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SEPTEMBER 1980

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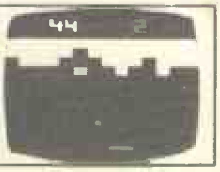

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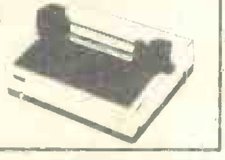

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PRACTICAL
ELECTRONICS

VOLUME 16 No. 9 SEPTEMBER 1980

CONSTRUCTIONAL PROJECTS

GENERAL FEATURES

NEWS & COMMENT

OUR OCTOBER ISSUE WILL BE ON SALE FRIDAY, 12 SEPTEMBER 1980
(for details of contents see page 63)

WATFORD ELECTRONICS

Continued from opposite side)

DIODES

AA129	25
AAZ15	15
BA102	15
BY100	24
BY127	12
CRO33	158
OA9	45
OA47	18
OA70	12
OA79	12
OA81	15
OA85	15
OA90	8
OA91	8
OA95	8
OA200	9
OA202	9
N914	4
N916	6
N400/2	5
N4003	6
N4004/5	6
N4006/7	7
N4148	4
S44	20
3A/100V	18
3A/400V	20
3A/600V	27
3A/1000V	30

SCR's Thyristors

0.8A30V	28
0.8A100V	30
0.8A200V	35
1A/50V	37
1A/100V	42
1A/200V	47
1A600V	70
5A300V	35
5A600V	43
8A300V	48
8A600V	85
12A300V	59
12A500V	92
12A800V	150
15A700V	195
BT106	150
BT116	150
C106D	38
MCR101	32
TIC44	22
TIC45	28
2N4444	140

BRIDGE RECTIFIERS (plastic case)

1A/50V	20
1A/100V	22
1A/200V	25
1A/400V	29
1A/600V	34
2A/50V	35
2A/100V	44
2A/200V	46
2A/400V	53
2A/600V	65
4A/100V	72
6A/100V	73
6A/200V	78
6A/400V	85
BY164	56
VM18 DIL	50

ZENERS

Range: 2V7 to 39V 400mW **8p each**

Range: 3V3 to 33V, 1.3W **15p each**

VARICAPS

MVAM2	165
MVAM115	140
BA102	25
BB105B	40
BB106	40

Noise Diode

Z5J 180

TRIACS

3A/100V	48
3A/400V	50
8A/100V	54
8A/400V	64
8A/500V	85
8A/800V	108
12A/100V	60
12A/400V	70
12A/800V	130
16A/100V	95
16A/400V	105
16A/500V	120
16A/800V	195
25A/400V	160
25A/800V	295
T2800D	120

DIAC

ST2 25

SPEAKERS

8Ω 0.3W 2"; 2½"	75
2.5: 3"	75
40Ω 2.5"	88
64Ω 2.5"	80
80Ω 2.5"	80
8Ω 5W 7"×4"	250
8Ω 3W 6"×4"	160

ALUM. BOXES

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2¾×5×1½"	75
4×4×1½"	75
4×2¼×1"	75
4×5¼×1½"	100
4×2¼×2"	75
5×4×2"	98
6×4×2"	110
7×5×2½"	185
8×6×3"	185
10×7×3"	210
10×4½×3"	198
12×5×3"	215
12×8×3"	265

OPTO ELECTRONICS

LEDS Plus. Clip

TIL209 Red 125"	13
TIL211 Grn 125"	18
TIL212 Yellow	22
TIL220 .2" Red	15
0.2" Yellow, green and Amber	18
Rectangular LEDS. Red, Green and Yellow	30
2N5777	45
OCP71	120
ORP12	63
LD271 Infra Red (emit)	40
TIL32 Infra Red (emit)	58
SFH205 (detector)	70
TIL78 (detector)	70

OPTO isolators

IL74	48
TIL 111/2 or 117	100

7 Segment Displays (Red Displays)

TIL312 & 313 .3"	105
TIL321 5" C.An	115
TIL322 5" C.th	115
DL704 3" C.Cth	99
DL707 3" C.Anod	99
DL747 .6" An	180
.8" Orange C.A.	250
FND357	120
.3" Green C.A.	150
±1.3" Red or Green	150
Bargraph 10 seg. Red	225

