suited to their own equipment. Whether or not pins A and B are inserted will depend upon the type of memory i.c.s used. The use of the pins is explained in Fig. 4. When the p.c.b. has been soldered and checked the i.c.s can be inserted. ★

run any CP/M80 software under it directly, because of course CP/M 8000 needs to run programs written in Z8000 code *not* 8080 code! As far as I have been able to discover, software to run under CP/M 8000 is pretty thin on the ground.

Things may improve in the future, since Commodore are planning to introduce a 16 bit personal computer based on the Z8000, but for the moment at least, you are on your own!

INTERFACING

To continue time honoured Z80 traditions, the Zilog designers have put their stamp on the Z8000 by scrambling up all the pin locations on the package so that they do not appear in boring, logical, groups. Let's face it, who needs the regular D0, D1, D2, D3, D4, D5, D6, D7, D8 etc. of the 68000 when you can have the exciting AD12, AD11, AD10, AD9, AD0, AD8, SN6, SN5, AD7 of the Z8000!

Also traditional is the need for a fast, high-drive, clock generator. Most clock designs I have seen published require a couple of Shottky T.T.L. packages and a handful of discrete transistors and resistors even to operate at 4MHz. This seems to be an area neglected by Zilog and long overdue for a special clock-chip like the 8284 in the 8086 family.

Unlike the other 16 bit manufacturers Zilog have defined a specific bus interface standard for the Z8000, called the Z-BUS. The Z-BUS conforms generally with the pin-outs of the Z8001 processor, but can also be used as a board-to-board bus to support more than one CPU. The bus is asynchronous and supports five types of bus transaction as follows:

Memory access. I/O transfer. Interrupt. Bus request. Resource request.

Address and data information are multiplexed together on pins AD0 to AD15, and so an external address latch is needed in most systems. An address strobe $\overline{AS}$, and a data strobe $\overline{DS}$, are provided to control demultiplexing.

An additional seven non-multiplexed address bits are output by the Z8001 as the "segment number" to expand the address range to 8M bytes, and a Byte/Word control line is provided to indicate whether the current memory reference applies to a word or to a byte operand. Despite the use of a 16 bit data bus, memory data is byte addressable because Ao is available to select the upper or lower byte in a word and can be combined with the $B/\overline{W}$ line to perform a similar function to the UDS and LDS strobes on the 68000. I/O transactions are indicated by the appropriate status code on ST0 to ST3 and use only the 16 bit address information on AD0 to AD15.

Three types of interrupt are provided, Non-Maskable (NMI), Non Vectored (NVI) and Vectored (VI). The only "funny" here is the NVI which is just an additional, simple, interrupt input for low priority applications which do not require the high status of the NMI or the complex vectoring of the VI.

The vectoring scheme used with the VI input should bring tears of nostalgia to the eyes of Z80 fans since it uses the same daisy chain prioritisation scheme. The interrupt outputs of all peripheral chips are wire-ORed together and to the $\overline{INT}$ input of the Z8000. All peripheral devices are daisy chained together with the IEO (Interrupt Enable Output) of the highest priority device connected to the IEI (Interrupt Enable In) of the next highest and so on down the chain. If any peripheral has a pending interrupt it will be serviced only if no higher priority devices require service and the IEO of the next highest priority device is therefore a 1. When this condition is satisfied the peripheral in question pulls its $\overline{INT}$ output low and the processor responds by performing an interrupt acknowledge cycle which causes the selected device to place its unique interrupt vector number on data lines AD0 to AD7.

During the acknowledge cycle the Z8001 stores its current status on the stack and reloads the four CPU status registers with the VI status block fetched from the Program Status Area of memory. You may remember from the register section that each exception class has its own four word status block, but since there can be more than one source of Vectored Interrupts, the four word block is extended to include a 256 entry vector table of new program counter values. The Interrupt Vector number from the interrupting device is used to select the appropriate entry from this table and the CPU recommences instruction execution at the start of the appropriate interrupt service routine.

This powerful interrupt scheme, while very similar to the Z80 arrangement, is not exactly the same (naughty old Zilog!) but fortunately it is still possible to connect Z80 peripherals to a Z8000 processor with the aid of some TTL translation logic.

One possible disadvantage of the Z80 and Z8000 interrupt scheme is that the priority status of all peripherals is fixed by the chip interconnections and cannot be changed. The Intel 8259 Programmable Interrupt Controller chip on the other hand, provides not only a fixed priority mode but also a rotating priority mode which can be used to ensure that a number of users of equal status get a fair crack of the whip.

Zilog have been generous in providing peripheral chips for the Z8000 family, although some of this apparent generosity is not quite what it appears! Since the Z80 family already had the most powerful 8 bit peripherals going, in some cases Zilog were able to simply modify their earlier designs slightly and give them a new number. By this means the Z80 CIO became the Z8036 CIO, with just a few pins changed to aid Z8000 interfacing! Needless to say, Zilog do not exactly shout about this feature.

To be fair to Zilog, this approach is perfectly sensible and gives them a big advantage over Motorola who have only a primitive 8 bit family to draw on and who are still struggling to get their 16 bit peripheral family together. It also allowed Zilog to concentrate effort on the relatively few *new* 16 bit peripherals like the Z8010 Memory Manager and to get these to market sooner.

The Zilog Z8010 Memory Management Unit (MMU) adds a new dimension to the memory addressing capability of the Z8001 by translating the physical address space of that processor into a logically segmented space which can be dynamically reconfigured under program control. In the basic Z8001 the 8M byte address space is divided up into 128 segments each 64K bytes long. The MMU divides the physical memory up into continuous 256 byte blocks to form 64 variable sized segments from 256 to 64K bytes positioned anywhere in the 16M byte address space, so that the logical addresses manipulated by the programmer can be flexibly transformed into the physical addresses required by the memory. The MMU therefore decouples the programmer from the memory and permits the relocation of available memory from one segment to another under system software control to suit the immediate needs of the system.

The technique of memory management has limited relevance to the small single user system, but is a very powerful technique, developed originally for large computers, to permit the optimum allocation of memory resources among competing tasks or users.

Since the segments recognised by the Z8010 have assignable attributes, memory protection schemes can be easily arranged in system software. Any request to access a segment illegally then causes a TRAP exception to the Z8001, and possible causes could be: writing to a read-only segment, a user trying to access a system (privileged) segment, or a detected segment overflow conditon.

Another useful and original member of the Z8000 peripheral family is the Z8038 FIO First-In-First-Out (FIFO) buffer unit. This 40 pin device contains a 128 byte FIFO RAM which can be used to synchronise I/O or interprocessor transfers by accepting data from one device and holding it until it can be accepted by a destination device. Empty, Full, and Wait/Request control lines are available to manage Z8038 transfers.

APPLICATIONS

The Z8001 processor is powerful, well supported by hardware, but unfortunately not yet as popular as the 8086 or the 68000. Perhaps this last fact will change when Commodore bring out their expected Z8000 based 16 bit personal computer, but meanwhile the application software base is very limited.

My personal feeling is that the Z8000 family is not the best choice if you have a data processing application in mind, but it might be a suitabale candidate for a 16 bit control application thanks to its high speed, low cost, and powerful interrupt and peripheral structure.

For most small applications the simpler Z8002 with its 64K byte address range will probably be sufficient, but Z80 users should beware the non-compatibility of the Z8000 family with existing Z80 software. My advice would be to wait a little longer for the forthcoming Z800 family which offers *compatible* 16 bit power!

all in your

OCTOBER

issue!

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Part One

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Guitar Active Tone Controls

A. Scragg

UNTIL quite recently most tone controls on an electric guitar consisted of a pot and capacitor configured as a low pass filter, with a 6dB per octave slope. This arrangement, although simple and reliable, does not give a large tonal range, tending to be dull and uninteresting with the treble thus removed. Increasingly, however, guitars and basses, particularly those of oriental origin, are being equipped with active tone controls giving separate treble and bass adjustment. This gives much better and variable sounds and has the additional advantage of buffering the guitar output, enabling a long cable to be used to the amplifier/mixing desk without noise pickup and the reactive loading reducing the treble response. This results in a crisper, punchier sound.

For those not wishing (or able) to invest in a new guitar simply for the benefit of active circuitry, this design is small enough to be built into the guitar body, or as a separate unit, into a small instrument case.

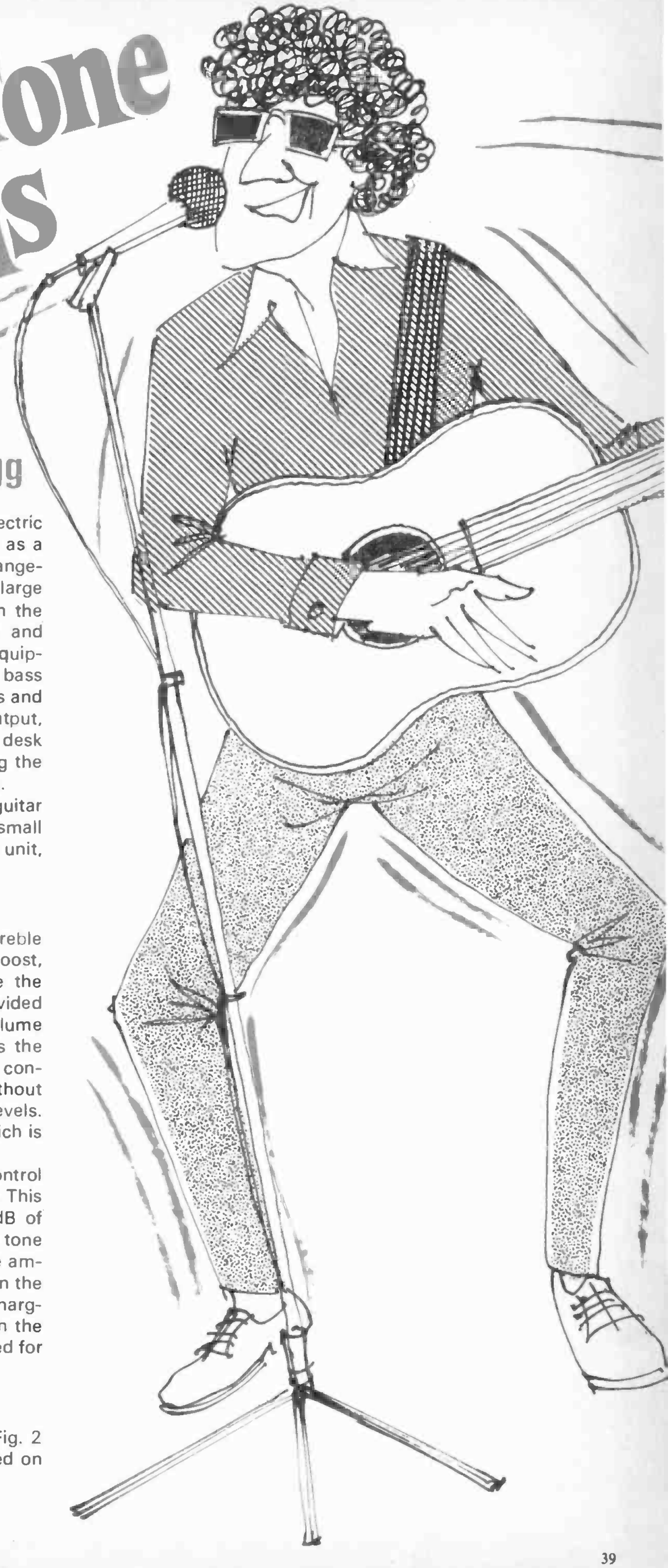
CIRCUIT DESCRIPTION

The active tone controls circuit provides volume treble and bass controls with a switch giving extra treble boost, which is very useful for solos. For best performance the guitar pickup needs to see a high impedance, this is provided by a bootstrapped input amplifier, which also has a volume control incorporating a loudness circuit, which boosts the treble at low volume settings to give the impression of constant tone balance throughout the volume range—without this the sound becomes flat and uninteresting at low levels. This is due to the characteristics of the human ear which is less sensitive to the high frequencies of quieter sounds.

The input amplifier is followed by the tone control circuitry—which is of the active treble and bass type. This circuitry has a nominal voltage gain of one with 20dB of boost and cut at 40Hz and 10kHz. The output of the tone control circuit provides the low impedance drive to the amplifier cable. The circuit is automatically turned on when the output jack is plugged in and there is also a facility for charging a NiCad battery, if fitted, by using a stereo plug in the same socket. Fig. 1 shows the plug connections required for normal and charging use.

HOW IT WORKS

The circuit of the active tone controls is shown in Fig. 2 and can be considered as three functional blocks based on the three i.c.s. They are:



1. A high input impedance amplifier incorporating the loudness, volume control and the treble boost circuitry.
2. A conventional Baxendall type active tone control circuit also providing the output.
3. A negative supply voltage generator.

The most unusual feature of the circuitry is the third functional block—the negative supply generator. The obvious question is why is it necessary at all as single supply op amp circuits could easily be used. There are two main reasons why. Firstly, the op amp used for the input amplifier is the Signetics NE 5534A (chosen for its excellent low noise audio performance) which requires a minimum supply voltage of ±3V. Using a PP3 battery of nominally 9V output, the battery life would be relatively short if used to power the circuit directly as its voltage soon decays from its nominal value, also the output from the guitar pickup has a very large dynamic range with large transients as the strings are played, so to avoid distortion due to op amp clipping as large a supply voltage as possible should be used. Another advantage of using positive and negative power supplies is that the signal path is referred to 0V avoiding the large switch on thump as coupling capacitors charge up. The supply currents are effectively separated from the signal path, reducing earth loop noise.

The negative supply generator uses an NE555 timer i.c. in its astable mode producing a square wave output at about 30kHz. This is outside the audio bandwidth to avoid any breakthrough to the output being heard.

The astable period is set by R7, R8, and C7 being the time for C7 to charge up to $\frac{2}{3}V_{cc}$ through R7 and R8 and discharge to $\frac{1}{3}V_{cc}$ through R8. The frequency of oscillation is given by:

$$f = \frac{1}{0{\cdot}693(R7 \times 2R8)C7}$$

The output of the astable is a.c. coupled and clamped by C9 and D1 respectively. This is rectified and smoothed by D2, C10 and C13 resulting in a negative supply of 6V. The voltage loss is due to the two diode 0·6V drops and the fact that the 555 output swing is not to its supply voltage; however, with this supply an output signal of 3V peak is available, which is quite sufficient!

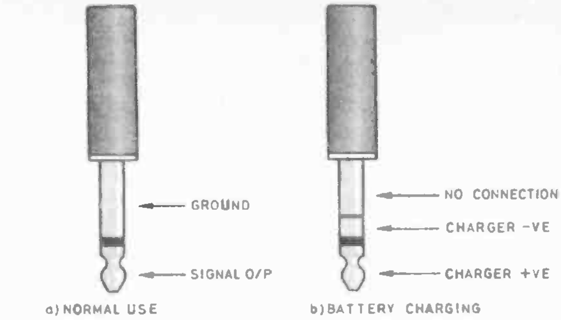


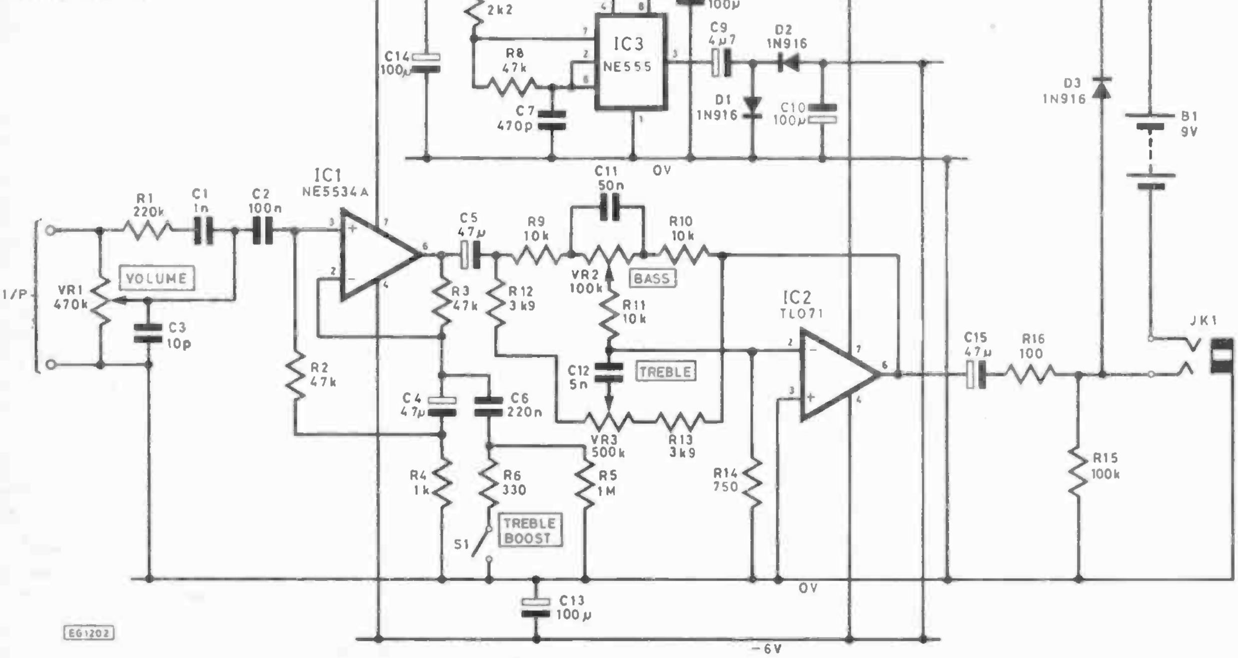
Fig. 1. Jack plug connections

While on the subject of power supplies, the battery is connected to the circuit by inserting the mono jack plug of the guitar lead into the stereo (three pole) output jack socket; this connects the outer two poles together, completing the circuit. Additionally, diode D3 links the output to the supply line; in normal operation this is reversed biased and therefore high impedance; however, if a rechargeable battery is used a stereo jack plug can be used to charge the battery *in situ*. The charger positive is connected to the inner pole, negative to the centre pole. In this mode the active tone control circuit is not connected. The charger used should be of the constant current type—10mA in the case of a PP3-type battery. This is very convenient if the circuit is installed in the guitar. As the supply current is about 10mA it makes good sense to use a rechargeable battery, especially if the guitar is used often, as a dry cell will only last about ten hours continuous running.

SPECIFICATIONS

Signal-to-noise ratio	64dB (referred to 5mV i/p)
Voltage gain	X48 (33dB)
Maximum signal output	3V peak
Supply current	10mA
Bass control	±20dB at 40Hz
Treble control	±20dB at 10kHz

Fig. 2. Circuit of active tone controls



The next functional block is the amplifier. VR1 is a simple volume control, R1, C1 and C3 give the loudness effect—being shorted out when the control is at full volume. C2 a.c. couples the input to stop the op amp bias current causing noisy pot operation. The amplifier itself is a bootstrapped non-inverting type. The purpose of the bootstrapping is to give a very high input impedance to the signal while providing a low impedance at d.c. so that the op amp bias current does not result in a large offset voltage. The circuit works as follows—initially with the treble boost switch open.

At d.c. capacitor C4 is an open circuit, giving the equivalent circuit shown in Fig. 3(a). It can be seen that the amplifier has unity gain and the input impedance at both op amp inputs is approximately the same (R3 and R2 + R4). They are arranged like this to balance out the bias current generated offset as far as possible so that in the worst case only a few millivolts of offset appears at the output.

At audio frequencies C4 is large enough to appear to be a short circuit. The equivalent circuit becomes that of Fig. 3(b). The gain and input impedance of this circuit are given by the following equations:

$$\text{Gain} = 1 + \frac{R3}{R4} \qquad \text{Input impedance} = \frac{R2A}{\left(1 + \frac{R3}{R4}\right)}$$

COMPONENTS . . .

Resistors		Capacitors		
		C1	1n	ceramic
R1	220k	C2	100n	ceramic
R2, R3	47k	C3	10p	ceramic
R4	1k	C4	47μ	10V bea
R5	1M	C5	47μ	10V bea
R6	330	C6	220n	C280
R7	2k2	C7	470p	ceramic
R8	47k	C8	100μ	10V bea
R9, R10, R11	10k	C9	4μ7	10V bea
R12, R13	3k9	C10	100μ	10V bea
R14	750	C11	50n	C280
R15	100k	C12	5n	ceramic
R16	100	C13	100μ	10V bea
All 10% ¼W carbon		C14	100μ	10V bea
		C15	47μ	10V bea

Semiconductors		Potentiometers	
D1, D2, D3	1N916	VR1	470k log
IC1	NE5534A	VR2	100k lin
IC2	TL071	VR3	500k lin
IC3	NE555		

Miscellaneous

S1—SPST miniature toggle switch

JK1—¼in stereo jack socket

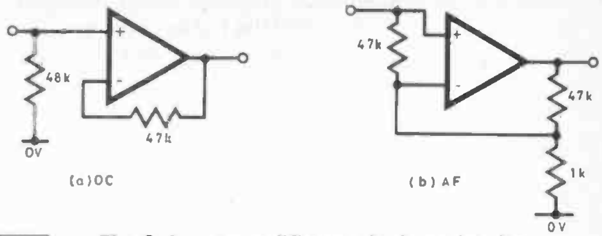


Fig. 3. Input amplifier equivalent circuits

Where A is the open-loop voltage gain of the op amp.

From the above equations it can be seen that the input impedance is very large and VR1 therefore defines the input impedance of the circuit as a whole. With the specified values the input impedance is 470k and the gain is x 48, but can be adjusted as required by altering R2 and R3.

When the treble boost switch is closed the feedback is reduced at high frequencies, giving a brighter, louder sound. R5 is used to stop thump when the switch is closed due to C6 charging up, through its own leakage resistance.

C5 a.c. couples the output of this stage to a Baxendall type active tone control circuit giving 20dB cut and boost at 40Hz and 10kHz.

CONSTRUCTIONAL DETAILS

Tantalum electrolytic capacitors are specified for their good electrical performance and small size. If the pots used are p.c. mounting types, they can mount directly on to the board; if not, Harwin pins can be used on the board and the pots connected to these. The treble boost switch, input and output are connected to these. The treble boost switch, input and output are connected via flying leads, as is the battery.

The prototype was built into the body of the guitar but could equally well be built into a small instrument case using a mono jack socket for the input. ★

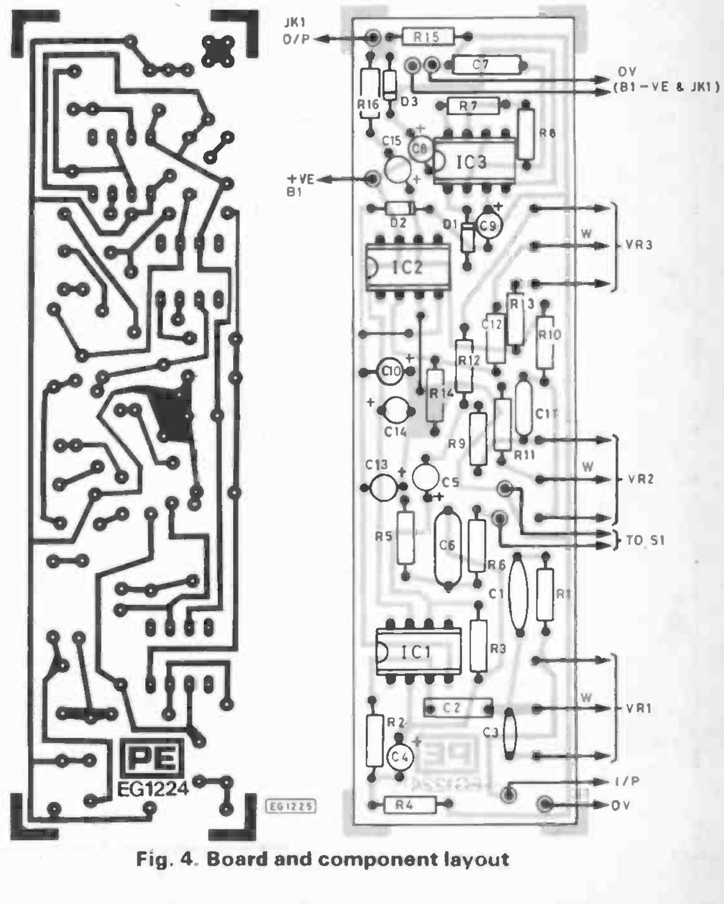


Fig. 4. Board and component layout

Ground Communication System

R.A.PENFOLD

THE idea of using the ground as a medium for communication is by no means a new one, and dates back as far as World War 1 at least. The basic arrangement for a communications system of this type is shown in Fig. 1.

An ordinary audio power amplifier driven by a microphone is all that is needed at the transmitting end of the system, plus two earthing rods which are placed in the ground some distance apart. The earth usually provides a fairly low resistance path between the two rods, but this resistance is actually made up from an infinite number of paths through the earth from one rod to the other. Most of the current flow between the rods takes a more or less direct route from one rod to the other, but some of the signal takes a much longer route and can therefore be detected some way away from the transmitting earthing rods. However, the longer the route taken by the signal, the greater the resistance it has to overcome, and the weaker the signal that is available due to the lower current flow. All that is needed to pick up the signal is another set of earthing rods feeding a pair of headphones or an amplifier and loudspeaker, but the inefficiency of this system gives only a fairly limited operating range.

Systems of this type generally only operate up to an absolute maximum range of about two miles, and often the maximum attainable range will be very much less than this. This still gives an adequate range for some purposes, and ground communications is certainly an interesting subject for the experimenter. A novel feature of ground communications is that it can be used for subterranean communications, unlike normal radio communications.

BLOCK DIAGRAM

Fig. 2 shows in block diagram form the simple ground communications system featured in this article. The transmitter consists of a microphone feeding a preamplifier stage, which in turn drives a power amplifier. A gain control is used in conjunction with an l.e.d. level indicator to ensure that the power amplifier is fully driven but not seriously overloaded.

The power amplifier is a bridge type, and this is necessary as a reasonably large output voltage swing is needed in order to give usable results. The amplifier uses a bridge amplifier integrated circuit which is normally used as a power booster for a car radio, giving an output power of about 18 to 20 watts r.m.s. into a 4 ohm impedance loudspeaker. In this case the output power is very much lower than this, and is likely to be in the region of 1 watt r.m.s. since the impedance across the earthing rods is typically between 50 and 100 ohms. This relatively low output power gives the unit a reasonably low current consumption so that battery operation is possible.

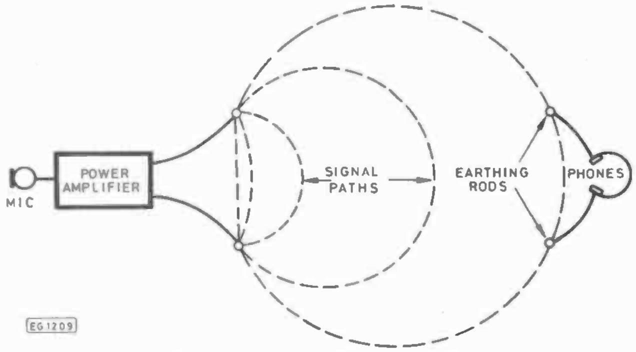


Fig. 1. Ground communication basic system

The receiver uses a high gain preamplifier followed by a 200Hz highpass filter and a small audio power amplifier. The latter drives a miniature loudspeaker, or medium/high impedance headphones can be used if preferred. The purpose of the highpass filter is to combat mains hum which always seems to be present, and can be very strong if the system is used very near to houses or other places where mains powered equipment is used (and earthed). The filtering is only partially successful as there are quite strong harmonics on the 50Hz mains signal. With these harmonics spaced at 50Hz throughout the audio band, it is not really feasible to filter them out completely. A high slope 200Hz highpass filter gives a worthwhile reduction without affecting the intelligibility of the received signal. It does not seem to be possible to use a balanced input and a phasing technique to reduce mains hum.

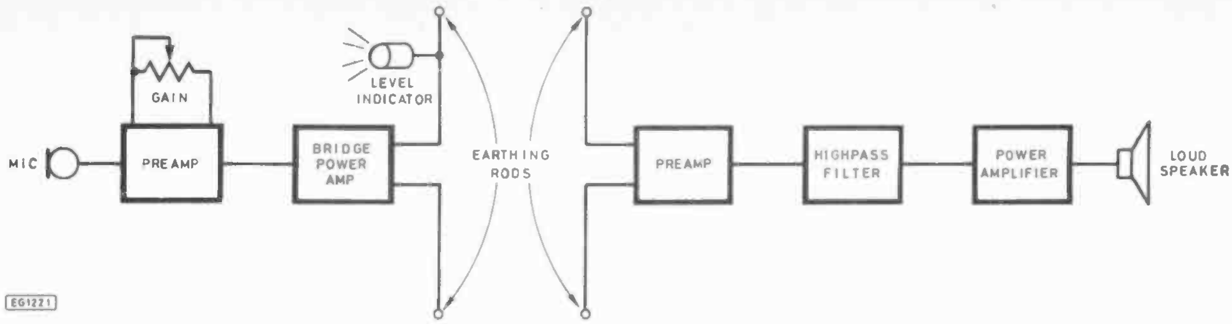


Fig. 2. The system in block diagram

It may seem wasteful to use separate circuits for the transmitter and the receiver when both are basically just high gain audio power amplifiers. However, circuits using a single amplifier with the loudspeaker used as a microphone in the transmit mode all provided mediocre results both in terms of audio quality and range, and a two amplifier circuit was therefore adopted for the final unit.

TRANSMITTER CIRCUIT

Fig. 3 shows the circuit diagram of the transmitter. The power amplifier uses an HA1388 bridge amplifier which will give over 20 volts peak to peak at the output using a nominal 12 volt supply. C9 and C10 are bootstrapping capacitors which help to maximise the output voltage swing from the two power amplifier. C11 and C12 are needed to aid stability while D2 and its associated components are used to give an indication of the output signal level. D2 will be forward biased on one set of half cycles, but only if the peak output voltage exceeds about 7 volts, since about 5·1 volts is needed to force D1 into conduction, while approximately 1·9 volts further is needed to overcome the threshold potential of D2. Thus about 14 volts or so peak to peak is needed at the output before D2 will light up, and the amplifier will be fully driven or nearly so provided D2 lights up when someone speaks into the microphone.

The voltage gain provided by IC1 is quite high and only about 10 millivolts r.m.s. is needed at the input (pin 3) in order to provide maximum output. This is still not sufficient to enable the circuit to be driven from a normal microphone, and TR1 is therefore used as a common emitter preamplifier stage which boosts the gain of the circuit by a factor of about one hundred. This enables the unit to be used with inexpensive low impedance (200 or 600 ohm) dynamic microphones. C13 rolls-off the high frequency response of the preamplifier which helps to prevent instability and also gives an improvement in the signal to noise ratio of the circuit.

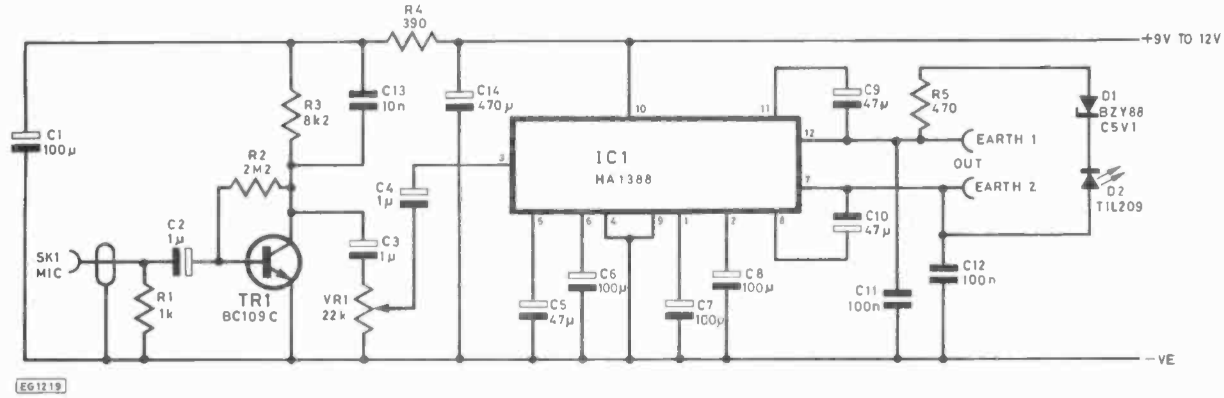


Fig. 3. The transmitter circuit. In use the current consumption can be in excess of 100mA so the battery should be a PP9 or six to eight HP7s. Ideally Ni-Cad cells are to be preferred

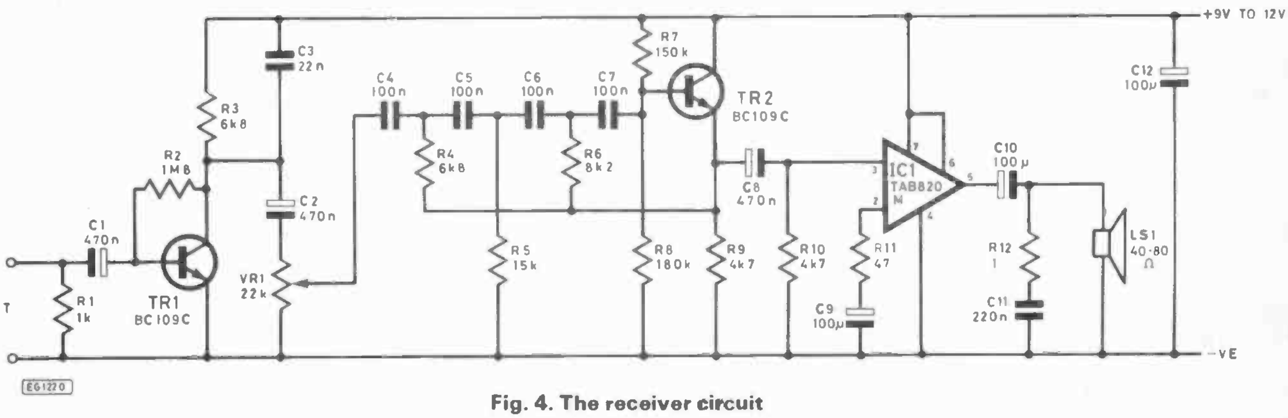
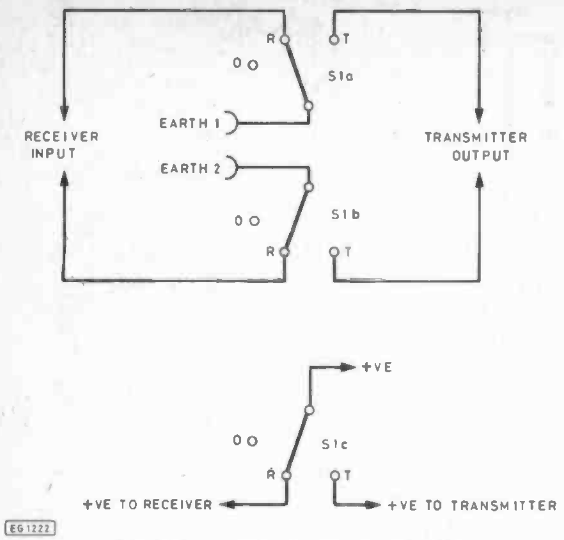


Fig. 4. The receiver circuit



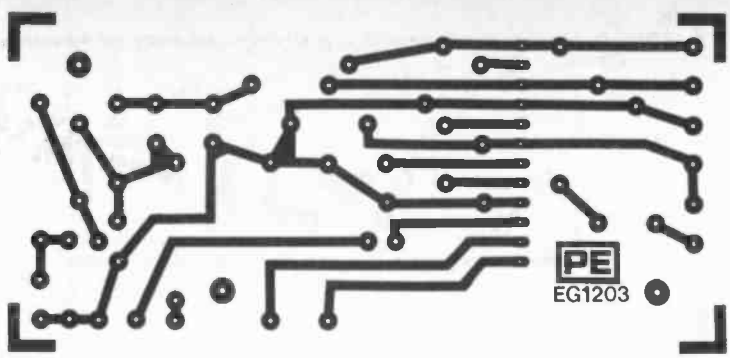


Fig. 5. Transmit/Receive switching

RECEIVER CIRCUIT

The receiver circuit uses a preamplifier which is similar to that employed in the transmitter, as will be apparent from the circuit diagram of Fig. 4.

From the output of the preamplifier the signal is passed via volume control VR1 to the highpass filter. This is a conventional active 24dB per octave type which uses TR2 as the unity voltage gain buffer stage and has a cutoff frequency of approximately 200Hz. Low frequencies do not significantly contribute to the intelligibility of a voice signal, and the filtering does not have any detrimental effect on the signal. There is little output from the transmitter below 200Hz anyway.

The power amplifier is a TBA820M (IC1) which gives an output power of about 150 milliwatts into a high impedance loudspeaker, and this gives a perfectly adequate volume level for this application. R11 is a feedback resistor which sets the closed loop voltage gain of IC1 at approximately 130 times. This gives the circuit an input sensitivity of about 2 millivolts r.m.s. for maximum output, and this is about the highest practical sensitivity.

For two way communications it is obviously necessary to have both a transmitter and a receiver plus transmit/receive switching at each end of the system. Suitable switching is shown in Fig. 5.

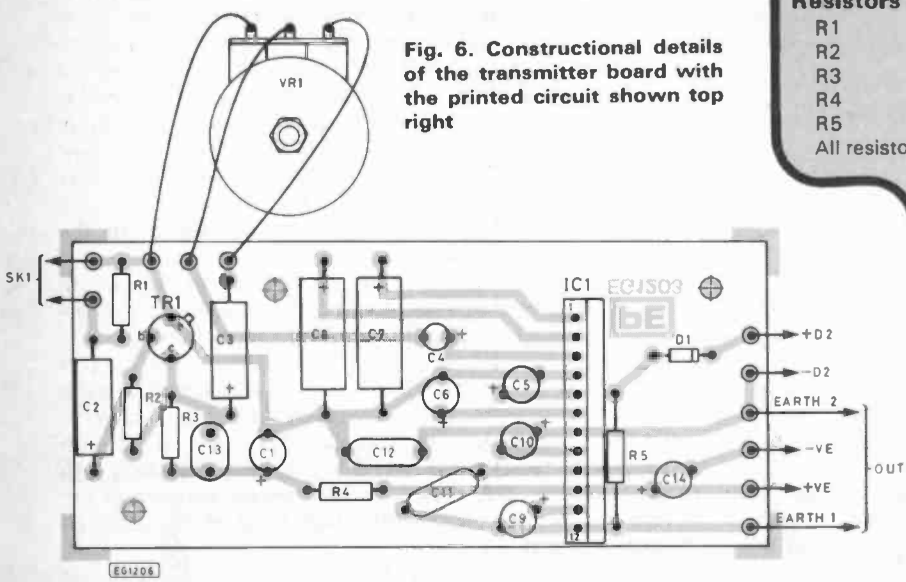


Fig. 6. Constructional details of the transmitter board with the printed circuit shown top right

CONSTRUCTION

The system can be built as separate transmitter and receiver units for one way communications, or as transceiver units for two way communications, but it will be assumed here that the system is constructed as two transceivers. The transmitter and receiver circuits are assembled on separate printed circuit boards which are shown in Fig. 6 and Fig. 7 respectively. Both boards are quite straight forward to construct, and the only unusual component used is the HA1388 (IC1 in the transmitter). This has a single line of twelve pins, but pin 1 is indicated in the standard fashion by a small dot or indentation on the body of the component. The HA1388 has a heat-tab which can be bolted to a heatsink, but in this application the output power is not likely to be sufficient to merit the fitting of even a small heatsink. This integrated circuit has comprehensive protection circuits incidentally, including a thermal shutdown circuit.

A metal instrument case measuring about 200 x 125 x 75mm will comfortably accommodate all the components including the batteries. The general layout of the unit can be seen from the photograph but is not especially critical. Miniature loudspeakers do not usually have provision for screw fixing and it will almost certainly be necessary to glue LS1 in position behind a grille made by drilling a matrix of small holes. The connections to the earthing rods can be made by way of a couple of 4mm sockets fitted on the rear panel of the case, plus a couple of leads fitted with 4mm plugs.

Once all the components have been installed in the case the point to point wiring can be added. The wiring to S1 is illustrated in Fig. 8.

TRANSMITTER BOARD

Resistors

R1	1k
R2	2M2
R3	8k2
R4	390
R5	470

All resistors ¼W 5% carbon film

Semiconductors

IC1	HA1388
TR1	BC109C
D1	BZY88C5V1
D2	TIL209 etc.

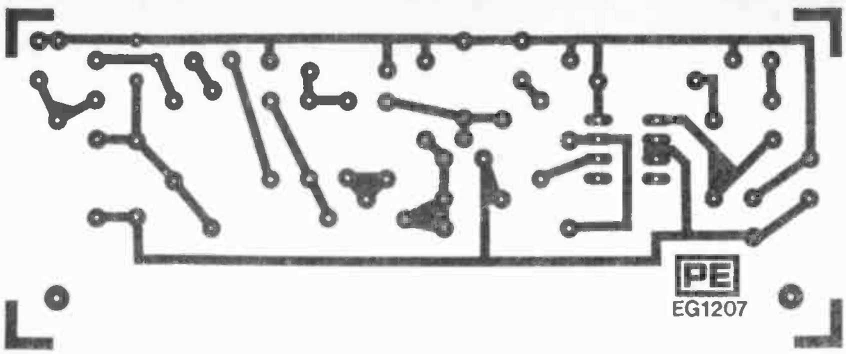
Capacitors

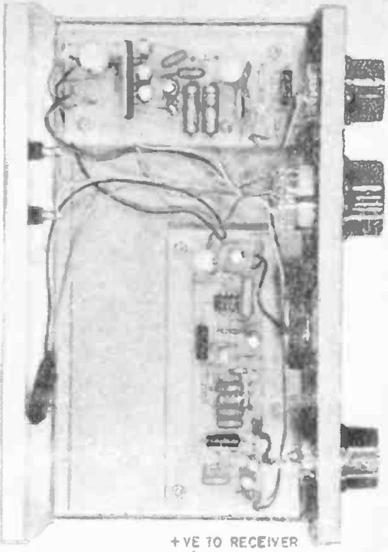
C1	100µ 16V radial electrolytic
C2, 3	1µ 63V axial electrolytic (2 off)
C4	1µ 63V radial electrolytic
C5, 9, 10	47µ 10V radial electrolytic (3 off)
C6	100µ 10V radial electrolytic
C7, 8	100µ 10V axial electrolytic (2 off)
C11,12	100n polyester
C13	10n mylar
C14	470p 16V radial electrolytic

Miscellaneous

SK1	3·5mm jack socket
VR1	22k log. carbon

Printed circuit board, low impedance dynamic microphone, control knob, Veropins, wire, etc.





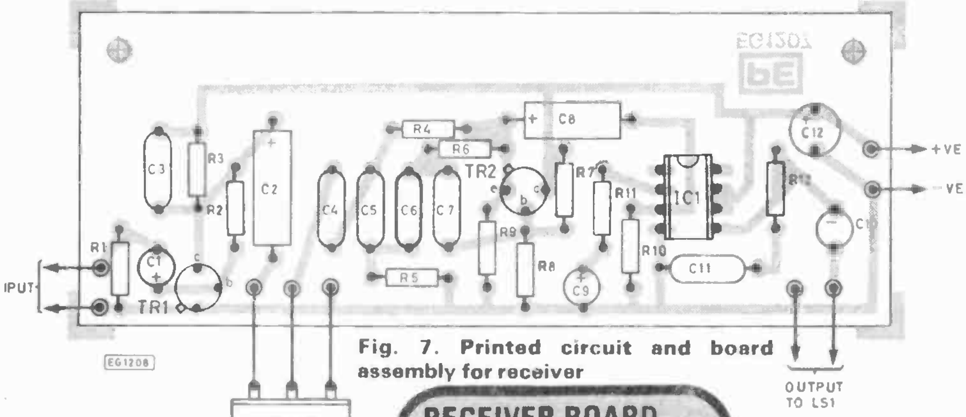


Fig. 7. Printed circuit and board assembly for receiver

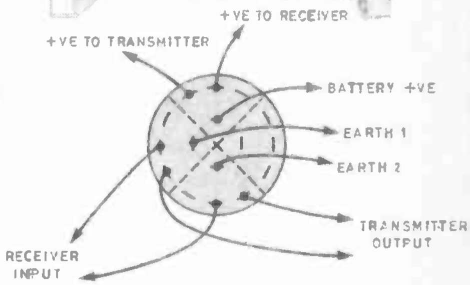


Fig. 8. Wiring to Transmit/Receive switch S1

RECEIVER BOARD

Resistors

R1	1k
R2	1M8
R3, 4	6k8 (2 off)
R5	15k
R6	8k2
R7	150k
R8	180k
R9,10	4k7 (2 off)
R11	47
R12	1

All resistors ¼W 5% carbon film

Semiconductors

TR1, 2	BC109C (2 off)
IC1	TBA820M

Capacitors

C1	0·47µ 63V radial electrolytic
C2, 8	0·47µ 63V axial electrolytic (2 off)
C3	22n polyester
C4, 5, 6, 7	100n polyester (4 off)
C9,10	100µ 10V radial electrolytic (2 off)
C11	220n polyester
C12	100µ 16V radial electrolytic

Miscellaneous

VR1	22k log. carbon
LS1	40 to 80R impedance miniature loudspeaker

Printed circuit board, control knob, Veropins, wire, etc.

ADDITIONAL FOR TRANSCEIVER

S1—3 way 4 pole rotary switch, control knob, two wander sockets, case, battery connector, wire, etc.

IN USE

Results obtained with the finished system are largely dependent on factors such as the efficiency of the earths used, the conductivity of the soil, and the level of mains hum present, rather than on the level of performance provided by the transceivers. It is therefore impossible to predict how great or restricted the range obtained using the system will be. However, in order to obtain good results it is essential to observe a few simple rules.

The most important of these is to place the two earths as far apart as is reasonably possible. Placing them only a metre or so apart is unlikely to give usable results, and a spacing of around ten metres will give vastly superior results. Wide spacing of the earths seems to be beneficial for both transmission and reception.

It is essential for the earths to make good contact with the soil. Early experiments were made using earths that consisted of small sheets of metal pushed into the soil, but this gave a very limited range indeed. Much better results seem to be produced using metal rods about 12 to 30mm in diameter and about one metre long hammered as deep as possible. Ideally these should be made of a metal that is resistant to corrosion.