Liquid Crystal Display

3½ digit 875p; 4 digit 975p

VOLTAGE REGULATORS

1A	TO3	+ ve	— ve	
5V	7805	145p	7905	220p
12V	7812	145p	7912	220p
15V	7815	145p		—
18V	7818	145p		—
1A	TO220 Plastic Casing			
5V	7805	60p	7905	65p
12V	7812	60p	7912	65p
15V	7815	60p	7915	65p
18V	7818	60p	7918	65p
24V	7824	60p		
100mA	TO92 Plastic Casing			
5V	78L05	30p	79L05	65p
6V	78L62	30p		—
8V	78L82	30p		—
12V	78L12	30p	79L12	65p
15V	78L15	30p	79L15	65p

CA3085	95	LM323K	625
LM300H	170	LM325N	240
LM305H	140	LM326N	240
LM309K	135	LM327N	270
LM317K	350	LM723	39
78H05 5V/5A	595p	TBA625B	85
UA78HG +5 to +24V 5A	650	TDA1412	120

VEROBOARD

	Pitch 0·1 (copper clad)	0·15 (copper clad)	0·1 (plain)	0·15 (plain)
2½×3¾"	66p	59p	47p	34p
2½×5"	75p	69p	—	39p
3¾×3¾"	75p	—	—	—
3¾×5"	86p	92p	72p	63p
3¾×17"	296p	260p	210p	178p
4¾×17"	387p	—	—	280p

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Spot face cutter	107p	DIP board	326p
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SWITCHES

SLIDE 250V

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

PUSH BUTTON
Spring loaded red button. Latching

SPST on off	65
SPDT C/over	75
DPDT 6 Tag	95

TOGGLE 2A 250V

SPST	32
DPDT	44
4 pole on off	54

SUB-MIN TOGGLE

SP changeover	59
SPST on off	54
SPDT c/off	70
SPDT Biased	85
DPDT 6 tags	70
DPDT C/OFF	79
DPDT Biased	115
3 pole c/over	150

MINIATURE
Non Locking
Push to make 15p Push Break 25
Push to change cover momentary 85p

ROCKER: 5A. 250V. SPST 30p

ROCKER: (white) 5A 250V SP change-over centre off 52p

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

ROCKER: (White) 10A/250V DPDT 85p

ROTARY: "Make-A-Switch" Make your own multiway Switch as required. Shafting assembly has adjustable stop.
Accommodates up to 6 Wafers 90p
Break before make Wafers. Silver contacts. 1 pole/12 way; 2 pole/6 way; 3 pole/4 way; 4 pole/3 way; 6 pole/2 way 59p
Mains DPST Switch to fit 40p
Screen & Spacers 6p

ROTARY: (Adjustable Stop Type)
1 pole/2 to 12 way, 2p/2 to 6 way, 3 pole/2 to 4 way, 4 pole/2 to 3 way 43p

ROTARY: Mains 250V AC, 4 Amp 52p

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1·80MHz	385p	10·7MHz	323p
1·8432MHz	362p	12MHz	392p
2·4576MHz	362p	14·318118M	300p
3·2768MHz	323p	18MHz	323p
4MHz	290p	18·432M	392p
4·032MHz	323p	20MHz	362p
4·433619M	135p	27·648MHz	350p
5·0MHz	365p	48MHz	323p
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16 pin 39p; 40 pin 295p
(DIL Sockets on opp. page)

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(Cannon type)

	Plugs	Sockets	Covers plastic
9 way	85p	110p	—
15 way	112p	160p	125p
25 way	168p	250p	145p
37 way	250p	360p	150p

DIL switches (SPST)

4 way	85p
6 way	98p
8 way	115p

EDGE CONNECTORS
double type

	·1	·156
2×10 way	—	85p
2×15 way	—	99p
2×18 way	115p	120p
2×22 way	130p	135p
2×25 way	149p	160p
2×30 way	170p	—
2×36 way	194p	—
2×40 way	210p	—
2×43 way	232p	—