For best results the earths should be positioned so that the four of them roughly form a rectangle (as in Fig. 1 which was discussed earlier). At the other extreme, having all four earths roughly in line will give very poor results and would probably result in the system failing to work at all.

Mains hum can be quite strong in built-up areas, and it might be worthwhile experimenting with the earthing rods in various positions in an attempt to minimise hum. It will often be the level of this mains interference that determines the maximum usable range of the system, but even where mains hum is very strong, it should be possible to obtain a range of 50 to 100 metres if efficient and well placed earths are used so that a strong signal is produced by the transmitter. In the interest of minimising any interference received it is advisable to have the leads from the transceiver to the earths as short as possible.

Radio interference might be a problem at times, but adding a capacitor of a few nanofarads in value across the input/output sockets should eliminate this interference.

It is important to set the microphone gain control correctly, and with the aid of l.e.d. indicator D2 this is quite easy. The gain control should be advanced just far enough to make D2 flash on signal peaks, but it should not light up brightly and continuously while someone is speaking into the microphone. This would result in severe clipping at the output of the transmitter with a high level of distortion on the output signal.

Getting to GRIPS with MAC

UK SATELLITE SYSTEM EXPLAINED

A NUMBER of European countries, including the UK, plan to have Direct Broadcast Satellite (DBS) systems operational or pre-operational by 1985/86. The UK plans include the two-channel UNISAT being developed by British Aerospace for leasing to the BBC. UNISAT will weigh about 1400kg with solar generator panels that should still be generating 1·7kW at the end of its 10 year design life.

This electrical power is sufficient to provide only two DBS channels to the full international standards agreed in 1977 to permit programmes to be received virtually anywhere in the British Isles by means of a small dish aerial of about 70cm (2 feet) diameter, mounted on roof-tops or at ground level, or anywhere which has direct line-of-sight to the satellite to be positioned 36,000km above the Equator at 31° West.

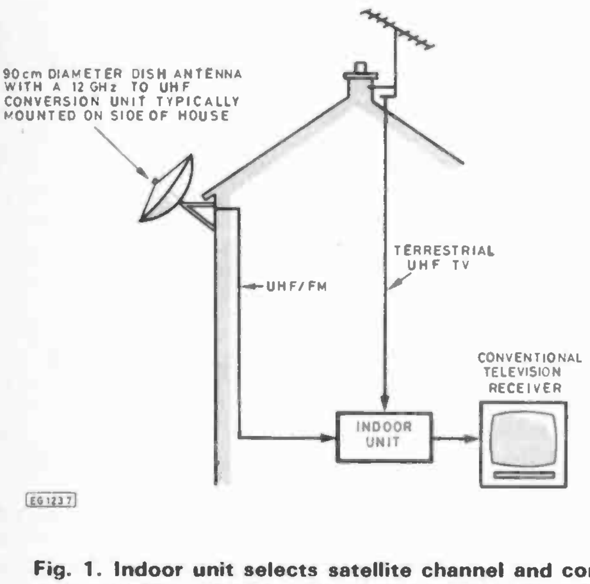


Fig. 1. Indoor unit selects satellite channel and converts satellite television standard to terrestrial television standard

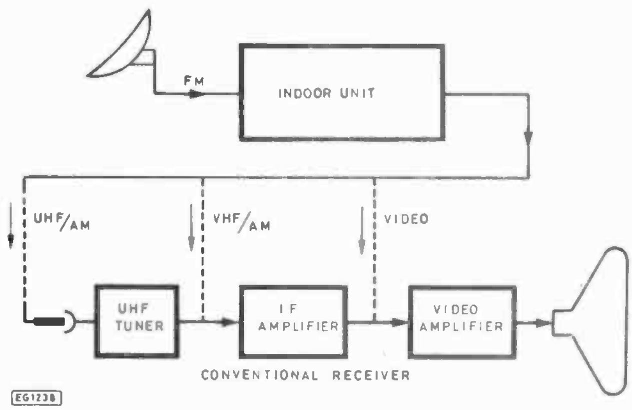


Fig. 2. Basic receiver options

DISH DEBATE

There is some debate about how many viewers will have a suitable place for their own dish aerial. Some will find trees or other buildings blocking their direct reception, and those living in flats may not have access to the roof or live on the wrong side of the building for a wall-mounted aerial. For such viewers, satellite channels could reach them through a communal or "syndicate" aerial mounted on the roof or from a master-aerial system in conjunction with a cable network. Economically there are advantages in communal and cable systems since the signals could be distributed in a form suitable for use with a standard television receiver. Those with their own DBS aerial will need a 12GHz to UHF conversion unit mounted with the aerial unit and also an "indoor unit" to provide a signal suitable for use with the receiver, preferably linking into the receiver at video frequency (RGB signals) as shown in Fig. 1 or by using a UHF modulator and the aerial input socket. It can be seen from Fig. 2 that there are a number of basic receiver configurations which could be adapted to interconnect a 12GHz FM receiver/adaptor with a conventional UHF/AM receiver. An adaptor providing a UHF/AM output could be connected directly to the aerial

socket of an existing receiver. Alternatively an output at the IF of the main receiver could feed into the IF amplifier section. Output at video frequency is particularly attractive in that it eliminates distortion and spurious signals which are inherent in low-cost modulators and multiple-conversion receivers.

In practice a single DBS transmitter should be receivable in about 98-99% of homes. The limited electric power available at the satellite has an important effect on the form of transmission. For terrestrial TV the vision signal is transmitted as an amplitude-modulated vestigial sideband signal (VSB). In Europe the complete 625-line television signal, including the frequency-modulated mono audio channel, fits into an 8MHz channel (Fig. 3). All these systems use frequency interleaving in order to encode the luminance (black and white) picture information with the chrominance (colour) information, the method differs in the PAL and SECAM systems. The third main colour-encoding system NISC, is not used in Europe but is used in a number of countries having 525-line systems. In all these three colour-encoding systems a subcarrier is used to carry the chroma information. For 625-line PAL the colour subcarrier is at the precise frequency 4·4336MHz.

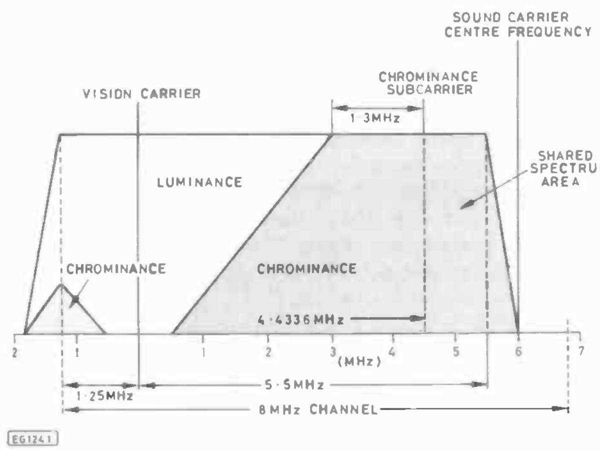


Fig. 3. The frequency bands occupied by the colour picture components and sound signals from an ideal transmitter

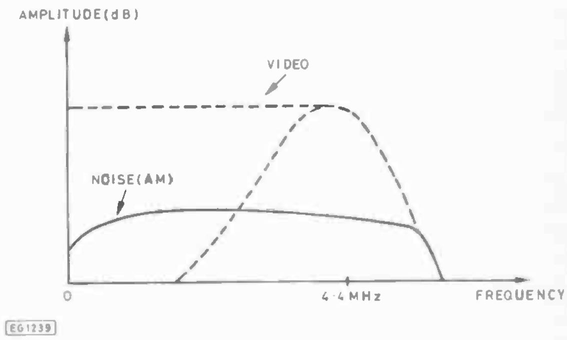


Fig. 4a. The noise spectra associated with AM signals

The use of a colour subcarrier means that the chroma information is converted upwards in frequency, in other words chroma is transmitted between roughly 3 to 5·7MHz—frequencies shared with luminance information of fine detail patterns. The result of this sharing can clearly be seen on domestic receivers in the form of cross-colour effects, the spurious colours seen on striped clothing, patterned suits, shirts and ties, etc. This is because to the receiver the luminance "pattern" looks like chroma information and is amplified in the chroma circuits. Conversely problems can arise from chroma information being mistaken for luminance. This problem is inherent in all conventional colour-encoding systems although it tended often to pass unnoticed in the first decade of colour when the sensitivity and resolution of studio cameras etc tended to be insufficient to exploit the full potential of the system.

TRIANGULAR NOISE SPECTRUM

However when a subcarrier colour-encoding system is used with a frequency-modulated vision signal there is a further problem that does not arise with *amplitude*-modulation. This is the so-called triangular noise spectrum. With an FM signal the noise rises with frequency, there is thus a higher noise content with chroma information transmitted at around 4·4MHz than when it is transmitted at its "baseband" frequency. For this reason a 625-line PAL picture transmitted over satellite circuits tends to suffer noise or "graininess" noticeable in the more highly saturated large colour areas shown in Figs. 4a and 4b.

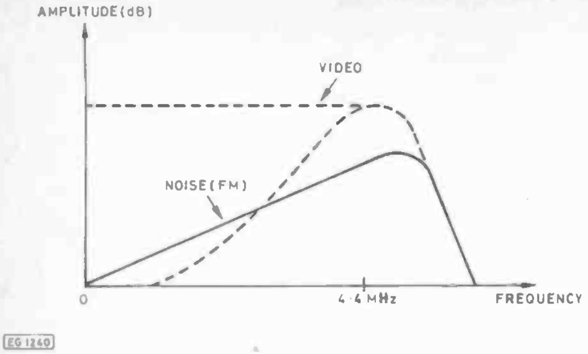


Fig. 4b. The noise spectra associated with FM signals

MULTIPLE SOUND CHANNELS

There is a further important difference envisaged between conventional terrestrial TV transmissions and DBS—the carrying of multiple sound channels. In the first place there is the wish to transmit high-quality stereo with sufficiently low cross-talk to permit these channels to be used for such purposes as simultaneous multilingual broadcasts or the carrying of totally independent "radio" programmes and also, if required, data transmissions such as an extended-capacity Teletext service, optional subtitling for the hard-of-hearing etc. With modern technology it is logical to use a digital system capable of extremely high quality. In terrestrial networks a problem with digital transmission is vulnerability to multipath "echoes" but digital, via satellite appears to be virtually free of such problems. For the first time broadcast audio can be planned to standards significantly better than existing VHF/FM stereo.

The UK, acting on the recommendations of the Advisory Panel on Technical Transmission Standards for Direct Broadcasting by Satellite (chaired by Sir Antony Part), has adopted a transmission system that takes into account not only the technical factors outlined above but also the advantages to industry and to viewers in making extensive use of LSI technology. The system C-MAC was developed and proposed by the IBA but is now the official UK standard, to be used for example on the first BBC channels on UNISAT. C-MAC has also been proposed as a European standard for DBS. 625-line PAL with VSB vision transmission will, of course, continue to be used over the terrestrial networks.

CHANNEL NO.	ASSIGNED FREQUENCY (MHz)	CHANNEL NO.	ASSIGNED FREQUENCY (MHz)
1	11727·48	21	12111·08
2	11746·66	22	12130·26
3	11765·84	23	12149·44
4	11785·02	24	12168·62
5	11804·20	25	12187·80
6	11823·38	26	12206·98
7	11842·56	27	12226·16
8	11861·74	28	12245·34
9	11880·92	29	12264·52
10	11900·10	30	12283·70
11	11919·28	31	12302·88
12	11938·46	32	12322·06
13	11957·64	33	12341·24
14	11976·82	34	12360·42
15	11996·00	35	12379·60
16	12015·18	36	12398·78
17	12034·36	37	12417·96
18	12053·54	38	12437·14
19	12072·72	39	12456·32
20	12091·90	40	12475·50

Table 1. Assigned frequencies for the 12GHz Satellite broadcasting band (Europe). Note: UK channels are 4, 8, 12, 16 and 20. Orbit position—31°W. Polarisation—right-hand circular in now current convention viewed with signals approaching receiving aerial

TIME-COMPRESSION MULTIPLEXING

The C-MAC system is based on a single FM transmission channel with no sound carriers, colour carriers or subcarriers. It is designed to meet the European satellite transmission parameters which specify the use of 27MHz wide channels with the carriers only 19MHz apart but with adjacent channel interference limited to agreed figures; 40 channels have been assigned, the frequencies of which are listed in Table 1. The basic parameters of C-MAC are listed in Table 2.

Satellite channel bandwidth: 27MHz. Triangular energy dispersal waveform added to video signal.

Luminance (Y):	Uncompressed, up to 5·6MHz Compression ratio 3:2 Compressed, up to 8·4MHz
Chrominance (U, V):	Uncompressed, up to 1·6MHz Compression ratio 3:1 Compressed, up to 4·8MHz Each chroma signal, U or V, is transmitted on alternate lines.
Sound/data:	Digital synchronization: 8-bit burst at start of each line period Digital rate: 20·25Mbit/s Basic audio sampling frequency 32kHz, 14-bit words (linear), 10-bit words (companded) During normal picture transmission 186 bits per line, representing TV frame capacity of 2906·25kbit/s. In each 8 millisec period (125 TV lines) exactly 256 samples of each sound channel are transmitted. Data frames similarly based on 8 millisecond periods.

Line period (64μs): Each line is made up of: sync burst and digital sound (194 bits); then transition to main clamp (zero level) 15 samples; chrominance (U or V), 335 samples; grey-to-black transition and black-level clamp (14 samples); luminance, 710 samples; transition into data (4 samples). Sampling clock frequency 20·25MHz.

Line frequency $\frac{2}{3} \times \frac{1}{864} \times 20250$kHz.

Table 2. C-MAC basic parameters, 625-line, 50Hz interlaced

Instead of frequency-interleaving the system uses time-multiplexing to permit the luminance and chrominance information to be transmitted sequentially rather than simultaneously. To enable this to be done within the framework of a standard 625-line format, both luminance and chroma signals are time-compressed on transmission and subsequently time-stretched at the receiver. Time-compression and time-expansion of signals is the fundamental principle of digital standards converters, digital time-base correctors and some other applications of digital technology in television. Basically one can clock a signal into an electronic memory at one rate and take it out again at a different rate. Since in a MAC system this is done within each 64μs line period the amount of electronic memory required is relatively small (Fig. 5).

Decoders can use a charge coupled device (c.c.d.) which is a memory device capable of storing a signal in analogue form, or alternatively the process can be carried out, as in a modern standards converter, in digital form using conventional digital memory devices. In the early development of the MAC system it

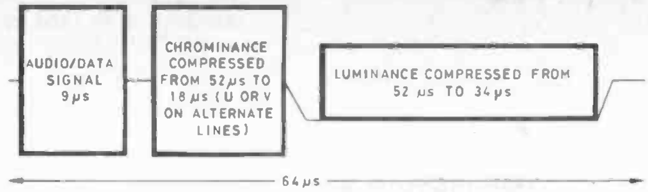


Fig. 5. Basic C-MAC Signal line format

was usually suggested that a c.c.d. analogue memory system should be used; however it has become evident that at least in the initial stages, the alternative and equally satisfactory digital system, using conventional digital memory, will prove the more economical process despite the requirement for simple A to D and D to A converters.

In practice, for mass production, the basic MAC video decoder is likely to take the form of two special-purpose large-scale-integrated (l.s.i.) devices, less than will be required for decoding the multiplexed digital audio channels; this factor is why it can be fairly claimed that C-MAC indoor units can be produced at virtually the same cost as a PAL plus multiplexed sound unit. Multiplexed sound of course does add fairly significantly to the cost of indoor units compared with the conventional single mono-channel sound system used for terrestrial television broadcasting. In practice the digital sound decoder needs roughly the same order of complexity as a Teletext decoder.

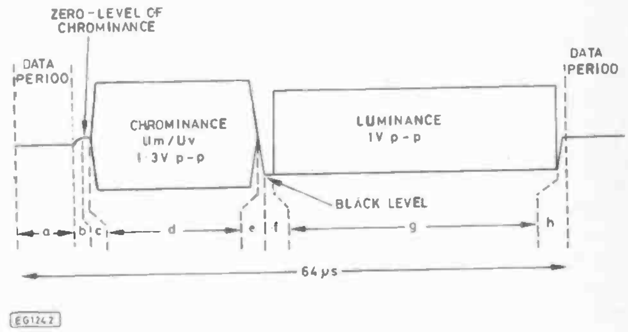
To sum up the MAC video system: The colour and luminance signals remain separate throughout the transmission system and are sent sequentially as Component signals by means of time compression in a time-Multiplexed form, with the FM transmission conveying the signals in Analogue form. Hence the name Multiplexed Analogue Component (MAC). In the decoder the time-stretching can be done using either analogue or digital techniques, with the digital approach being favoured currently on economic grounds.

IBA's mobile experimental satellite up-link terminal, first demonstrated at Wembley in 1978 and since used on a North Sea oil rig and in Austria, the Azores and Spain. This unit provided a vital test-rig for MAC sending up signals to the OTS satellite

AUDIO TRANSMISSION

The audio signals are transmitted in digital form, as bursts of data at 20·25Mbit/s in the line-blanking interval at the start of each line-period. The C in C-MAC refers to the general form of the multiplexed sound system. It stems from the investigation by members of the European Broadcasting Union of a number of possible ways of transmitting digital sound with or without sub-carriers etc, designated as A, B or C-type sound. There are also further variations within these categories. The C system proposed and accepted by the UK is a complex but flexible system in which the multiplexing is defined by a regularly transmitted "structure map". This permits the exact mix of sound/data channels to be changed at will. Further when no video signal is present (for example outside TV broadcasting hours) the 20·25Mbit/s data signal can be run continuously, providing either a large number of very high quality sound-only services or an enormous data capacity for Teletext.

The digital burst normally consists of a run-in, a sync word and 174 bits of data. It should be appreciated that the circuitry required to demultiplex this data stream is complex but fortunately can be largely implemented in integrated form. To explain the flexible data structure in detail however would require an article in itself.



a = 194 bits	— synchronization, sound/data
b = 4 samples	— transition from end of data; Includes leading edge of pedestal signal added to video to provide energy dispersal
c = 15 samples	— main clamp period
d = 355 samples	— chrominance (U or V)
e = 4 samples	— grey-to-black transition
f = 10 samples	— black-level clamp period
g = 710 samples	— luminance
h = 4 samples	— transition into data; includes trailing edge of pedestal signal added to video to provide energy dispersal

Fig. 6. Detailed C-MAC Video waveform (lines 23 to 310 and 335 to 622) for normal picture transmission (not to scale)

DATA STRUCTURE

Each TV line consists of a 9μs digital burst, then 17·5μs of colour information and finally 35μs of luminance information. A detailed illustration of the C-MAC video waveform is given in Fig. 6. Although the vision signal is analogue in form, it is convenient to think of it as being "sampled" at the same digital rate of 20·25MHz. This rate represents 1296 samples for each 64-microsecond line period of which 1114 sampling periods are used for the luminance and chrominance signals. The remaining 182 sampling periods correspond to the line blanking interval and represent the 182 bits of the 20·25Mbit/s digital signal (174 carrying the audio/data information). Both sound and video signals can be encrypted for subscription channels more readily than conventional composite-coded transmissions. It is easy to rearrange the luminance and chrominance information to "scramble" the pictures, and the digital sound can readily be made unintelligible to a standard decoder.

It should be appreciated that time-compression or "shrinking" of a signal represents an overall increase in video bandwidth since each video component is actually transmitted in less time at a higher frequency. However the additional bandwidth remains within that available in a satellite channel, and the slight degradation in signal/noise ratio in no way compares with the additional chroma noise that would result from the use of a 4·43MHz subcarrier on an FM transmission. Because MAC reduces significantly the problem of noise in the highly coloured areas the overall effect is to provide the user with a picture that remains acceptable at lower signal inputs to the 12GHz front-end. This means in effect that the viewer can use a smaller dish aerial, or alternatively has more in hand to counter gradual deterioration of the dish reflector or aerial pointing errors. Since a smaller dish is less directional as well as offering less wind resistance, the installation of a DBS aerial for MAC is usefully less critical than for conventional colour-encoded signals.

DIGITAL FILTERING

While C-MAC remains a 625-line system, the separation of colour and brightness information greatly facilitates the addition of digital signal-processing within the receiver. For this reason techniques that would provide additional luminance information within a MAC transmission by means of what is called "three-dimensional" digital filtering have been investigated by the IBA. This processing takes advantage of the series of gaps in the spectrum which carry only high-frequency diagonal information. If these HF diagonals are excluded the gaps become available to carry additional information. This extended-definition option would be useful for providing high-fidelity pictures, with a subjective resolution of roughly 1000 lines they would be suitable for use with future large-screen, high-resolution picture-display systems. Such a system requires several fields of digital memory within the receiver and is not at present economic for domestic sets. This can usefully be combined with the prospect of the flicker-free pictures that can be provided by displaying 625-line 50Hz pictures at 100Hz and sequentially, rather than in interlaced form.

Digital processing in receivers has already been demonstrated by receiver manufacturers but a major advantage with the MAC system is that the requirement for motion-detection in order to suppress digital processing in areas of fast motion are greatly eased by component (YUV) rather than composite signals.

VIDEO INTERFACE

To obtain the full advantages of MAC the interface between the "indoor unit" and the television receiver proper needs to be at video frequency, i.e. YUV signals (Fig. 7). The fitting of a

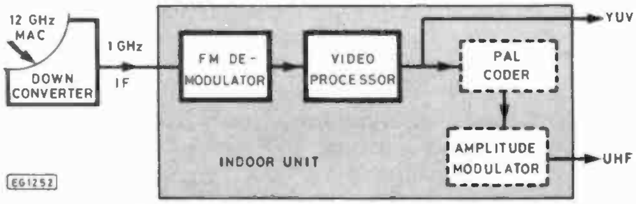


Fig. 7. Basic MAC satellite converter

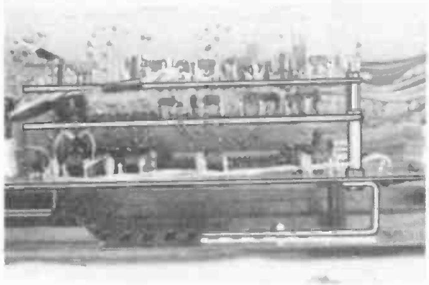
suitable socket to receivers also offers very significant advantages—indeed such sockets have been mandatory in France since 1980. With a video socket, the need for the UHF modulators currently used in VCR machines, video games, Teletext adaptors, home computer etc. is eliminated, resulting in greatly improved displays when these units are in operation. The trend towards YUV interfacing can also be seen in the growth of "unit video". This does not mean that the current sets cannot be used with MAC but it does mean that the signal fed to an aerial socket has to be in composite-coded form and this reintroduces the problems of cross effects that MAC can eliminate. ★

LOGIC ANALYSER

Part Two

D. MANDELZWEIG

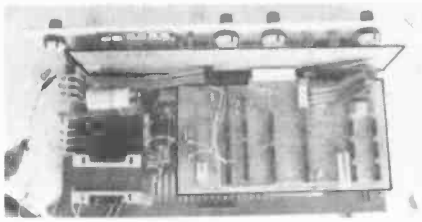
LAST month, the operation of the basic analyser was described in detail. This month we will describe the construction of the basic unit, and some initial tests that can be done. Interwiring has been kept to a minimum (in fact, besides the power supply, there is no interwiring for the basic unit) by the use of the front panel p.c.b., but due to the complexity of the project, it is suggested that only reasonably experienced constructors attempt to build the unit. It is also strongly recommended that the construction method described is followed closely. Failure to do so could result in an analyser that is difficult to complete!



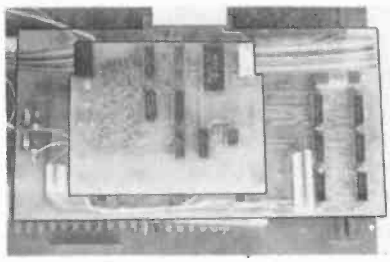
Sandwich construction of the Analyser

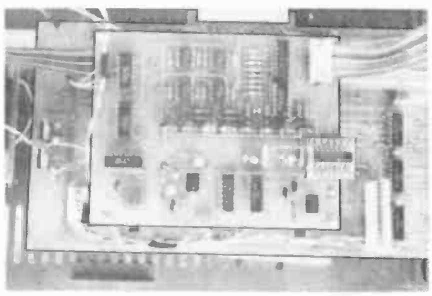
MAIN PCB

Refer to Fig. 2.3: Start construction of this p.c.b. with the soldercon i.c. socket strips (or wire-wrap sockets, although the former method is preferred). Cut the strips into 7, 8, 10 or 12 pin lengths as necessary. Place a strip at a time in the board, starting from the middle of the board (IC27 for example) working outwards. Solder, on the front side, only those pins of a strip which have a track coming to its pad on the front side of the board. When soldering the pin, be very careful that no solder flows between the contacts. If this should happen, the single pin can be replaced at a later stage, once the rest of the strip has been soldered under the board. (The top of the pins can be broken off and the soldered pin removed and replaced.) Before soldering in the pins for IC19 and IC18, solder in SK6. SK6 is cut to length from a piece of double-sided, wire-wrap, p.c.b. edge connector. Allow the connector to stand proud of the p.c.b. and solder the pins to the pads on the top of the board. As no tracks to SK4 and SK5 are on the front side of the p.c.b., proper 16-pin i.c. sockets can be used for these sockets. Once all the strips are in place, turn the board over and solder *all* the pins on the back of the board. *Do not* break off the tops of the pins until later, when the i.c.'s are to be inserted, to avoid the pins becoming misaligned.



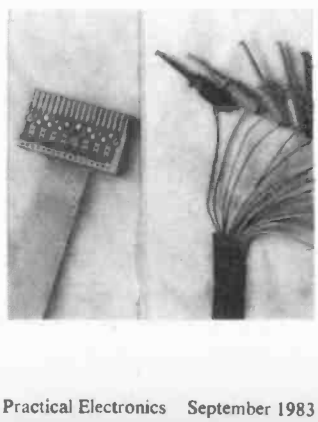
Plan view, showing PSU location





Next solder in SK8 in a similar fashion to SK6, followed by the resistors and then the capacitors. Be sure to get the polarity of the capacitors correct. Solder in Vero pins for the screened wire that will go to SK7, as well as for the wire that will go to S20 wiper. Put in the links A, B, C and $\pm$12V using thin insulated wire. IC40 and IC41 can be soldered in. Now, lying the board on a flat surface, component side up, use the discarded leads of the resistors and capacitors cut in half, to fill the remaining holes in the p.c.b.

Solder the leads on the top side, turn the board over and solder the leads on the underside. Finally, trim the leads on the front side, leaving neat through-hole connections. Solder lengths of hook-up wire to the p.c.b. for later connection to the PSU +5V, 0V, +15V and −15V. Now very carefully check that all socket pins, component leads, Vero pins, through-hole connections and wires have been soldered on the front side of the p.c.b. where necessary—i.e. where tracks lead to pads on the front side. Carefully break off the tops of the socket strips, and using an ohmmeter, check that



Coloured "Easy-Hooks" are used for the data probes

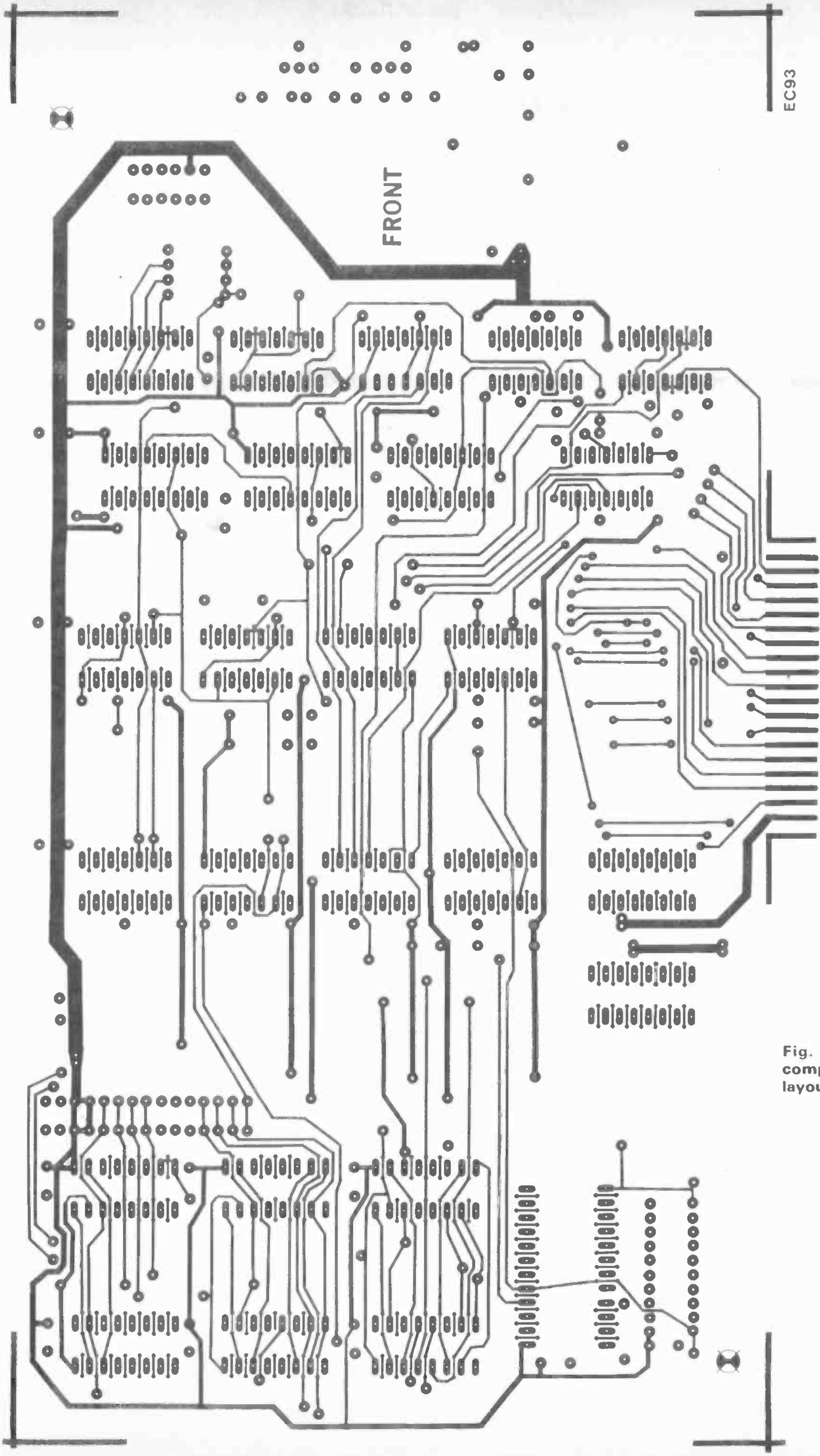


Fig. 2.1. Main p.c.b. component-side track layout (actual size)

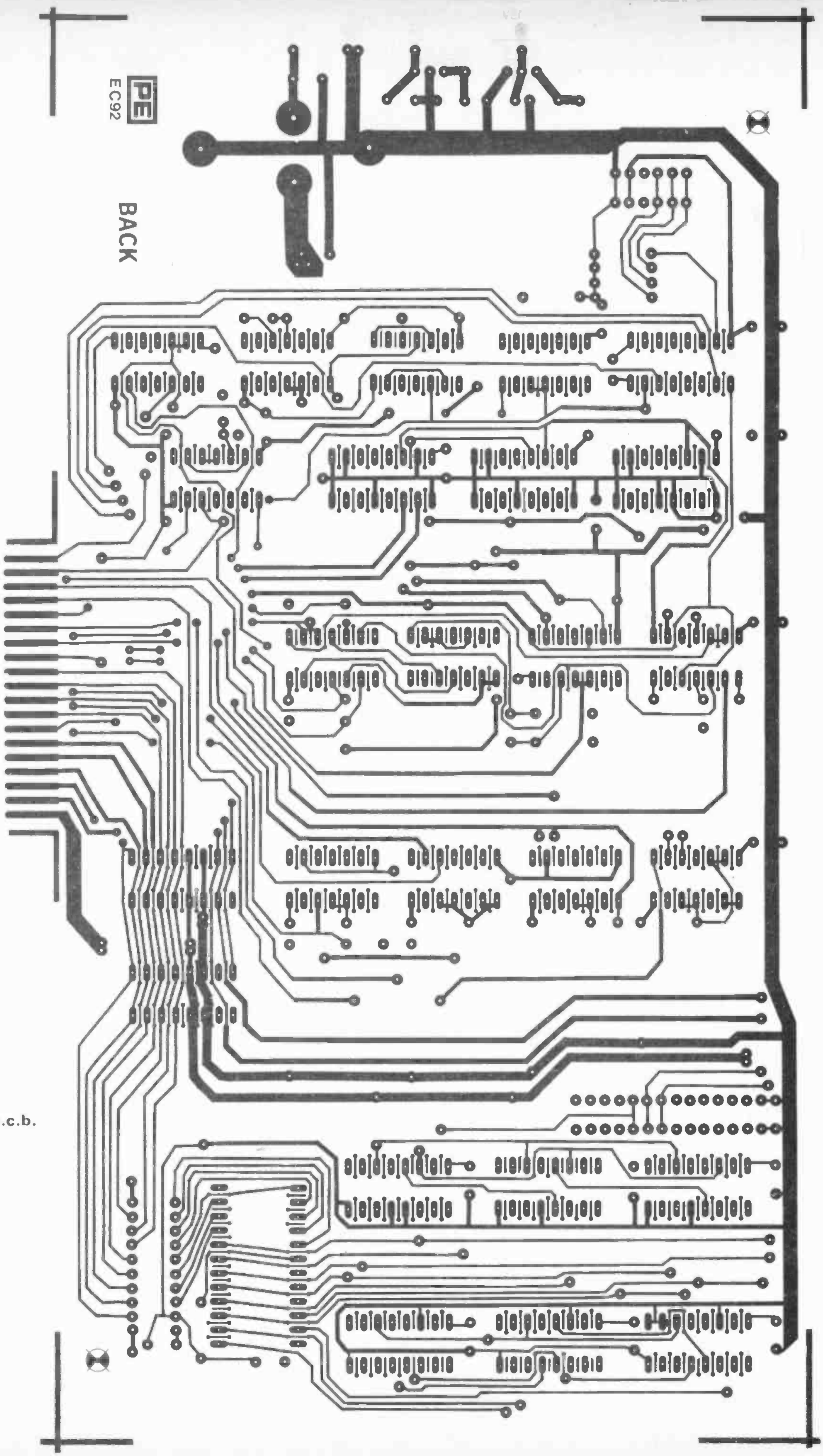


Fig. 2.2. Main p.c.b. track layout

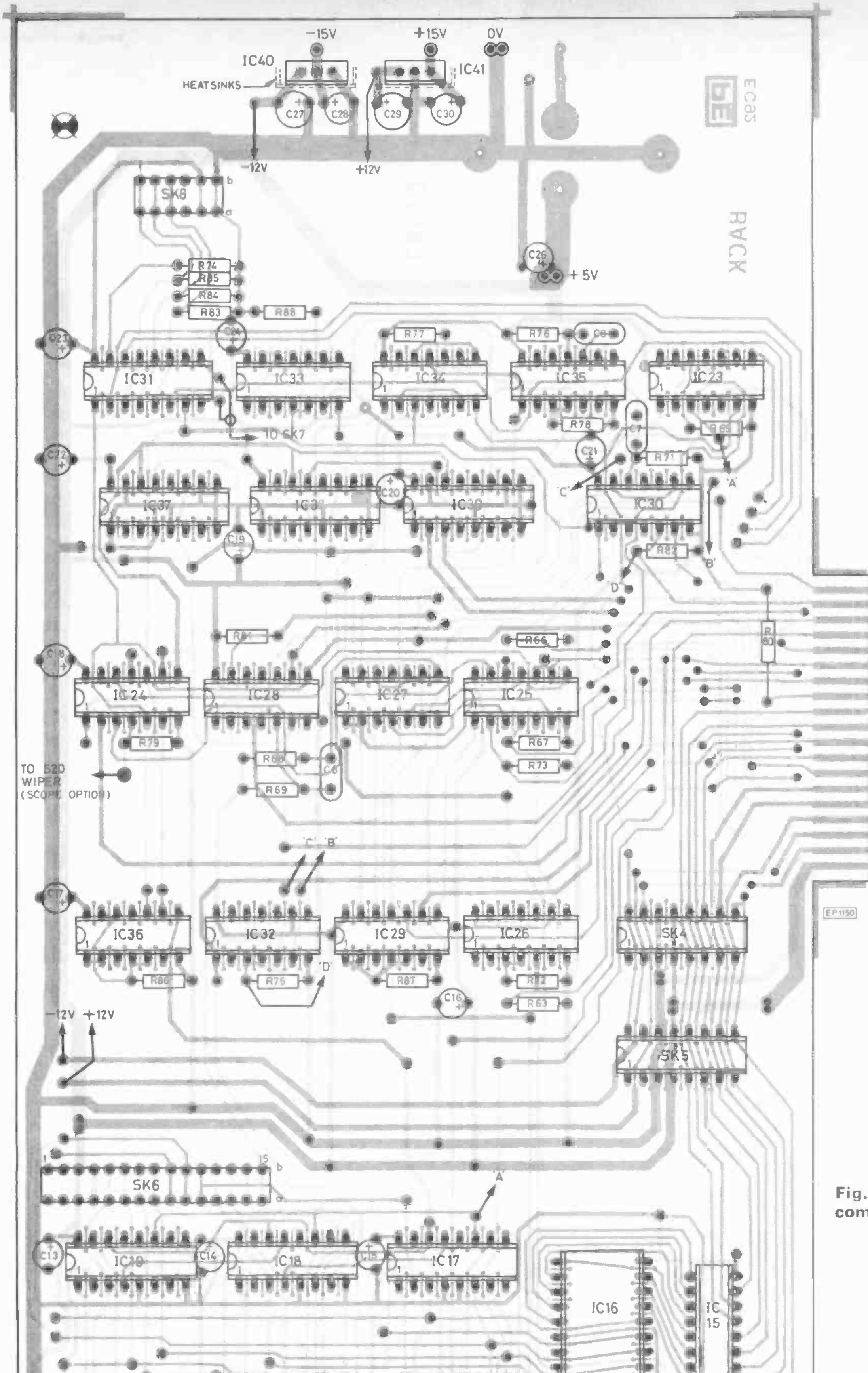


Fig. 2.3. Main p.c.b. component layout

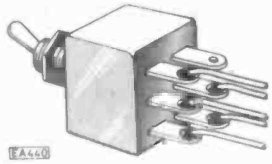
there is no short across the +5V and 0V leads. Do a final inspection of both sides of the p.c.b., looking for track shorts and solder splashes. When satisfied, plug in all the i.c.'s, ensuring that the pins make positive connections with the sockets. Plug in the RAM (IC16) last of all. Finally screw a small heatsink to IC40 and IC41. If a single heatsink is used, IC40 must be insulated from the heatsink.

FRONT PANEL PCB

This is the most difficult of the p.c.b.'s to construct, but if the following steps are followed carefully, there should be no trouble. First, drill the front panel to the dimensions given in Fig. 2.4, and fit the red perspex display filter. Do not letter the panel yet. Now cut 25mm lengths of stiff bare copper wire and solder the pieces to each contact of the switches which have a pad on the p.c.b. See Fig. 2.5 for an example of S4. When this has been completed, put all the switches in their positions (see Fig. 2.11) on the p.c.b., but do not solder the wires—just bend them slightly at the back of the p.c.b., so that they cannot fall out. Plug X 1 and X 6 into a wire-wrap socket each and position them on the p.c.b., also without soldering. Now align the loose switches with the holes in the front panel, fit the panel, and then tighten the switches in position, making sure they are straight and all fixed to the same depth. Gently ease the p.c.b. as close as possible to the switches—on the prototype, this was virtually as far as the original solder tags of S5, S14 and S19. Make sure the p.c.b. is parallel (in both directions) to the panel, and then solder all the switch leads on the rear of the p.c.b. Adjust displays X1 and X6 so that they lie flush with the perspex filter and solder the sockets on the rear of the p.c.b. Loosen the switches and remove the front panel. Solder the switch leads to the front of the p.c.b. where necessary. Fit the soldercon strips and, as with the main p.c.b., solder those pins where necessary on the front side of the p.c.b., one strip at a time. When finished solder the pins on the rear of the p.c.b. and fit and solder the resistors and capacitors. The other display sockets can be soldered to the board, ensuring that they are level with the two previously soldered in place. SK3 can be a proper 14 pin i.c. socket, as no tracks have to be soldered on the front of the p.c.b. to this socket.

Fit and solder TR1 and then in the same manner as for the main p.c.b., make the through-hole connections, leaving the holes for D1–3 and SK1 and SK2 open. Cut a length of p.c.b. edge connector, 2 slots bigger than required, for SK2. Remove the two extra contacts from one side of the connector. Solder the connector to the *rear* side of the p.c.b., with the open slots on the right of the p.c.b., looking from the rear. Fill the second slot from the end with some stiff plastic to act as a key for the main p.c.b.

Fig. 2.5. Example of wiring to switch S4

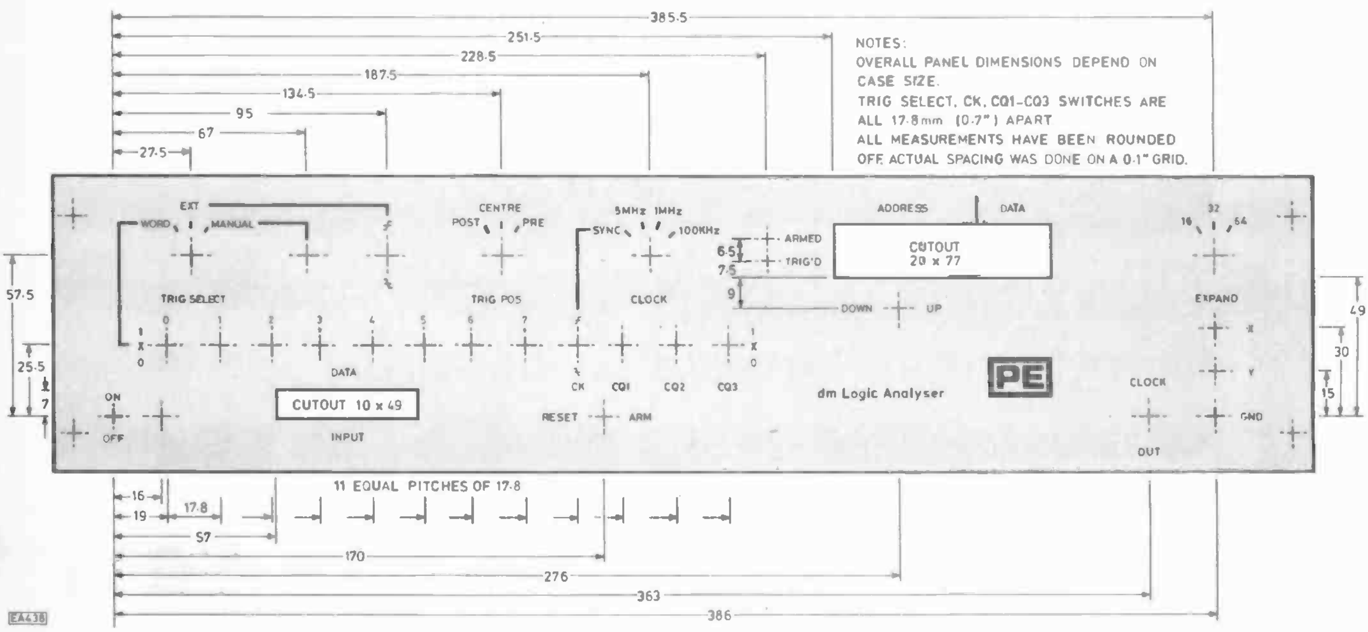


In the prototype, SK1 was not mounted on the p.c.b. For this socket, a piece of single-sided edge connector (18 fingers long) was used, and was wired using 25mm lengths of wire-wrap wire to the p.c.b. Note that only 17 fingers are actually used. The connector was mounted using mounting ears bought with the connector and stand-off pillars, as shown in Fig. 2.6. At this stage however, only wire the connector to the p.c.b.—the connector need only be screwed to the front panel when finally completing the unit. Mount D1–3 on the panel and refit the p.c.b. It need only be held by two or three switch nuts. The l.e.d. leads will most likely be too short, so push some discarded resistor leads through the p.c.b., solder them to the l.e.d. leads (this can be done with the p.c.b. mounted behind the panel) and then solder the extended leads to the p.c.b. This completes the front panel p.c.b. Leave the assembly as is for the preliminary tests.

POWER SUPPLY

Cut the key hole in the main p.c.b. and mate the p.c.b. with the front panel p.c.b. Place the assembly in the case and mark holes for mounting the main p.c.b. on stand-off pillars. In the prototype, small pieces of aluminium were bent and used. However, final mounting is left to the constructor, as it will be largely dependent on the case used. This applies to the layout of the power supply as well. The

Fig. 2.4. Front panel drilling details



photos show clearly how the prototype was arranged. Two separate transformers were used and were screwed to the case. The heatsink for IC42 was mounted on one side to the transformer and on the other to a small aluminium bracket. The capacitor C33 is mounted to the case and C31 and C32 are soldered directly to the regulator. BR1 was mounted on the side of the transformer, as can be seen. BR2, C34 and C35 were soldered to a piece of Vero board and mounted with a bracket to T2's mounting pillar. For test purposes, connect the mains via FS1 on the rear panel, direct to the transformer(s). Connect the +15V, −15V and 0V leads from the main p.c.b. to the power supply (use long leads for the meantime to aid testing) but do not connect the +5V lead just yet.

PROBE

A photograph of the prototype probe shows the basic construction. A piece of Eurocard size Vero board with gold-plated edge connector fingers was cut to size. As no keying is used, cut the board slightly larger than the width of SK1's opening. Then file the board to just fit the socket. This will ensure repeatable alignment when inserting the probe. 14-way ribbon cable was soldered to the Vero board and on the other side, coloured Easy-hooks were used. The wiring for the probe is shown in Fig. 2.7.