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6-0-6V 100mA; 9-0-9V 75mA; 12-0-12V 75mA 98p
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12VA: 4·5-1·3A 4·5V-1·3A; 6V-1·2, 215p. 1·2A 12V-·5A 12V-·5A 235p (30p p&p)
24VA: 6V-1·5A 6V-1·5A; 9V-1·2A 9V-1·2A; 12V-1A 12V-1A; 15-·8A 15-·8A; 20V-·6A 20V-·6A 320p (55p p&P)
50VA: 6V-4A 6V-4A; 9V-2·5A 9V-2·5A; 12V-2A 12V-2A; 15V-1·5A 15V-1·5A; 20V-1·2A 20V-1·2A; 25V-1A 25V-1A; 30V-·8A 30V-·8A 365p (60p p&p)
100VA: 12V-4A 12V-4A; 15V-3A 15V-3A; 20V-2·5A 20V-2·5A; 30V-1·5A 30V-1·5A; 40V-1·25A 40V-1·25A; 50V-1A 50V-1A 695p (74p p&p).
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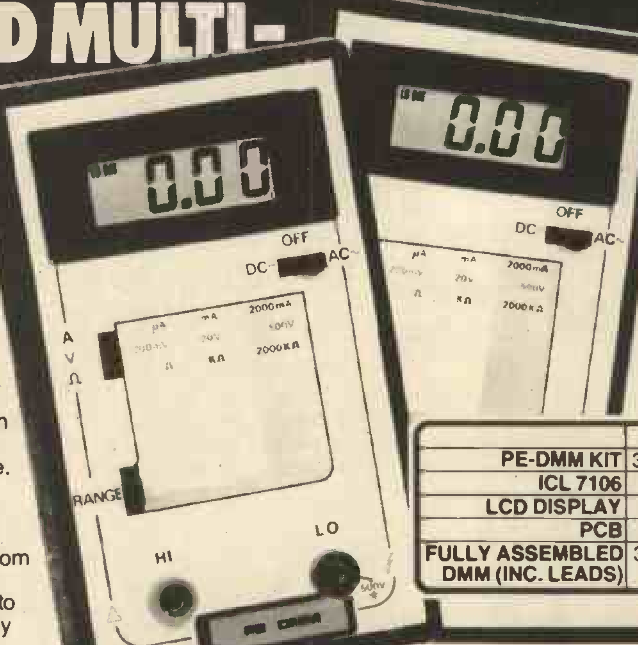

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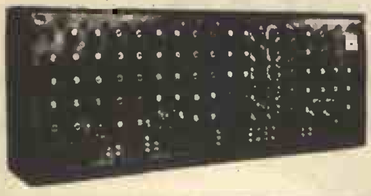

BASIC COMPONENTS SETS include all necessary resistors, capacitors, semiconductors, potentiometers and transformers. Hardware such as cases, sockets, knobs, keyboards, etc. are not included but most of these may be bought separately. Fuller details of kits PCBs and parts are shown in our lists.

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A very advanced unit using sophisticated i.c. techniques instead of mechanical spring lines. The basic delay range of 24 to 90mS can be extended up to 450mS using the extension unit. Further delays can be obtained using more extensions.

Main unit basic comps and PCB (as publ.) KIT 78-3 £55.40

Extension unit basic comps and PCB (as publ.) KIT 78-4 £52.77

Text photocopy 86p

ELEKTOR ANALOGUE REVERB

Using i.c.s instead of spring-lines the main unit has a maximum delay of up to 100mS, and the additional set extends this up to 200mS. May be used in either mono or stereo mode.

Main unit basic component set KIT 83-1 £29.49

Additional Delay basic components KIT 83-2 £20.07

PCB (as publ.) to hold both kits PCB9973 £4.52

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NEW KITS

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Basic comps, PCB (as publ.) KIT 99-1 £9.60

Text photocopy 40p

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Basic comps, PCB (as publ.) KIT 98-1 £5.48

Text photocopy 20p

P.E. SPLIT-PHASE TREMOLO

A simple but effective substitute for a rotary cabinet. The output of an internal generator is phase-split and modulated by an input signal from an electronic guitar or other instrument. Output amplitudes, depth & rate are variable. May be fed to one or two amplifiers.