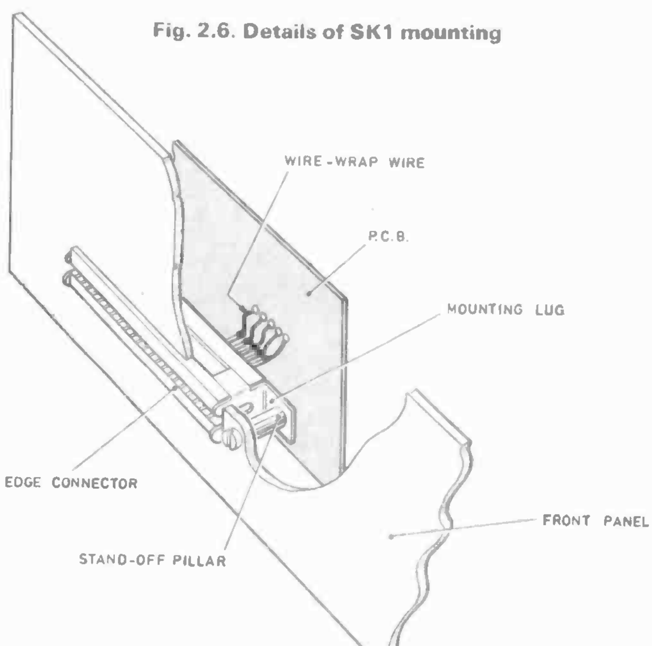
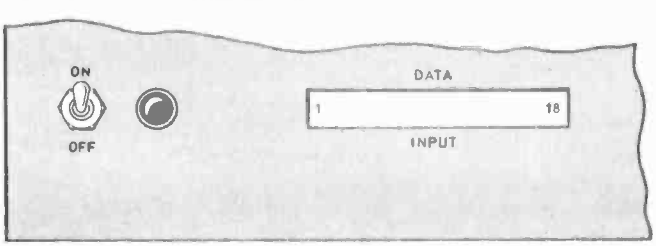


Fig. 2.6. Details of SK1 mounting

Fig. 2.7. Probe wiring details

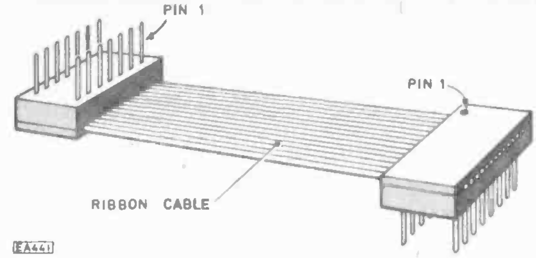


1	–	7	D5	13	CQ1
2	D0	8	D6	14	CQ2
3	D1	9	D7	15	CQ3
4	D2	10	0V	16	EXT TRIG
5	D3	11	+5V	17	+12V
6	D4	12	CLOCK	18	−12V

EA442

NOTE: +5V, +12V & −12V ARE NOT TAKEN TO THE PROBES

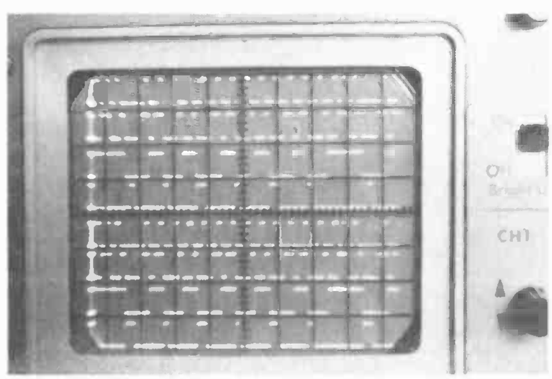
Fig. 2.8. Ribbon cable connections for options

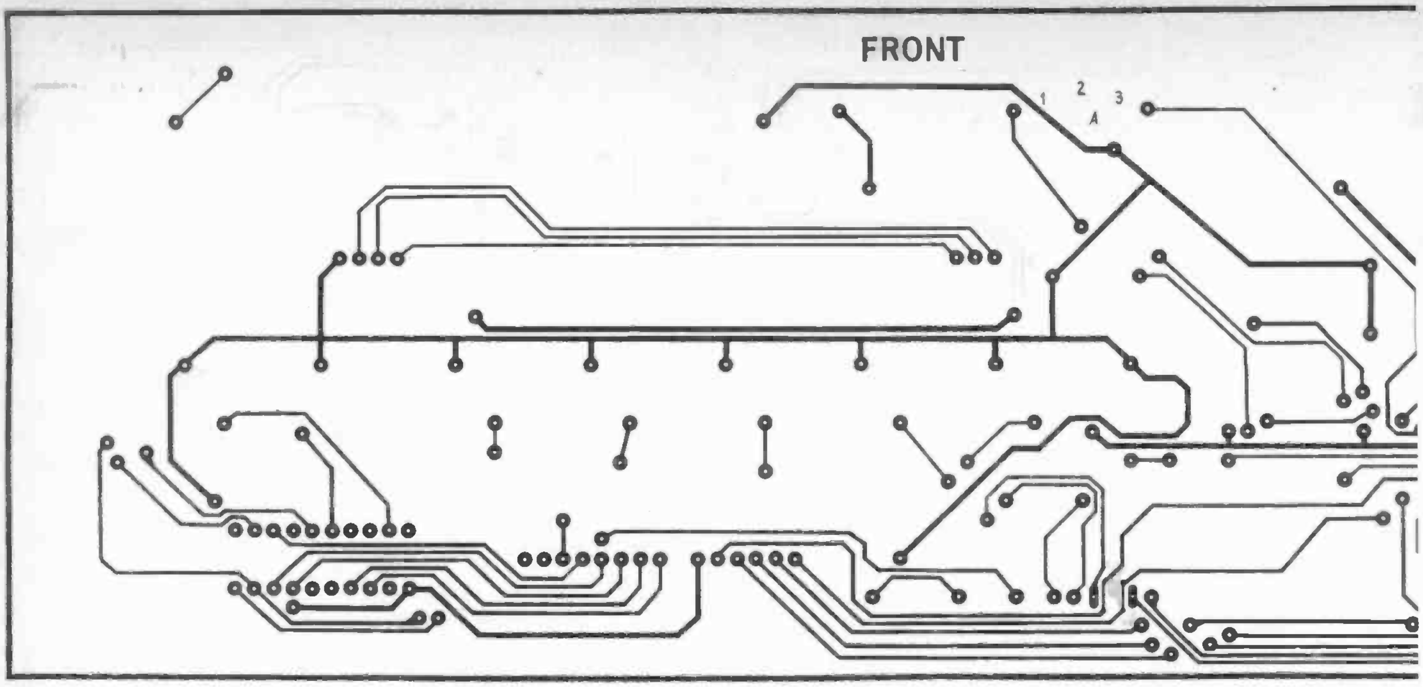


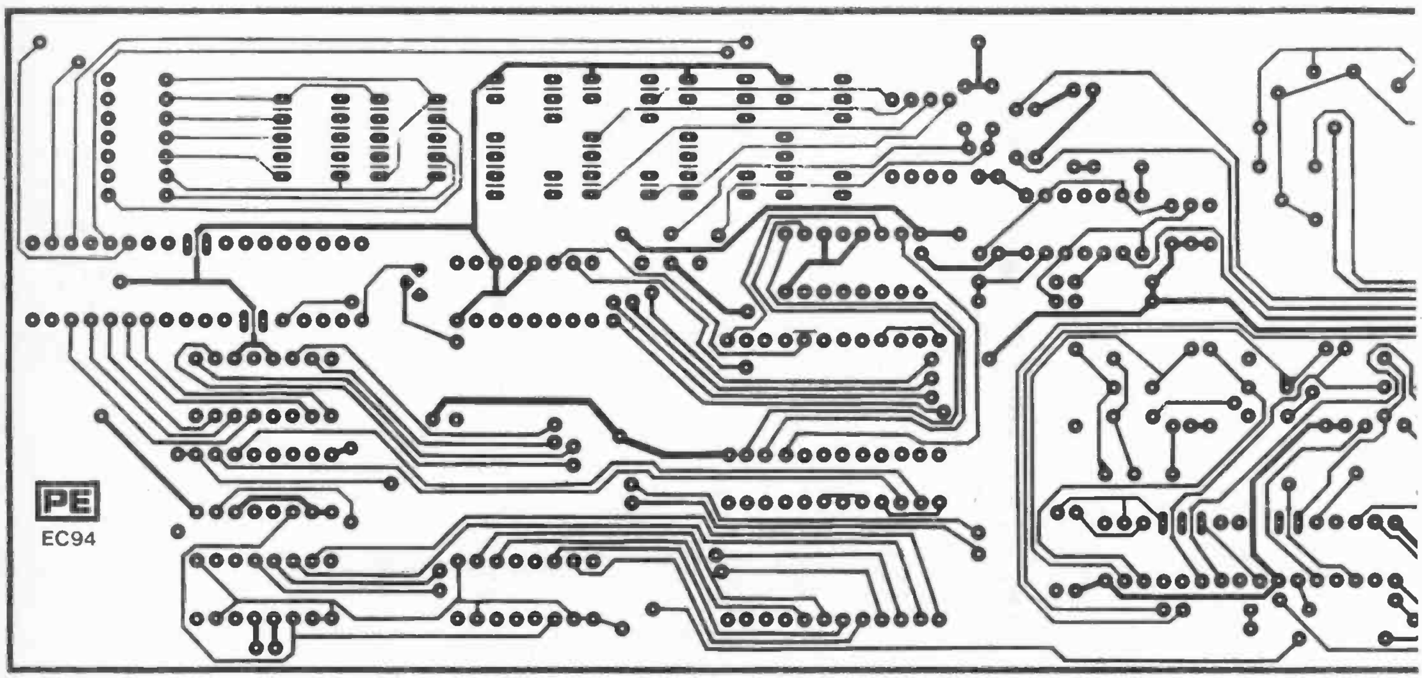
PRELIMINARY TESTS

Switch on the power supply and check that IC42 has +5V on its output and that the outputs of IC40 and IC41 are at −12V and +12V respectively. If an oscilloscope is available, check that there is no oscillation on any of the power rails. If all is correct, switch off the power supply and solder the +5V lead to IC42. Connect the main p.c.b. to the front panel assembly, plug in the probe and switch on. The Address displays should have a random number between 0 and 1023 displayed. If the ARM and/or the TRIG l.e.d. is on, use S16 to reset the unit. The l.e.d.s should extinguish. Using S17 it should be possible to get the Address to increment or decrement. The Data display will remain blank. Select MANUAL trigger on S19 and PRE trigger on S5. Using S16 ARM the analyser and the ARM l.e.d. should light. Now press S15, the Address should show 1023 and TRIG l.e.d. should light. Pressing RESET (S16) should cause the l.e.d.s to extinguish. Repeat the procedure with CENTRE and POST selected. For CENTRE, 511 should be displayed and for POST 0 will be displayed and in this case, the TRIG and ARM l.e.d.s should extinguish. Monitor pin 2 of IC15 with an oscilloscope, while scanning up and down the memory with S17. Random highs and lows should be seen. Now connect a t.t.l. compatible clock to the clock input. If possible use a frequency of 100Hz. Select SYNCH CLOCK, PRE trigger, WORD trigger, WORD select switch S6 (DØ) to '0' and the other data switches as well as the clock qualifier switches to "don't care". ARM the analyser, then switch DØ to "don't care". When this is done, the TRIG l.e.d. should light, the display should change to 1023 and then approximately 10 secs later (if a 100Hz clock has been used) the l.e.d.s should extinguish. If pin 2 of IC15 is now monitored, the output should always be high, regardless of the Address position. Repeat the above, but connect the DØ probe to 0V and start with the DØ switch switched to "1".

When the analyser has completed the store process, check pin 2 of IC15 once again and this time the output should be low for any Address position. If all has gone well, then it can be assumed that the basic unit is virtually operational. If not, use the circuit description to follow through the circuit, checking levels at each gate output in turn, until the fault is found.







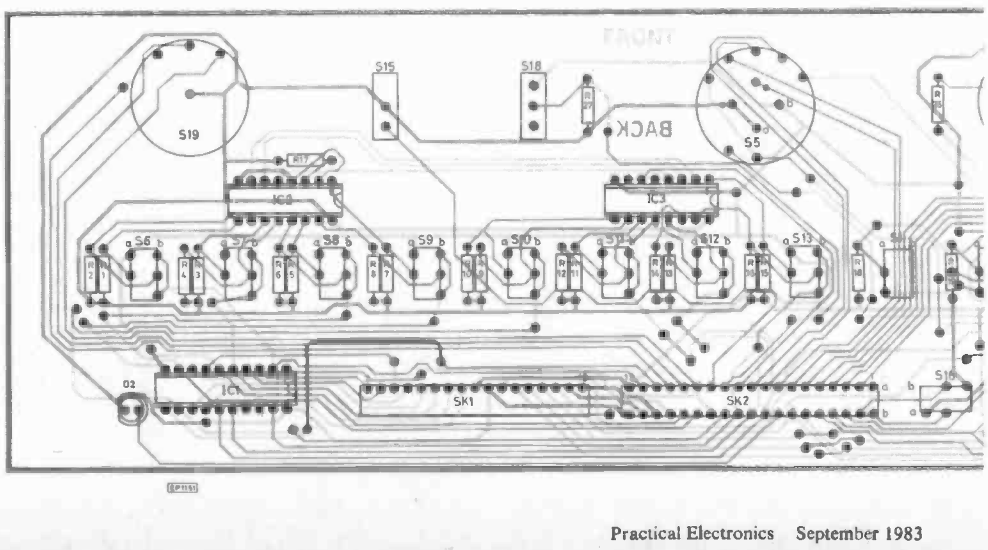
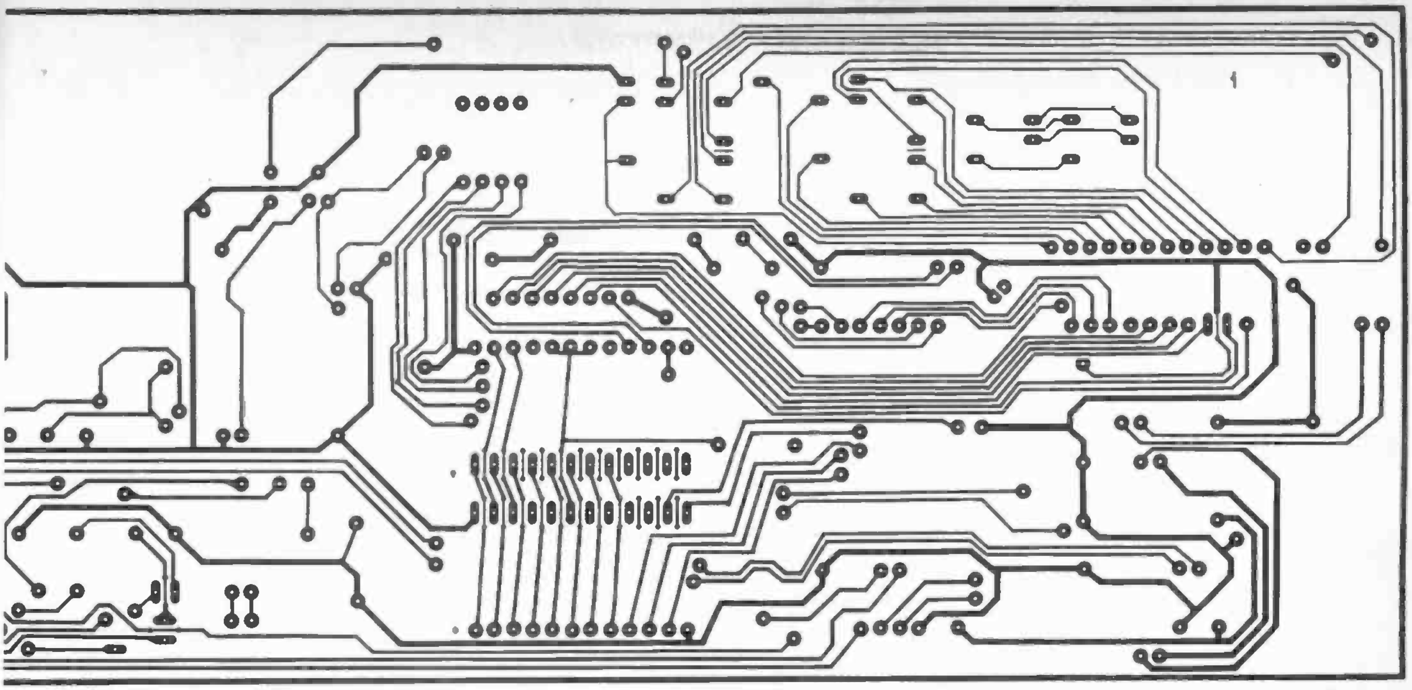
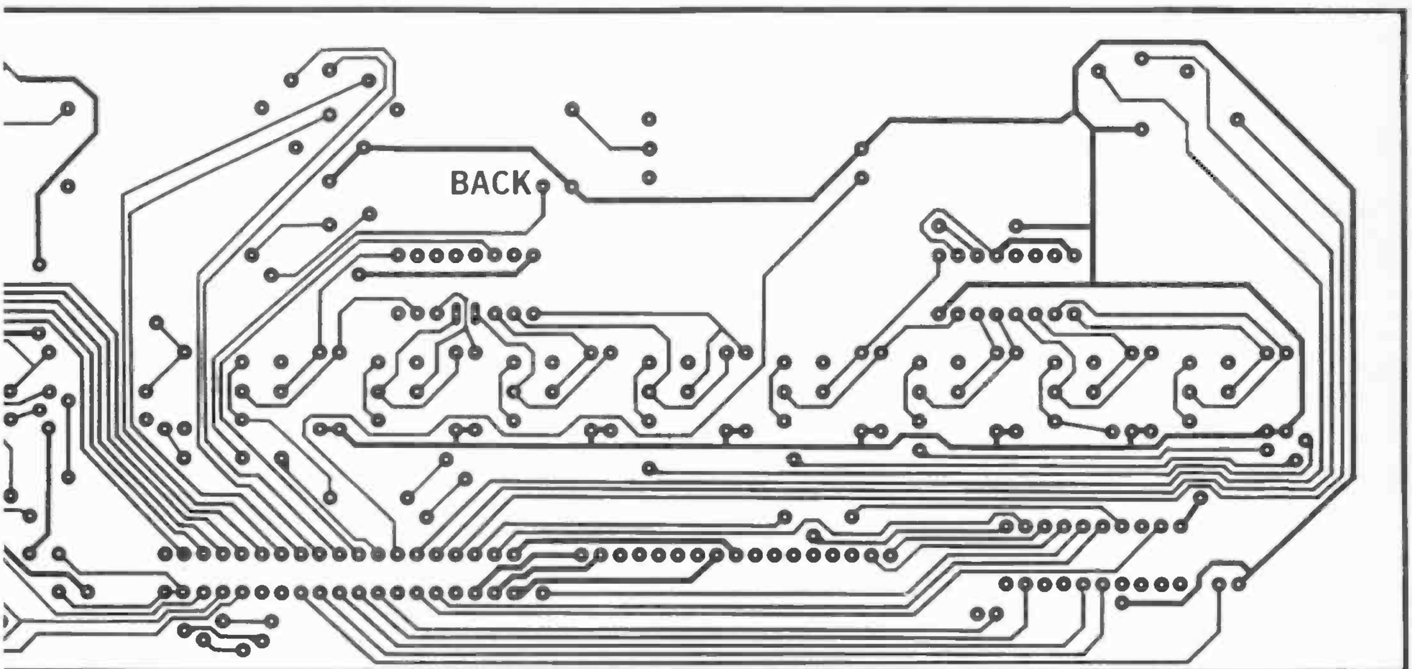


Fig. 2.9 (top). Front panel p.c.b. layout (component side, actual size)



EC95



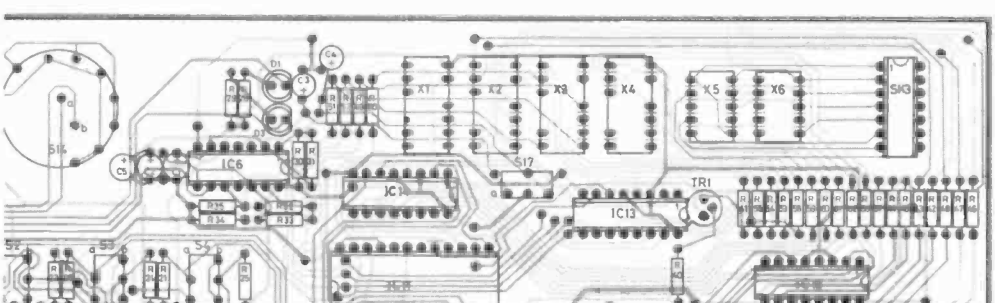


Fig. 2.10 (above). Front panel p.c.b. layout (track side, actual size)

Fig. 2.11. Front panel p.c.b. component layout

Initial calculations proved that a p.c.b. edge connector would conduct adequate current to supply the front panel p.c.b. However, the subsequent requirement of *two* 2716 EPROMS increased current consumption. To avoid a voltage drop due to track resistance a wire is connected between the +5V regulator and the front panel p.c.b. (close to the EPROMs). The 0V line could be similarly duplicated.

COMPLETING THE BASIC UNIT

If the basic unit works as described, one can confidently complete the construction. Should problems arise, it is a simple matter to disassemble the unit because of the modularity of the design. Construction is completed as follows:

Remove the main p.c.b. from the front panel p.c.b., then remove the p.c.b. from the panel. Mark the panel with Letraset, or if possible use the new photographic method using special sensitised sheets of aluminium. This method, although a little expensive, makes for a very neat finish. Mount the ON/OFF switch and S20 as well as SK101, SK102, SK103 and SK7. Refit the front panel p.c.b., using all the switch nuts. Fit the main p.c.b. to the case, as well as the front panel assembly. For the time being, leave the power supply leads longer than necessary and do not connect the ON/OFF switch up yet. Finally a 60mm length of ribbon cable can be prepared for one of the display options. Use 16-core ribbon cable and 16-pin headers. The headers should be fitted as shown in Fig. 2.8. (If both options are to be installed, make up two.)

NEXT MONTH: The Display Options.

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KORG MS10 Synthesiser as new, with guarantee £200, 16K ZX81 keyboard, I/O port, inverse video £100. J. Wilson, 36 Sunningdale Avenue, Lowestoft, Suffolk, Tel: (0502) 64729.

WANTED any polyphonic synthesiser, 3–6 octaves. Any offers? Mr. A. Goffart, Spindles, Lewannick, Launceston, Cornwall PL15 7QD. Tel: Coads Green 317.

TECHNICAL info. required for Olivetti TC800 floppy disk unit. Will pay for info. Mr. M. P. Morrow, 19 Rockhampton St., Gorton, Manchester 18. Tel: 061 231 3523.

CROMEMCO Bytesaver II S.100 board 8-Kbyte EPROM memory and programmer fully populated including 8 x 2708s £30. Tel: 0734 475180. Valentine Kassessinoff, 372 Peppard Road, Caversham, Reading, Berks RG4 8UZ.

EXIDY Sorcerer Computer. P.W.O. 56K, 2 x 315K disk drives, MX80ft printer, monitor, lots programs. £7750 new—sell £2500 o.n.o. Mr. Hausser, 27 Fore Street, Bugle, nr St. Austell, Cornwall PL26 8PA. Tel: 0726 850129.

VINTAGE Wireless sets and spares urgently wanted. Must be pre-war equipment. Mr. S. Busbridge, 29 Clarence Drive, East Preston, Littlehampton, Sussex. Tel: Rustington (090-62) 5615.

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BBC numeric keypad send s.a.e. for details. P.T. Squire, 16 Priory Park, Bradford on Avon, Wilts BA15 1QU.

ZX81 + 16K with sounder + ZONIX prog. Sound generator + manual/books/tapes all nearly new £89. Peter Cunningham, 11 Berwyn Ave, Penyffordd, nr Chester, Clwyd. Tel: Caergwrle 760172.

AVO valve (to collect) tester plus sundry electronic p.c.b.'s £10. P. Reynolds, 32 Common Approach, Benfleet, Essex SS7 3LA.

UK101 32 x 48 16K RAM 12K BASIC motherboard EPROMS + programmer, Sound 1/2MHz 3/600B + much software £170 o.n.o. N. Brooks, 103 Drake Rd., Harrow, Middx. HA2 9DZ. Tel: 01-868 9524.

PRINTER golfball type, 10 inch paper, serial I/O RS232 £75. Also PET interface to Centronic and disk. Both in good working order. R. Pearce, 8 Hollyoak Road, Coxford, Southampton. Tel: (0703) 788278.

ACORN Atom full RAM. 3 introduction tapes, leads p.s.u. manual and circuit Acorn built £120 o.n.o. J. Brooks, 26 Duncan Way, Loughborough, Leics. LE11 0QN.

SONY open-reel VTR—offers. Maplin 2800 Synth, incomplete £100. Transcendent 2000 with carrying case £200. N. Dodsworth, 7 Neville House, George St., Corby, Northants. Tel: 0536 200105.

WANTED for UK101, new BASIC ROMS 1, 3 & 4. Frost, 133 Dorset Ave, South Wigston, Leicester. Tel: 0533 782852.

PE Micro Controller + data £35 carriage paid. D. Slater, 25 New Market St., Colne, Lancashire BB8 9BU.

WANTED video/audio u.h.f. modulator. UM1286 any reasonable price paid. Send details to: Mr. P. Rattray, 2 Dupplin Terrace, Kinnoull, Perth PH2 7DG.

MICROTAN 65 + manual, factory built. Never used. £30 o.n.o. Write to: Mr. D. Pritchard, 17 Effingham Rd, Billesley, Birmingham B13 0BN.

NASCOM 1 32K RAM 4800 Baud Cassette, with case, sep. ICL power supply 7 amp, what offers? Mr. P. Norman, 1 Blacksmiths Cl, Abbotsley, Cambridgeshire. Tel: Gt Gransden 479.

OHIO superboard £50 (faulty), various S100 boards cheap, scrap record decks £2 (direct drive) wanted minifloppy. Hugh Bridge, 363 Kennington Lane, Vauxhall, London SE11 5QY.

RELAYS 6-pole changeover 12V. coil (R.S. Stock No. 349–153) 40 off for sale new unused £1.25 each. Mr. D. Harries, 17 Eccleshall Ave, Oxley, Wolverhampton, Staffs. Tel: 0902 780958.

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THANDAR PFM200 Freq. meter, as new £55, PDM35 Microamps defective £15. Charles Bowden, 7 Parc Eglos, Helston, Cornwall TR13 8UP.

WANTED 20W amp. 2, 20W speakers. Hasan Abdulla, 58 Donnington Gdns, Reading, Berks RG1 5LZ.

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PE BAZAAR SEPTEMBER '83

Space Watch...

THE SUN

It is rather difficult these days to select a theme for discussion from the multifarious new ideas around our own local star. At the present time there are arising a number of contradictory theories. To be fair, perhaps it might be kinder to say 'suggested ideas'. There is a point here about dispensing information. There abound suggestions of trouble internally, trouble externally and trouble at a distance.

A closer look at some of these is quite revealing. Over the last three or four years some doubts have arisen about current theories; some of these are the result of speculation. To bring the ideas together does present some difficulty but it is well worthwhile and an important consideration for the future of space activities. For obvious reasons in a review of this kind no persons are directly named or associated with any particular idea.

A steady watch has been kept on the rotation of the Sun for some time and these details are well documented. Conjectures as to whether it is a stable body, so far as position is concerned, are another matter. From Germany came information that the position of the centre of mass of the Sun undergoes continual change. It was shown that the centre of mass of the solar system changed its position relative to the Sun's centre for instance; observations made confirmed this shift.

The variations between 1945 and 1981 amounted to a spiral path which began half the Sun's diameter from outside the Sun to the centre of the Sun. This spiral continued until in 1982 it had passed still in spiral movement to a whole Sun's diameter outside the Sun. Extrapolation to 1990 shows it will again be at the centre of the Sun and thence—again on its way outside the Sun. Now the rate of this change is varying all the time, increasing as it moves nearer to the centre of the Sun and decreasing as it moves away from the centre. The speed is not constant but variable. This has been shown in some detail because it links with Sunspot cycles of various periods.

There is also current interest in matters dealing with unequal homogeneity of the Sun. This also adds to the confusion because here also there are different suggestions, such as sequential cycles of change of cyclic movements. Also there are doubts about some of the conclusions that have been drawn. Quite a measure of new thinking is coming together at present—perhaps this is a sign. Perhaps the days when the populace took for granted what 'great men' said are over. Age offers the benefit of experience but that which is new or innovative belongs to all ages.

SPACE FACTORIES

From the very beginning of the space era it has always been the plan to manufacture goods in space if possible. It has a simple answer to get away from Gravity. It is a little difficult to understand why it should be the cause of complaints. Now it is to be expected that better processes will be forthcoming from Earth based plants. It sounds very much like sour grapes on somebody's part. But then of course a band wagon is a band wagon. Perhaps it will be possible that people will get medication that is so badly needed. If the pilot attempts at electrophoresis were successful then the answer is 'go on'. If a better process is discovered let the people have the benefit.

PIONEER 10

As this issue of *Spacewatch* is being written there are still a few hours to the time when Pioneer 10 will be the first man-made object to pass out of the Solar System. The spacecraft has far exceeded its design parameters. NASA hope to go on with tracking procedures until the 1990s. It survived the Jupiter hazards with striking success and taught us much. It takes some 4·5 hours for signals from the spacecraft to reach the Earth and now difficulties are arising. Navigation is a problem that is being dealt with at the present time.

At the great distance that exists between the spacecraft and the Sun preparations are now being made for an alternative system. NASA has been instructing the vehicle to make certain Moon Maps for itself. The Sun would by now only be a pin point. This then is the nature of this distant piece of equipment of man's devising which can now be taught from afar how to care for itself and its mater. It is rather a slow process though, for it takes a working day of some 9 hours for each session.

A PIECE OF JUPITER

A small part of Oxfordshire has almost become a part of the planet Jupiter. At a cost of some £200,000 there will be an attempt to simulate the conditions that would be encountered by a visitor to that planet. This is the sample cell. It consists of a metal tube, double walled, some ten metres long. The imitation planet is like a gigantic thermos flask. It is expected to commence operations in October. At that time it will be fed with samples of gases to simulate atmospheric conditions virtually anywhere in the Solar System. When liquid nitrogen is passed through it, the double walled tube cools down the gases to as low as 170°C. The pressure in the tube can be varied between one millionth of an atmosphere to five times the Earth's atmospheric pressure at sea level. There is a spectrometer which records the spectral signatures of the gases within the tube.

A library of spectra would be available for researchers and they would save much time by simply comparing spectrometer readings from a spacecraft with known readings gained on Earth. This will enable the NASA team to ensure that they gain full benefit from the results of the Galileo probe due to be launched in 1988. The Rutherford and Appleton Research Establishment will once again make contributions to the space age.

UNREST ABOUT SATELLITE SPACE

Considerable concern is being expressed by many nations because of the amount of now useless hardware circulating in space. Complaints about this from those ready to take part in the Space Age have become very noticeable. A meeting is now being arranged for some thirty nations. The Third World is particularly annoyed with the present state of affairs. They are putting their case very strongly and saying that the developed countries already have more than their fair share.

Space above 30,000km contains the valuable geostationary orbits that are vital for communications such as television and telephone. Everybody naturally wants a part of it. The real trouble now is congestion—the frequency band allocated for this purpose is the 4GHz band; this means restraints. Not least of these is the fact that vast areas need to be covered in many cases and this would mean overlapping, and since some would call for areas as large as Western Europe the problem is very forbidding. It would mean that those countries wishing to cover large areas would dominate distribution.

Since this space has in many cases already been allocated the bands are full. The outcome is a very difficult problem under the circumstances since in the hands of some elements World chaos could be caused. Since the frequency bands allocated to television are in the 12·2–12·7GHz band and since also some 32 bands are allocated it means a separation of 20° for each band. The threat of 'overspill' is the real danger since each channel may need 200 watts. The Tower of Babel?

VENERA

The Soviet Space Agency has launched two Venera space-craft for the exploration of Venus and other tasks. Accurate information is a little confusing with regard to these missions. It is certain that they are much more limited than the projects by NASA. According to American sources these two spacecraft were launched on the 5th of June 1983 and the second on June 16th 1983. They are expected to begin their mission of imaging the surface of the planet or taking detailed radar altimeter data around October, probably in the early part of the month. The United States vehicle cannot be launched until 1986.

Frank W. Hyde

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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.

PROPORTIONAL A.C. CONTROL WITHOUT RFI

THE Versatile IC 555 timer is used here as a simple zero-crossing-detector of an a.c. mains supply, for proportional control of a.c. power. IC1 is connected as a monostable multivibrator as shown in Fig. 4, and is triggered at the crossing of every half cycle of the a.c. waveform. Two types of triggering control circuits are given in Figs. 1 & 2.

In Fig. 1, R1 and D1 form a potential divider across the a.c. mains supply and produce an approximate square wave output, which is in perfect phase relation with the input a.c. This is 180° phase shifted by the transistor stage TR1 and is added up by diodes D2 and D3 to generate negative pulses at each zero-crossing. This is fed to the trigger point IC1, pin 2 (Fig. 4). Alternatively the non-ideal square wave output from the potential divider itself can be used to trigger IC1, as shown in Fig. 2. This is possible because it is found that when the input at the trigger point (pin 2) either exceeds 1/3 Vcc or falls below −0·6V, the output at pin 3 goes high. Using this property IC1 is set and re-set every time these parameters occur and pulses are generated at the output pin 3, in proportion. However, the output pulses can be widened by properly choosing the monostable time period. In both cases, the monostable time period is set by R1 and C1 to about 1ms to ensure firing of the triac.

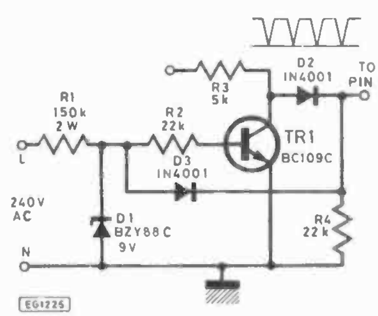


Fig. 1

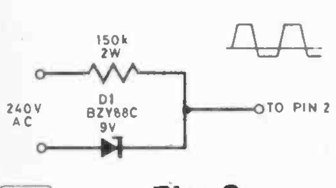


Fig. 2

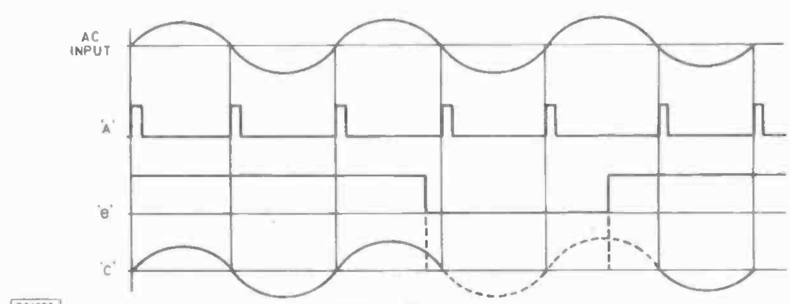


Fig. 3

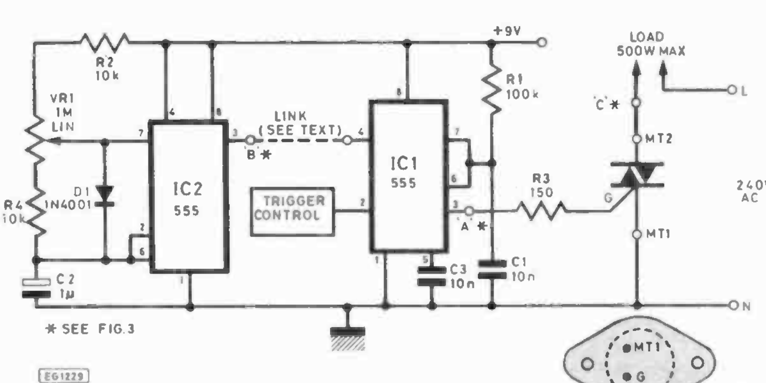


Fig. 4

Switching IC1, pin 4 (reset point) either to Vcc or ground, the triac makes simple On-Off control of power without RFI generation. For continuous control of power IC2, which is connected as a variable duty-ratio astable multivibrator, can drive pin 4 of IC1. The On-Off ratio is variable from about 1% to 99%. When the output of IC2 goes high, the triac is fired at every zero-crossing of a.c. supply as shown in Fig. 3. The output a.c. power is variable in discrete steps of half cycles, over the full range.

D. Venkatasubbiah,
New Delhi.

GENERAL PURPOSE TIMER

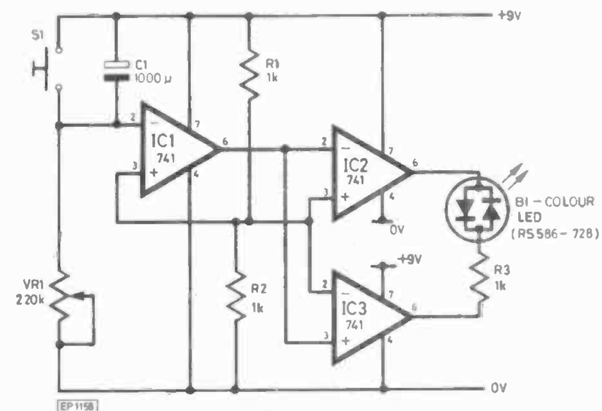


Fig. 1

THE circuit shown in Fig. 1 is a general purpose timer, which has a variety of uses. It is adjustable up to about three minutes and at the end of the timed sequence gives a visible output in the form of a colour change of the two-colour l.e.d.

The circuit operation is as follows:

When the push button is depressed C1 is momentarily short-circuited, which leaves IC1 (pin 2) at 9 volts. This voltage slowly reduces towards zero, as the capacitor is charged up. The charging rate is dependent upon the value set by the variable resistor (VR1). When the voltage is reduced to less than the voltage at IC1 (pin 3) (half supply voltage), the output of IC1 switches from zero to 9 volts, which in turn causes a change in the output states of IC2 and IC3. This reverses the direction of the current between these two outputs and so changes the colour displayed by the l.e.d.

This prototype was based on a 9 volt supply though the time constant should remain the same irrespective of the supply voltage.

A. Marshall,
Old Basford,
Nottingham.

OVER VOLTAGE PROTECTION

THE above circuit was developed for an existing variable 3-20V 0-20A stabilised power supply, based on a 741 design. It should work with any similar power supply with little or no modification.

Obviously with a power supply of such a large current rating, an over voltage circuit was considered essential.

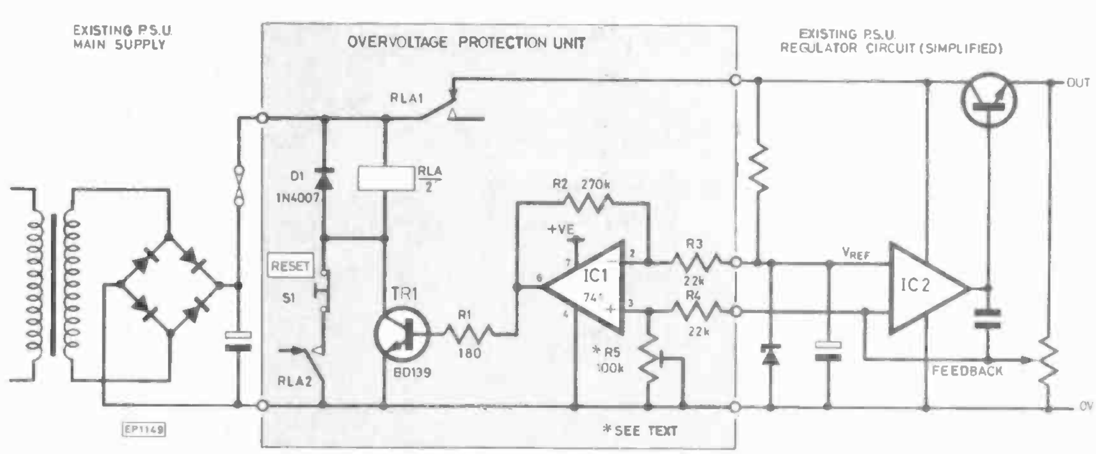
The protection circuit is designed to operate at about 1V above the output voltage of the p.s.u. i.e. if the p.s.u. was set to 10V then it would trip at about 11V and so on.

IC1 is used as a comparator and compares, via R3 and R4, the reference voltage for IC2 with its feedback voltage from the output. Normally, when the regulator stage is working correctly these two voltages are the same, regardless of what the p.s.u. is set at. If however a fault occurs causing the output to go above the set voltage, IC1 senses the change between the reference and feedback voltages and turns TR1 on. This energises the relay which self latches via the normally open contacts and disconnects the mains supply from the regulator circuit.

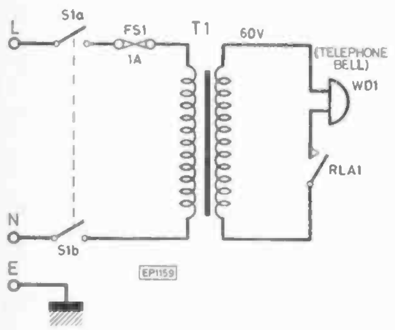
Preset R5 determines the point at which the circuit operates above the output voltage of the p.s.u., and should be adjusted to between $\frac{1}{2}$V and 1V across R4.

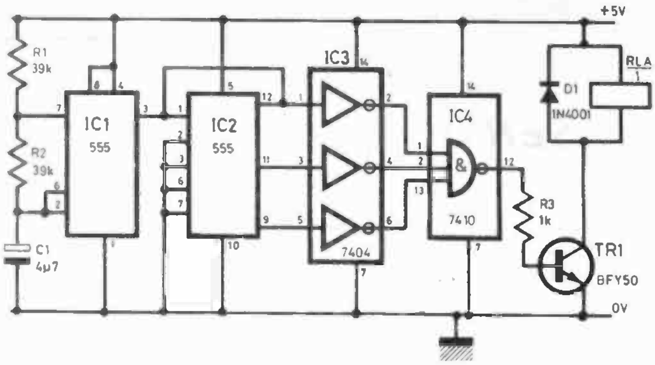
If the output voltage of the p.s.u. is turned down quickly with a fairly large capacitive load, the circuit will trip. This however can be reset by S1 'push to break' which unlatches the relay, the contacts of which must be capable of carrying 20A.

N. Wilson,
King's Lynn,
Norfolk.



PSEUDO TELEPHONE RINGER





THIS circuit was used in our school play in order to simulate a telephone ringing sound using a standard telephone (WD1).

IC1 provides a square wave with a frequency pulse of around 0·6 sec which is fed to the decade counter (IC2). Two pulses are selected by the gates of IC3, which through IC4 switch the relay and sound the bell.

J.K. Yeoman,
Haywards Heath.

AUTOMATIC NI-CAD CHARGER

THE circuit shown permits mass-plate ni-cad cells to be left unattended while charging at their maximum rate (one tenth capacity), automatically giving an indication and switching off the current when charging is complete, thus preventing damage to the cells. Battery voltages from 1·2V to 12V with charging rates of 6mA to 1A can be accommodated simply by selecting the appropriate component values.

The charging current is generated by IC2 which is a 5V regulator connected as a constant current source, the output of which is set by R8. IC1 is an 8211 voltage detector chip. At switch-on C2 holds pin 3 of IC1 low, producing a 0V condition on pin 4 which operates TR1 and hence D6 and RLA. RLA1 connects the constant current-output to the battery to be charged.

As the battery charges the voltage at 'A' increases until eventually pin 3 of IC1 reaches 1·15V, at this point pin 4 goes from 0V to open circuit, TR1 switches off and TR2 operates causing RLA to release, D6 to extinguish and D8 to light. This disconnects the charging current to the battery and holds pin 3 of IC1 high, hence to reset it is necessary to switch the power off and then on again.

To initially set the circuit up calculate the required value of R8 and assemble the components, omitting VR1 and R1 with a strap between points A and B. Connect up the battery to be used in conjunction with the charger and switch on. When satisfied that it is fully charged measure the voltage at A, from this determine the values of VR1 and R1 to be used and connect them in circuit. VR1 is selected to provide a degree of fine adjustment because as the cells approach their fully charged state the increase in voltage is small.

With the battery connected and charged adjust VR1 until D6 just extinguishes. When satisfied that it is properly set up the strap between A and B can be removed and the circuit function rechecked.

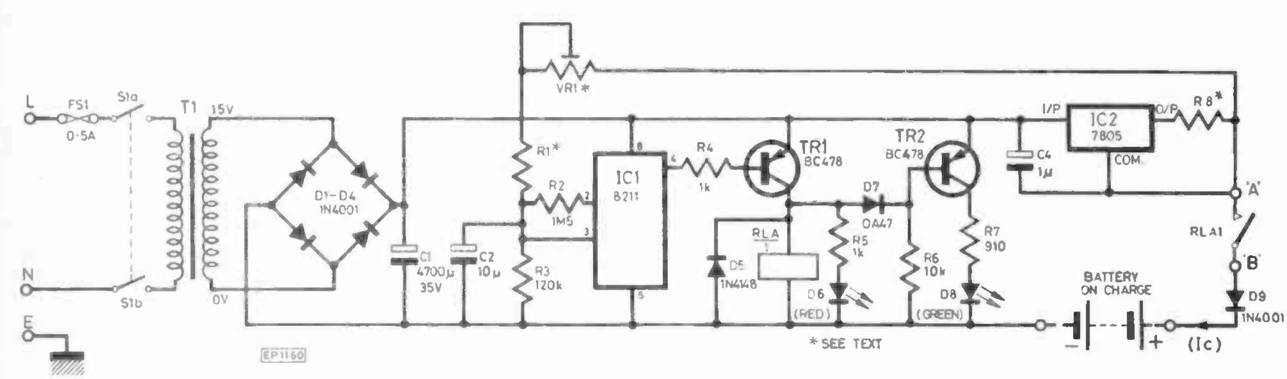
$$(I_c) = \frac{\text{Capacity of battery to be charged}}{10}$$

$$R8 = \frac{5}{(I_c)-(5\times10^{-3})}\ \Omega$$

$R1 + R2 = ((\text{voltage at A}) \times (10{\cdot}43 \times 10^4)) - (12 \times 10^4)$.

See text for (voltage at A).

G. Francis,
Filton,
Bristol.



SOUND CHASER

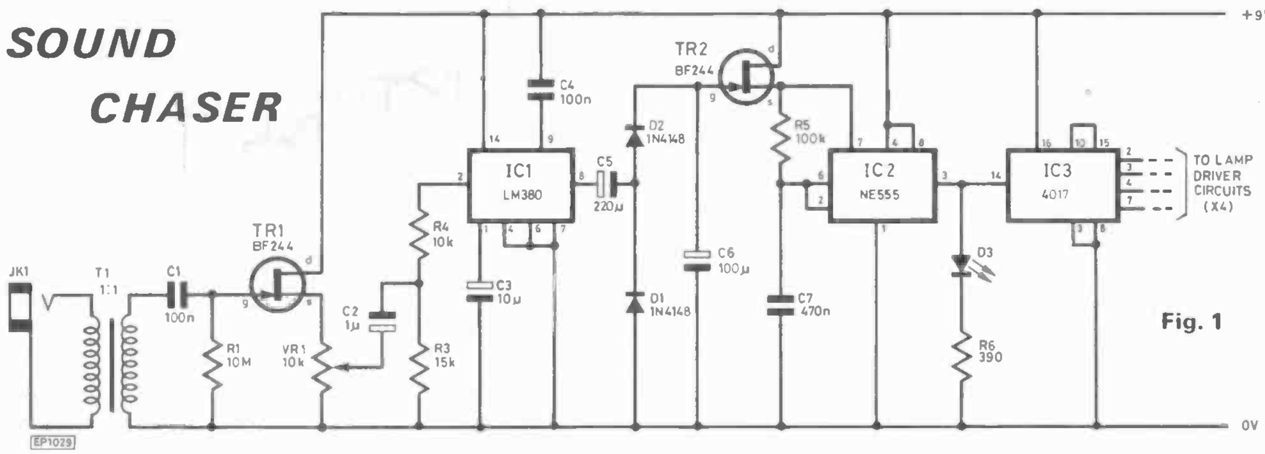


Fig. 1

NUMEROUS circuits for disco light displays have been published but there still remains a gap in the market. On one hand there are sound to light displays, but these generally give an ambiguous flickering light display. Alternatively there are chasers which, while not flickering, are not related to the music and so do not stimulate dancing.

This circuit is for a sequencer where the light change frequency is determined by the tempo and volume of the music which is more interesting than the more usual types of display.

TR1 and IC1 are used to amplify the input signal to the correct level which is then rectified by D2 to give an envelope of what appears across C6. The voltage of the gate determines the source-drain impedance of the f.e.t., TR2, which is one of the frequency determining components of IC2. The oscillator output is fed to IC3. The four outputs of this are each fed to a driver circuit (Fig. 2) which drives the bulbs.

A. Garraway,
Ashford,
Kent.

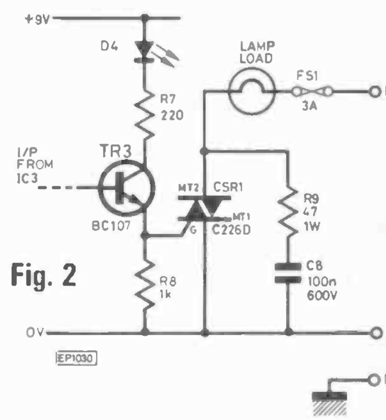


Fig. 2

SLIDE PROJECTOR DIMMER

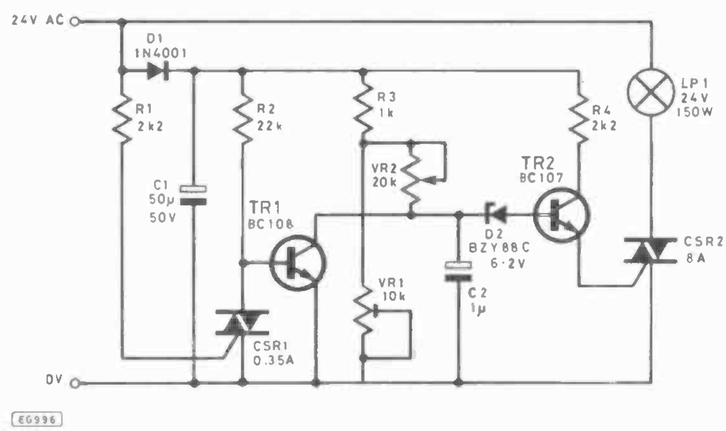
THIS circuit combines reasonable simplicity with good control of the lamp from zero to maximum brightness.

CSR1 is a low current triac (RS 262–028) which acts as a zero crossing detector, R2 being too great to allow it to turn on permanently. The pulses so obtained are used to discharge C2 via TR1 every half cycle. C2 is charged by R3 and VR2. When the voltage across C2 exceeds about 8V, the Zener conducts switching on the main triac CSR2 via TR2.

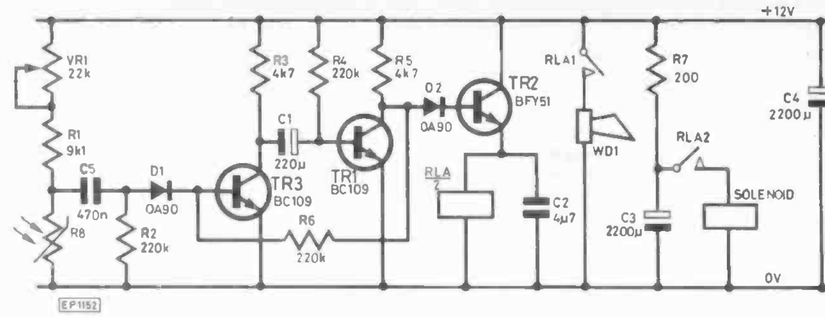
Lamp intensity is controlled by VR2. When this is set to zero the lamp will be at maximum brightness. With VR2 set to maximum resistance, VR1 can be adjusted so that the lamp goes out.

When installing the unit into your projector remember that CSR2 must have an adequate heat sink. R1 and R4 should be 0·5W resistors.

J. O. Linton,
Harrogate.



INTRUDER ALARM WITH CAMERA UNIT



A desirable feature for intruder alarms is to identify the intruder when the location is unoccupied.

This is easily achieved by incorporating a camera unit with an auto-wind facility, the shutter release being triggered at the moment of intrusion.

The circuit is light to dark activated. By enclosing the photo cell in a 20mm dia by 50mm long tube, high directional sensitivity can be achieved, coupled with high immunity to false alarms.

TR1 and TR3 form a monostable network, while TR2 acts as a relay driver, drawing virtually no current in the quiescent state.

The relay (RLA) is used to switch on a siren (WD1) as well as energise a solenoid activated striker attached to the shutter release.

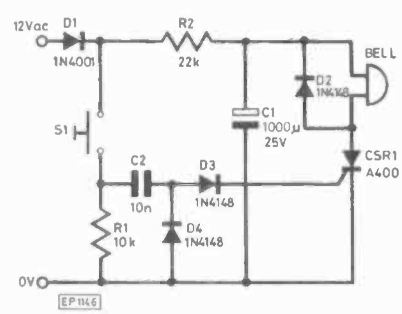
S. N. Rumala,
Minna,
Nigeria.

SHOP BELL DELAY

MANY small shops have a switch and bell system connected to their door. The owner has provided this so that he is informed of the arrival of a customer in the shop when he is elsewhere. However, during busy periods, the noise of the bell repeatedly sounding can be unpleasant.

This simple circuit reduces the number of times the bell will ring by preventing a second sounding shortly after the first. It will operate directly from a 12V or 8V bell transformer supply, since diode D1 performs rectification. Alternatively, it may be run from a battery—in which case it will give very long battery life as it draws only ½mA, even when the bell is ringing.

Operation is as follows—when the bell



has not been rung for a time, C1 is fully charged through R2, and once charged no more current is taken from the supply. When the door operated switch S1 is closed, C2 is charged through the gate of the SCR. This current turns on the SCR, which in turn connects the bell across C1 which discharges through the bell giving a ring of about one second. D2 protects the SCR by damping spikes produced by the bell. Since the time constant C1/R2 is many seconds, the bell cannot immediately be rung again.

The type of SCR used is not critical and the CSR1A400 or a similar TO5 device will work well.

D. J. Greaves,
Cambridge.

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Patents Review

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POWER-CUT RESERVE

Precise Power Corporation of Florida has filed a European patent application 0069568 on a clever system for saving computer data during a power-cut. According to the inventor it can also insulate computer users from related problems, like unstable mains frequency and voltage.

Fig. 1 shows a patented solution. Three-phase mains comes in at 20 to drive synchronous motor 12 which is in direct mechanical connection with generator 14. This produces a replica of the mains voltage which is fed out on line 22 to the computer load 24. The motor 12 also drives a second

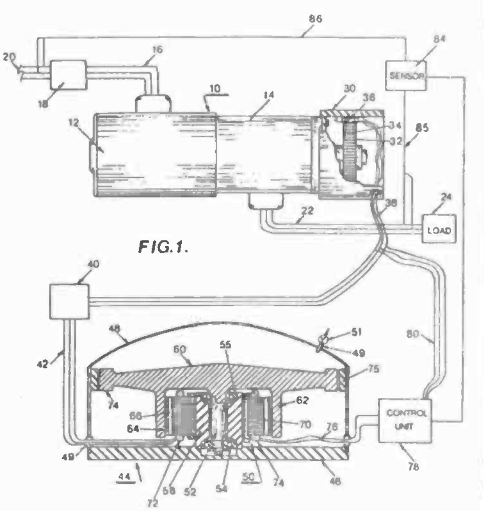

FIG.1.

generator 30, which outputs a high frequency supply, e.g. ten times the mains frequency, on line 38. This high frequency current drives a motor 50 which carries a heavy flywheel 60 running in a vacuum or other low windage-loss atmosphere. The wheel takes around half an hour to run up to full speed, but when it is running it stores around 5kW hours of energy.

Under normal mains supply conditions, the computer takes its power from the mains via the ganged motor 12 and generator 14. If the mains supply fails or falls the flywheel keeps running, with its speed falling only slightly over a period of minutes. The second generator 30 now functions as a drive motor for the mains generator 14. So the computer receives a constant power supply. When power is restored, the flywheel works up to full speed again, which takes between 15 and 30 minutes.

SOUND SENSITIVE SWITCH

James Taylor of Oregon has filed a European patent application 0067502 on a sound sensitive light switch. The idea is to replace an existing wall switch with a sensor that turns the lights on when it hears a noise. It then leaves them on while the noise continues, and switches them off after a period of silence. This way you can turn the lights on in a dark room simply by tapping the wall or making a noise. People who leave the lights on when they leave a room will no longer waste electricity because the lights will switch off automatically. There is an over-ride for people who like to make a noise in the dark or sit silently with the lights on.

In the circuit (Fig. 1) a microphone feeds a signal on line 22 to fixed gain amplifier 24 which is connected to variable gain amplifier 26. Sensitivity is controlled by variable resistor 27. Transistor 30 is normally biased on, but when the signal from amplifier 26 exceeds a threshold it is shut off. A re-set signal on line 8 triggers oscillator and counter chip 33 to produce a timed control signal on line 12 for triacs 44, 64. Photo resistor 32 biases transistor 30 when the switch is in a well-lit area, so that sensitivity to noise is less in daylight. On/off over-ride is provided by circuit 14. Variable resistor 54 controls triac 44 so that the unit can also be used as a conventional dimmer.

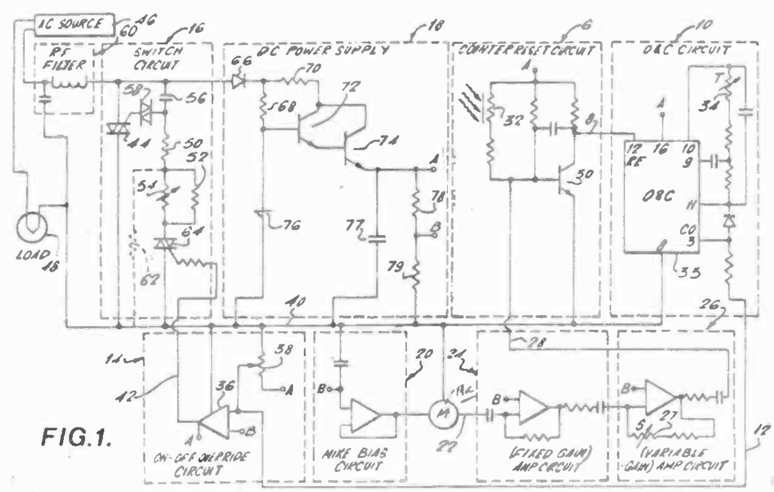

FIG.1.

QUART INTO PINT POT

The BBC, in British patent 2 105 548, suggests a simple approach to modifying the aspect ratio of a TV picture, to give wide screen images, without using up more transmission bandwidth. The traditional 4:3 ratio is of course now out of date, because most films are shot in a wider screen format. For projection television there is much to be said for widening the ratio. But this normally requires a complete re-think on the technology, as for instance pursued by Sony with its 1125 line, high definition, 5:3 wide screen TV system.

The BBC believes that the existing 625 line, PAL system can be easily modified to give a wider aspect ratio. Conventionally each picture line is transmitted in 64 microseconds, but only 52 microseconds are used for picture display. The remaining 12 microseconds, known as the horizontal blanking interval, are used to carry a synchronizing pulse for the horizontal sync circuits, a black level clamp pulse and a colour burst to synchronize the PAL decoder.

The blanking interval is also used to let the scanning spot glide back to the start of the next line. But in future solid state displays, such as l.c.d. or l.e.d. screens, won't need fly back time. Also, according to the BBC, the colour synchronizing information can be drastically shortened in time, or eliminated altogether, and the receiver locked by the sound carrier. This leaves up to 60 microseconds of each 64 microsecond line available for picture display, which in turn can give a wide screen aspect ratio with no increase in video bandwidth. Although the system would be impractical for broadcast transmission, because it would require receiver modifications, it could be used over existing channels for closed circuit TV of wide screen format.

MICRO-BUS

Compiled by DJD.

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

THIS month's Micro-Bus features an EPROM extension board for the ZX81 or ZX80, a BASIC program to solve simultaneous equations, and the solutions to the BASIC problems featured in the last Micro-Bus.

EPROM EXTENSION BOARD

The circuit shown in Fig. 1 was submitted by *I. P. Bryant*, and will add up to 8K of EPROM or RAM to a ZX80 or ZX81. The extra memory appears in the memory space directly above the 8K monitor ROM, and the circuit uses 2716 or 2516 EPROMs as these are available at a reasonable price.

The circuit is interfaced to the ZX81 bus by means of the edge connector. For ZX80 users there is no ROM chip select signal on the connector, but this can be created by connecting IC6 pin 6 to the spare edge connector, and then cutting the track between IC12 pin 11 and IC6 pin 6 and connecting a 680 ohm resistor across the break. The edge connector will now be identical to the ZX81's.

The circuit does not need to include any write protection because the 1k resistors in the ZX80/81's data bus provide this.

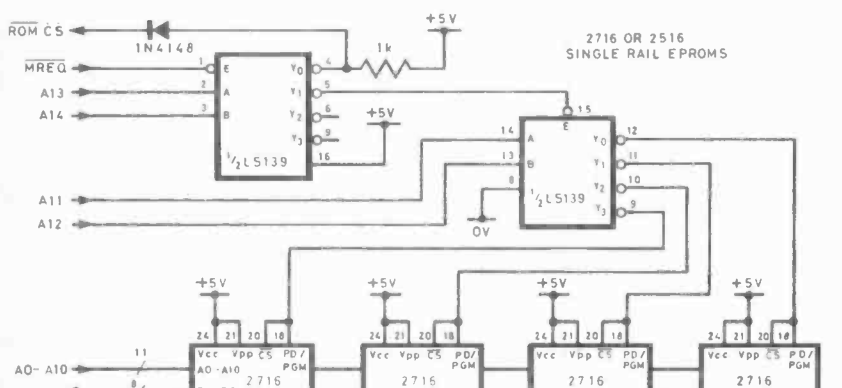

Fig. 1. Circuit adds 8K of EPROMs to a ZX80 or ZX81

SIMULTANEOUS EQUATIONS

Simultaneous equations crop up in many different branches of electronics. For example, one can determine the resistive, capacitive, and inductive components of a passive component by measuring its impedance at three different frequencies, and then solving three simultaneous equations to find R, C, and L. The BASIC program of Fig. 2 was submitted by *A. Schoultz* of South Africa, and can be used to solve such equations. The program was developed on a ZX81, but can fairly easily be modified to run on any BASIC-speaking microcomputer.

The number of equations which can be solved is dependent only on the amount of available memory. On a ZX81 with a 16K RAM pack the program has no trouble solving ten equations with ten unknowns, and takes about 22 seconds. As an example, to solve the three equations:

$a + 2b + 3c = 42$
$7a + b - 8c = 36$
$3a - 2b + 2c = 54$

one enters the coefficients in order:
1, 2, 3, 42, 7, 1, −8, 36, 3, −2, 2, 54.

The program should then produce the correct answer:
$a = 14, b = 2, c = 8$.

PROGRAM OPERATION

The program, lines 10 to 150, first inputs the number of equations and sets up three arrays. Array A holds the coefficients of the variables, and array B holds the constants. The solution is returned in array X. Lines 1000 to 1036 solve the equations, and lines 1037 to 1048 print out the solution.

To alter the program for other machines, those features peculiar to the ZX81 will have to be altered. The value of Q on line 15 is chosen so that CHR$(Q+1) will give the letter A, for the printing of the equation variables; other machines that use ASCII will need Q=64. The PRINT AT Y,X statement in lines 110, 140, 1043, and 1046 can be replaced by

```
   5 REM *** SIMULTANEOUS EQUATIONS ***
  10 PRINT "NO. OF EQUATIONS =";
  15 Q=37
  20 INPUT N
  30 PRINT N
  40 DIM A(N,N)
  50 DIM B(N)
  60 DIM X(N)
  70 LET C=INT(30/(N+1))
  80 FOR I=1 TO N
  90 FOR J=1 TO N
 100 INPUT A(I,J)
 110 PRINT AT I*2,J*C-C;A(I,J);" ";CHR$(J+Q)
 120 NEXT J
 130 INPUT B(I)
 140 PRINT AT I*2,J*C-C;"= ";B(I)
 150 NEXT I

1000 FAST
1001 FOR I=1 TO N-1
1002 LET R=I
1003 LET M=A(I,I)
1004 FOR J=I+1 TO N
1005 IF A(J,I)<=M THEN GOTO 1008
1006 LET R=J
1007 LET M=A(I,J)
1008 NEXT J
1009 IF M=0 THEN PRINT "SOLUTION ABORTED."
1010 IF R=I THEN GOTO 1019
1011 FOR K=1 TO N
1012 LET S=A(I,K)
1013 LET A(I,K)=A(R,K)
1014 LET A(R,K)=S
1015 NEXT K
1016 LET S=B(I)
1017 LET B(I)=B(R)
1018 LET B(R)=S
1019 FOR J=I+1 TO N
1020 LET M=A(J,I)/A(I,I)
1021 FOR K=1 TO N
1022 LET A(J,K)=A(J,K)-M*A(I,K)
1023 NEXT K
1024 LET B(J)=B(J)-M*B(I)
1025 NEXT J
1026 NEXT I
1027 REM BACK SUBSTITUTION
1028 LET X(N)=B(N)/A(N,N)
1029 FOR I=N-1 TO 1 STEP -1
1030 LET S=0
1031 FOR J=I+1 TO N
1032 LET S=S+X(J)*A(I,J)
1033 NEXT J
1034 LET X(I)=(B(I)-S)/A(I,I)
1035 NEXT I
1036 PRINT "--------------------------------"
1037 SLOW
1038 FOR I=1 TO N
1039 LET J=(N+I+1)*2
1040 IF J<=20 THEN GOTO 1046
1041 SCROLL
1042 SCROLL
1043 PRINT AT 20,0;CHR$ (I+Q);" = ";X(I)
1044 NEXT I
1045 STOP
1046 PRINT AT J,0;CHR$ (I+Q);" = ";X(I)
1047 NEXT I
1048 STOP
```

Fig. 2. Program for the ZX81 will solve simultaneous equations

a TAB(X,Y) function, but note that the order of row and column is the other way round. Finally, the commands FAST, SLOW, and SCROLL can be removed.

PUZZLE SOLUTIONS

Here we present the solutions to the six problems featured in the last Micro-Bus. Each problem centred around a program written in BBC BASIC, and readers were invited to send in solutions.

NUMBER TRICK

In the first problem you were asked to explain how a "number trick" worked. The appearance of the trick was as follows: a spectator was shown 60 random numbers, and asked to remember one; they were then shown a selection of numbers, and asked to say whether their number was present. After 6 such selections the program was (usually) able to name the number they were thinking of.

The trick works on the principle that six yes/no (binary) pieces of information will serve to distinguish between up to 64 different things (since 2↑6=64). For the sake of screen layout the trick used only 60 different numbers, and random numbers are substituted for the numbers 1 to 60 simply to disguise the trick. These random numbers are stored in an array numbered 1 to 60 and the following explanation refers to them as A(1) to A(60).

Each selection shows only those numbers that have a '1' in a particular position in their binary representation. This is achieved in the program by the expression:

IF (N DIV 2↑(6-M)) MOD 2 THEN PRINT A(N);

which only prints the Nth number if N has a '1' in position M. For example, if M is 6 the expression is effectively:

IF N MOD 2 THEN PRINT A(N);

and the numbers A(1), A(3), A(5) . . . etc will be printed. The selection procedure is repeated for values of M from 1 to 6. The spectator's six yes/no replies are then assembled into a binary number which directly gives the position N of the chosen random number.

As a postscript to the trick you were asked whether the trick might ever fail. The answer is yes! If, by chance, a random number appears more than once in the initial set of 60 numbers the spectator's replies will cause an incorrect identification; in fact, the computer will reply with the number whose position N is the logical OR of the positions of the spectator's numbers. This unlikely event could easily be avoided by ensuring that the 60 random numbers were all different.

MYSTERIOUS SEQUENCE

The next problem was to explain why the sequence of numbers:

2, 5, 10, 17, 26, 37, 50, 65, 82

was printed out by a program which performed some manipulations on an array of 100 numbers. The operation of the program can be made slighty more obvious if it is modified, as shown in Fig. 3, so that the arrays start from 0 rather than 1; the sequence printed out is then:

1, 4, 9, 16, 25, 36, 49, 64, 81, 100

which may be familiar as the squares of the numbers 1 to 10. These result for the following reason: we start off with an array A(0) to A(100) whose elements are all zero, or 'false'.

```
10 DIM A(100)
20 FOR N=1 TO 100
30 FOR J=0 TO 100 STEP N
40 A(J)=NOT A(J)
50 NEXT J: NEXT N
60 REM
70 FOR N=0 TO 100
80 IF A(N) THEN PRINT N;
90 NEXT N
```

Fig. 3. The Mysterious Sequence problem is revealed by this BASIC program which prints out a series of squares

Then, for each value of N from 1 to 100 every Nth element is inverted. For example, A(6) will be inverted for N=1, 2, 3, and 6, and since it has been inverted four times it will end up with the value 'false'. It is clear that each element of the array is inverted once for each of its divisors, so only numbers with an odd number of divisors will end up 'true'. Now, only perfect squares have an odd number of different divisors, since all other numbers can be expressed only as the product of two different numbers, so the numbers printed out by the program in Fig. 3 will be all the squares. The program given in the original problem adds one to these numbers by starting the array from 1 rather than 0.

NUMBER TRAILS

The next puzzle program took a starting number, and found the sum of the squares of the digits of that number. This process was repeated until a stable result, such as '1', was obtained, which was printed out. The examples 7 and 19 were given, each of which gives 1 as an eventual result. In the latter case we obtain the trail:

19 →82 →68 →100 →1

If you tried the program with other starting numbers you were probably frustrated to find that the program 'hung up'; we can see why if we take the starting value '4':

4 →16 →37 →58 →89 →145 →42 → 20 →4 . . . .

and so the sequence repeats for ever, never reaching a stable value. However, if we add a test for this loop to the terminating condition by altering line 60 to:

60 UNTIL S=T OR T=4

we find that every number up to 99 either ends on 1, or reaches 4 indicating that it is in this loop. It is fairly easy to see that all starting values above 99 will soon lead to a value below 99, so every starting number, however large, will eventually lead to one of these two possibilities.

If the rule is to cube each digit before adding, the picture is somewhat more complicated, and we leave this for exploration by the reader; suffice it to say that the system contains five stable end numbers (one of which is 371), and two loops.

DECIMAL TO HEX

The decimal-to-hex program used the unusual recursive definition of a function FNHEX shown in Fig. 4 to convert a number

```
10 DIGITS$="0123456789ABCDEF"
70 DEF FNHEX(DEC)
80 IF DEC<16 THEN =MID$(DIGITS$,DEC+1,1)
90 =FNHEX(DEC DIV 16)+FNHEX(DEC MOD 16)
```

Fig. 4. Recursive function converts decimal number DEC to a hexadecimal string

DEC into a string representation of its hex equivalent. The definition, in plain English, is as follows: "To convert a number into hexadecimal: if it is less than 16 then the result is the corresponding hex digit extracted from the string DIGIT$; otherwise the answer is a string formed by the hex equivalent of the number divided by 16, followed by the hex equivalent of the number mod 16.

The problem was to explain why the hex equivalents of the decimal numbers in the series 1111, 11111, 111111, 1111111 . . . all end in the digit '7'. Looking at this series, it is obvious that each term differs from the previous one by a multiple of 10000; for example, 1111111 – 111111 is 1000000, obviously a multiple of 10000. Now, this number 10000 is itself a multiple of 16, so in hex it is a number which ends in zero. Thus adding multiples of 10000 to 1111 does not effect the last digit of the hexadecimal form of the result. The same is obviously true for series consisting of any repeated digit.

Incidentally, the problem of generating a series of N '1's is made especially simple by using the EVAL and STRING functions with the expression:

40 J=EVAL(STRING$(N,"1"))

The same method can be used for investigating the behaviour of other series.

RECURSIVE FUNCTION

The last of the puzzle programs printed out the first ten values of a mystery function. For

```
 2 MODE 0: DIM A(250)
 5 FOR N=0 TO 250
 7 DRAW N*4,FNH(N)*7: NEXT: END
10 DEF FNH(N)
20 IF N<2 THEN A(N)=1: =1
30 A(N)=A(N-A(N-1))+A(N-A(N-2)): =A(N)
```

Fig. 5. Program plots the behaviour of a non-recursive version of the FNH function

fairly large values of the function it takes a long time to calculate values, but we can rewrite it non-recursively to calculate the first 250 values and plot them; see Fig. 5.

TWICE FUNCTION

As a postscript, readers were asked to construct a function FNTWICE which would

```
FNTWICE(A$,N) = EVAL

(A$ + "(" + A$ + "(" + STR$(N) + "))")
```

Fig. 6. TWICE function in BBC BASIC evaluates any given function twice

take any function, and perform its operation twice in succession. The solution is shown in Fig. 6, and makes use of the versatile EVAL function provided in BBC BASIC which evaluates an expression passed to it.

The function works as follows. Suppose we call it to evaluate:

FNTWICE("SQR",256)

The function will construct the string:

"SQR(SQR(256))"

and pass it to EVAL to be evaluated, giving the result 4.

BEST SOLUTIONS

The next Micro-Bus will give the names of the readers who sent in the best solutions to these problems.

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4000 CMOS
4000 10p, 4001 12p, 4006 50p, 4007 14p, 4008 36p, 4009 24p, 4010 24p, 4011 11p, 4012 16p, 4013 20p, 4014 48p, 4015 40p, 4016 20p, 4017 32p, 4018 45p, 4019 25p, 4020 48p, 4021 40p, 4022 45p, 4023 13p, 4024 32p, 4025 13p, 4026 80p, 4027 20p, 4028 40p, 4029 45p, 4030 15p, 4031 125p, 4032 80p, 4033 125p, 4034 140p, 4035 45p, 4036 275p, 4038 110p, 4040 40p, 4041 40p, 4042 40p, 4043 40p, 4044 40p, 4045 105p, 4046 50p, 4047 45p, 4048 50p, 4049 24p, 4050 24p, 4051 45p, 4052 60p, 4053 50p, 4054 90p, 4055 90p, 4056 90p, 4059 450p, 4060 55p, 4063 90p, 4066 27p, 4067 225p, 4068 14p, 4069 14p, 4070 14p, 4071 14p, 4072 14p, 4073 14p, 4075 14p, 4076 48p, 4077 16p, 4078 16p, 4081 14p, 4082 15p, 4086 40p, 4089 125p, 4093 24p, 4094 90p, 4095 75p, 4096 70p, 4097 290p, 4098 90p, 4099 100p, 40102 150p, 40103 180p, 40105 120p, 40106 40p, 40109 100p, 4500 575p, 4501 28p, 4502 60p, 4503 45p, 4504 75p, 4506 35p, 4507 35p, 4508 130p, 4510 45p, 4511 45p, 4512 48p, 4154 110p, 4515 110p, 4516 55p, 4517 260p, 4518 40p, 4520 50p, 4521 90p, 4522 120p, 4526 60p, 4527 60p, 4528 50p, 4532 70p, 4534 400p, 4536 270p, 4538 90p, 4539 70p, 4543 75p, 4553 245p, 4555 35p, 4556 35p, 4557 300p, 4560 120p, 4566 160p, 4568 250p, 4569 170p, 4572 30p, 4583 90p, 4584 36p, 4585 75p, 40014 40p, 40085 90p, 40097 45p, 40163 60p, 40174 50p, 40175 50p, 40193 60p, 14411 £7, 14412 £8, 14416 380p, 14419 280p, 14490 350p, 14495 300p, 14599 290p

LINEAR ICs
AD7581 £14, AN103 200p, AY1-5050 99p, AY3-8910 350p, AY3-8912 500p, AY5-1350 350p, AY5-4007D 520p, CA3028A 120p, CA3019 80p, CA3046 70p, CA3048 220p, CA3059 285p, CA3080E 70p, CA3086 48p, CA3089E 200p, CA3090AQ 375p, CA3130E 90p, CA3140E 40p, CA3160E 100p, CA3161E 150p, CA3162E 450p, CA3189E 300p, CA3240E 110p, CA3280G 200p, D7002C 390p, DAC0808 200p, DG308 300p, HA1366 190p, HA1388 250p, ICL7106 700p, ICL7650 400p, ICL7660 200p, ICL8038 300p, LC7120 300p, LC7130 350p, LC7137 270p, LF347 150p, LF351 48p, LF353 95p, LF356P 95p, LF357 110p, LM10C 325p, LM301A 25p, LM310 120p, LM311 70p, LM318 150p, LM319 215p, LM324 30p, LM334Z 90p, LM335Z 140p, LM339 50p, LM348 65p, LM358P 60p, LM377 175p, LM380 75p, LM381AN 180p, LM382 120p, LM386 90p, LM387 120p, LM389 95p, LM393 100p, LM394CH 300p, LM709 36p, LM710 50p, LM711 70p, LM725 300p, LM733 60p, LM741 18p, LM747 70p, LM748 35p, LM1886 £5, LM1889 350p, LM2917 200p, LM3302 75p, LM3900 50p, LM3909 85p, LM3911 125p, LM3914 200p, LM3915 200p, LM3916 225p, LM13600 110p, M51513L 230p, M51516L 500p, MB3712 200p, MC1310P 150p, MC1413 100p, MC1458 36p, MC1495L 350p, MC1496 70p, MC3340P 150p, MC3401 50p, MC3403 65p, MF10CN 300p, MK50240 900p, MK50398 £7, NE531 140p, NE555 16p, NE556 45p, NE564 420p, NE565 120p, NE566 155p, NE567 140p, NE570 410p, NE571 400p, NE5534A 125p, PLL02A 500p, RC4136 60p, RC4558 60p, S566B 225p, S50240 900p, SAD1024A 850p, SN76477 450p, SN76489 480p, SP0256AL £10, TA7120 150p, TA7204 150p, TA7205 90p, TA7222 150p, TA7310 150p, TBA231 120p, TBA641BX1 £4, TBA800 80p, TBA810 100p, TBA820 80p, TBA950 225p, TC9109 750p, TCA210 250p, TCA220 350p, TCA940 175p, TDA1004A 300p, TDA1008 320p, TDA1010 200p, TDA1022 500p, TDA1024 120p, TDA1170 300p, TDA2002V 325p, TDA2003 325p, TDA2020 320p, TL071/81 25p, TL072/82 45p, TL064/74 95p, TL084 90p, TL094 200p, TL430C 70p, UAA170 170p, UA2240 120p, ULN2003A 75p, UPC1156H 275p, XR210 400p, XR2206 300p, ZNA134 £23, ZNA234 850p, ZN414 95p, ZN419C 190p, ZN424E 130p, ZN425E 340p, ZN427E 580p, ZN428E 450p, ZN429E 210p, ZN450E 790p, ZN459 600p, ZN1034E 200p, ZN1040E 670p

CPUs
1802CE 650p, 2650A £12, 6502 350p, 6502A 500p, 6800 225p, 6802 225p, 6809 650p, 6809E £12, 68809 £12, 8035 350p, 8039 £3, 8080A 250p, 8085A 450p, 8086 £22, 8748 £16, INS8060 £11, TMS9980 £20, Z8 £24, Z80 290p, Z80A 320p, Z80B £12, 8088 £18, TMS5100 £10, TMS9995 £12

SUPPORT DEVICES
2651 £12, 3242 800p, 3245 450p, 6620 280p, 6522 310p, 6522A 550p, 6532 550p, 6551 650p, 6821 100p, 68B21 220p, 6840 375p, 68840 650p, 6850 110p, 68B50 220p, 6852 250p, 6854 770p, 6875 500p, 8154 950p, 8155 350p, 8156 350p, 8205 225p, 8212 110p, 8216 100p, 8224 110p, 8226 250p, 8228 270p, 8243 280p, 8250 850p, 8251 250p, 8253 390p, 8255 255p, 8256 £36, 8257 £4, 8259 £4, 8279 440p, 8284 350p, 8288 100p, 8755A £15, 9901 £10, TMS5220 £12, TMS9909 £9, TMS9911 £16, Z80PIO 250p, Z80APIO 280p, Z80CTC 250p, Z80ACTC 250p, Z80ADART £7, Z80ADMA £9, Z80SIO-0/1/2 £9

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CRT6545 900p, CRT5027 £18, CRT5037 £18, EF9365 £36, EF9366 £36, MC6845 £6, MC6847 650p, SFF96364 £8, TMS1601 £12, TMS9918 £36, TMS9927 £14, TMS9928 £20, TMS9929 £16

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24 pin 575p, 28 pin £8, 40 pin 975p

MEMORIES
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AD558CJ 775p, AD561J £20, AM25S10 350p, AM25LS251 £2, AM26LS31 125p, AM26LS32 125p, D7002 390p, DAC80 £28, DM8131 275p, DP8304 250p, DS3691 300p, DS8830 140p, DS8831 140p, DS8832 250p, DS8833 225p, DS8836 150p, DS8838 225p, MC1488 55p, MC1489 55p, MC3466 250p, MC3459 450p, MC3470 650p, MC3480 850p, MC3486 300p, MC3487 300p, MC4024 325p, MC4044 325p, MC14411 675p, MC14412 750p, ULN2003A 75p, 75107 90p, 75108/9 90p, 75110/12 90p, 75114/15 160p, 75121/22 140p, 75150P 120p, 75154 140p, 75159 220p, 75365 150p, 75451/2 72p, 75453/4 72p, 75491/2 65p, 8T26 120p, 8T28 120p, 8T95/96 80p, 8T97/98 80p, 81LS95 80p, 81LS96 80p, 81LS97 80p, 81LS98 80p, 81LS120 250p, 9602 220p, 9637AP 160p, ZN425E-8 350p, ZN426E-8 350p, ZN427E-8 650p, ZN428E-8 500p, SN74S262AN £10, MC66760 750p

CRYSTALS
32 768KHz 100p, 100KHz 250p, 200KHz 280p, 1MHz 290p, 1 008MHz 275p, 1 8432MHz 210p, 2 00MHz 225p, 2 45760MHz 210p, 2 5MHz 250p, 2 662MHz 250p, 3 276MHz 150p, 3 5795MHz 100p, 3 686MHz 300p, 4 00MHz 150p, 4 194MHz 200p, 4 43MHz 110p, 4 608MHz 250p, 4 9152MHz 250p, 5 00MHz 175p, 6 00MHz 150p, 6 144MHz 150p, 7 00MHz 150p, 7 168MHz 175p, 8 00MHz 175p, 8 86MHz 175p, 10 00MHz 175p, 10 50MHz 250p, 10 70MHz 150p, 12 00MHz 150p, 14 318MHz 175p, 14 756MHz 250p, 15 00MHz 200p, 16 00MHz 200p, 17 7MHz 200p, 18 00MHz 200p, 18 432MHz 150p, 19 968MHz 150p, 20 000MHz 200p, 26 690MHz 150p, 38 6667MHz 175p, 48 0MHz 175p, 55 5MHz 400p, 116MHz 300p, 145 80MHz 250p

KEYBOARD ENCODER
AY-5-2376 700p, 74C922 420p, 74C923 500p

MODULATORS
6MHz UHF 375p, 8MHz UHF 450p

DISC CONTROL
FD1771 £20, FD1791 £22, FD1793 £23, FD1795 £28, FD1797 £28, FD2793 £42, FD2797 £42, WD1691 £15, WD2143 550p, 8271 £36

BAUD RATE GENERATOR
MC14411 675p, COM8116 700p, 4702B 750p

TELETEXT DECODER ICs
SAA5020 £6, SAA5030 £7, SAA5041 £16, SAA5050 £9

CHARACTER GENERATORS
RO-3-2513UC 750p, RO-3-2513LC 700p

REAL TIME CLOCK
MM58174 800p, MCM66760 700p

WIRE WRAP SOCKETS BY TEXAS
8 pin 25p, 14 pin 35p, 16 pin 40p, 18 pin 50p, 20 pin 60p, 22 pin 65p, 24 pin 70p, 28 pin 80p, 40 pin 100p

LOW PROFILE DIL SOCKETS BY TEXAS
8 pin 9p, 14 pin 10p, 16 pin 11p, 18 pin 16p, 20 pin 18p, 22 pin 22p, 24 pin 24p, 28 pin 26p, 40 pin 30p

VOLTAGE REGULATORS FIXED PLASTIC

1A	+ve		-ve	
5V 1A	7805	40p	7905	45p
12V 1A	7812	40p	7906	45p
15V 1A	7815	40p	7912	45p
18V 1A	7818	40p	7915	45p
24V 1A	7824	40p	7918	45p
5V 100mA	78L05	30p	7924	45p
12V 100mA	78L12	30p	79L05	50p
15V 100mA	78L15	30p	79L12	50p
			79L15	50p

OTHER REGULATORS
LM309K 1A 5V 135p, LM317K 250p, LM317T 1A Adj 200p, LM337T 100p, LM323K 3A 5V 450p, LM723 150mA Adj 37p, TL494 400p, 78S40 300p, 78HGKC 600p, 78HO5KC 550p, 78MGT2C 140p, 78GUIC 200p, 79GUIC 225p, 79HGKC 700p, TL497 300p, LM350T 350p

OPTO-ELECTRONICS
2N5777 45p, OCP71 180p, ORP12 120p, ORP60 120p, ORP61 120p, TIL78 55p

OPTO-ISOLATORS
ILD74 130p, MCT26 100p, MCS2400 190p, ILQ74 180p, MOC3020 150p, TIL 112 70p, TIL 113 70p, TIL 116 70p

LEDS
0.125": TIL32 55p, TIL209 Red 10p, TIL211 Gr 12p, TIL212 Ye 15p, TIL216 Red 18p
0.2": TIL220 Red 10p, TIL222 Gr 12p, TIL228 Yel 15p, Rectangular LEDs (R, G, Y) 30p

DISPLAYS
DL704 140p, DL707 Red 140p, FND357 120p, FND500 90p, FND507 90p, MAN3640 175p, MAN4640 200p, NSB5881 670p, TIL311 600p, TIL312/3 110p, TIL321/2 130p, TIL330 140p, 7750/60 200p

DRIVERS
9368 250p, 9370 300p, UDN6118 320p, UDN6184 320p

TRANSISTORS
AD161/2 40p, BC107/8 14p, BC108B 15p, BC109C 16p, BC169C 10p, BC172 12p, BC177/8 17p, BC179 18p, BC182/3 10p, BC184 10p, BC187 30p, BC212/3 10p, BC214 12p, BC237 10p, BC327 16p, BC337 10p, BC338 15p, BC461 30p, BC477/8 30p, BC516/7 36p, BC547B 12p, BC548C 12p, BC549C 12p, BC557B 14p, BC559C 16p, BCY70 20p, BCY71/2 22p, BD131 60p, BD132 80p, BD135 40p, BD136 35p, BD139 40p, BD140 40p, BD189 60p, BD242A 60p, BD379 40p, BD380 40p, BF244B 25p, BF256B 50p, BF257/8 30p, BF259 35p, BF337 30p, BFR39 20p, BFR40/1 20p, BFR79 20p, BFR80/1 25p, BFX29 40p, BFX30 34p, BFX84 25p, BFX85 30p, BFX88 25p, BFX89 150p, BFY50 24p, BFY51/2 24p, BFY56 30p, BFY90 80p, BRY39 40p, BSX19/20 24p, BU104 225p, BU105 190p, BU108 250p, BU109 225p, BU126 150p, BU180A 120p, BU205 175p, BU208 200p, BU406 145p, BUX80 400p, J310 50p, MJ802 400p, MJ2501 225p, MJ2955 90p, MJ3001 225p, MJE340 50p, MJE2955 90p, MJE3055 70p, MPF102/3 30p, MPF104/5 30p, MPF105 30p, MPSA06 30p, MPSA12 50p, MPSA13 50p, MPSA20 50p, MPSA42 50p, MPSA43 50p, MPSA56 25p, MPSA70 50p, MPSU06 55p, MPSU07 60p, MPSU45 90p, MPSU65 78p, TIP29A/B 35p, TIP29C 40p, TIP31C 50p, TIP32A 40p, TIP32B 45p, TIP32C 50p, TIP33A 60p, TIP33B 65p, TIP33C 70p, TIP34A 65p, TIP34B 70p, TIP34C 80p, TIP35A 120p, TIP35B 140p, TIP35C 150p, TIP36A 140p, TIP36B 150p, TIP36C 160p, TIP41A 45p, TIP41B 50p, TIP41C 55p, TIP42A 50p, TIP42B 45p, TIP42C 60p, TIP54 160p, TIP120/22 60p, TIP142 110p, TIP147 120p, TIP2955 60p, TIP3055 60p, VN10KM 50p, VN66AF 90p, VN88AF £1, ZTX108 10p, ZTX300 13p, ZTX500 13p, ZTX502 15p, ZTX504 18p, 2N697 20p, 2N698 40p, 2N706A 18p, 2N708 18p, 2N918 35p, 2N930 18p, 2N1131/2 36p, 2N1613 30p, 2N1711 25p, 2N2102 70p, 2N2160 295p, 2N2219A 25p, 2N2222A 25p, 2N2369A 17p, 2N2484 25p, 2N2646 40p, 2N2904/5 25p, 2N2906A 25p, 2N2907A 25p, 2N2926 9p, 2N3053 25p, 2N3054 55p, 2N3055 48p, 2N3442 140p, 2N3553 240p, 2N3584 250p, 2N3643/4 48p, 2N3702/3 10p, 2N3704/5 10p, 2N3706/7 14p, 2N3708/9 12p, 2N3773 300p, 2N3819 25p, 2N3823 50p, 2N3866 90p, 2N3902 700p, 2N3903/4 18p, 2N3905/6 16p, 2N4037 65p, 2N4056 65p, 2N4123/4 27p, 2N4125/6 27p, 2N4401/3 25p, 2N4427 90p, 2N4871 50p, 2N5087 27p, 2N5089 27p, 2N5172 18p, 2N5191 70p, 2N5194 75p, 2N5245 40p, 2N5296 65p, 2N5401 50p, 2N5457/8 32p, 2N5459 32p, 2N5460 60p, 2N5485 36p, 2N5875 250p, 2N6027 30p, 2N6052 300p, 2N6059 325p, 2N6107 65p, 2N6247 190p, 2N6254 130p, 2N6290 65p, 2SC1172 150p, 2SC1306 150p, 2SC1307 150p, 2SC1957 90p, 2SC2969 198p, 2SC2028 120p, 2SC2029 250p, 2SC2078 200p, 3N128 120p, 3N140 120p, 3N141 110p, 3N201 110p, 3N204 120p

DIODES
BY127 12p, OA47 9p, OA90/91 9p, OA200 9p, OA202 10p, 1N914 4p, 1N916 7p, 1N4148 4p, 1N4001/2 5p, 1N4003/4 5p, 1N4006/7 7p, 1N5401/2 12p, 1N5403/4 14p, IS920 9p

BRIDGE RECTIFIERS
1A 50V 19p, 1A 100V 20p, 1A 400V 25p, 1A 600V 30p, 2A 50V 30p, 2A 100V 35p, 2A 400V 45p, 3A 200V 60p, 3A 600V 72p, 4A 100V 95p, 4A 400V 100p, 6A 50V 80p, 6A 100V 90p, 6A 400V 120p, 10A 400V 200p, 25A 400V 400p, 40290 260p, 40361/2 75p, 40408 90p, 40409 100p, 40410 100p, 40411 300p, 40594 120p, 40595 120p, 40673 75p, 40871/2 100p

ZENERS
2.7V-33V 400mW 9p, 1W 15p

TRIACS PLASTIC
3A 400V 60p, 4A 400V 70p, 6A 500V 88p, 8A 400V 75p, 8A 500V 95p, 12A 400V 85p, 12A 500V 105p, 16A 400V 110p, 16A 500V 130p, T2800D 130p

THYRISTORS
1A 50V 70p, 1A 400V 90p, 3A 400V 45p, 8A 600V 140p, 12A 400V 160p, 16A 100V 180p, 16A 400V 180p, C106D 45p, MCR101 36p, 2N4444 180p, 2N5060 30p, 2N5061 32p, 2N5064 35p

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*Projects for Book 8 were in an advanced state at the time of writing, but contents may change prior to publication (due 13th August 1983).

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