Basic comps, PCB & chart KIT 102-3 £17.58

Text photocopy 65p

P.E. MINISONIC WAVEFORM CONVERTER

A simple converter that modifies the Minisonic sawtooth waveform to produce triangle and sine outputs. Ideally one should be used with each Minisonic VCO.

Basic comps, PCB & chart KIT 96-1 £3.98

DISCO-CROSS FADER

The cross-fade between 2 decks is switch-initiated and can be preset on the panel for a cross fade rate of between about ½ sec & 24 secs. Basically a stereo unit but may be used in mono.

Basic comps, PCB & chart KIT 94-1 £11.83

P.E. GUITAR MULTIPROCESSOR

An extremely versatile sound processing unit capable of producing, for example, flanging, vibrato, reverb, fuzz and tremolo as well as other fascinating sounds. May be used with most electronic instruments.

Set of basic comps, PCBs & charts (excl. SWs) KIT 85-5 £54.56

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Text photocopy 55p

TREMOLO UNIT

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Basic components, PCB & chart KIT 54-1 £3.74

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A slightly modified and extended version of the P.E. unit.

Basic components, PCB & chart KIT 74-1 £5.19

Text photocopy 39p

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Basic components, PCB & chart KIT 75-1 £6.73

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Basic components, PCB & chart KIT 51-1 £4.93

P.E. AUTO-WAH UNIT

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Basic components, PCB & chart KIT 58-1 £9.68

Text photocopy 58p

ELEKTOR WAVEFORM CONVERTER

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Basic comps, PCB & chart, but excl. sw's KIT 67-1 £9.24

P.E. SWITCHED TONE TREBLE BOOST

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Basic components, PCB & chart KIT 89-1 £4.34

Text photocopy 78p

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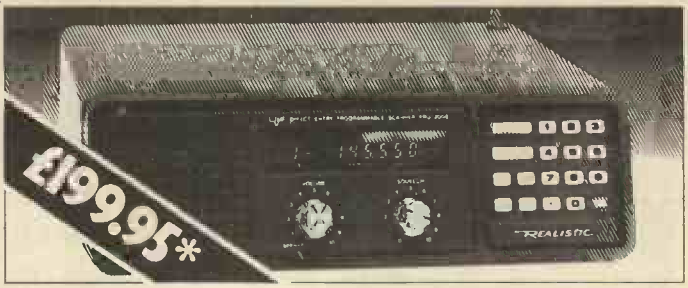

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HEF4002	22	HEF4047	109	HEF4517	478
HEF4006	119	HEF4049	57	HEF4518	118
HEF4007	22	HEF4050	57	HEF4519	69
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HEF4019	58	HEF4072	23	HEF40098	92
HEF4020	112	HEF4073	23	HEF40106	78
HEF4021	107	HEF4075	23	HEF40160	149
HEF4022	103	HEF4076	130	HEF40192	149
HEF4023	22	HEF4077	22		
HEF4024	76	HEF4078	23		
HEF4025	22	HEF4081	23		
HEF4026	244	HEF4082	23		
HEF4027	57	HEF4085	80		
HEF4028	89	HEF4086	80		
HEF4029	113	HEF4093	63		
HEF4030	58	HEF4094	219		
HEF4031	250	HEF4154	208		
HEF4035	138	HEF4502	114		
HEF4040	107	HEF4505	714		
HEF4041	94	HEF4508	230		
HEF4042	83	HEF4510	135		
HEF4043	100	HEF4511	157		

Voltage Regulators

LM309DAIK1	119
UA723CN	42
UA7805CU	78
UA7812CU	78
UA7815CU	78
UA7905CU	97
UA7912CU	97
UA7915CU	97
UA78L05CS	38
UA78L12CS	38
UA78L15CS	38

LINEAR

CA3046	84
CA3080E	77
CA3130E	99
CA3140E	48
CA3189E	283
LM301AN	34
LM339N	78
LM380N	104
LM381AN	198
LM3900N	75
MC3403P	156
NE531	131
NE536T	259
NE555N	28
NE556N	66
NE566N	171
NE570N	485
NE571N	505
RC4136	146
TBA120S	88
TDA1022	713
TDA1034B	239
TL081CP	84
TL084CN	156
UA741CN	20
UA741CT	47

Zener Diodes

400mW C4V7-C33 BZY88/BZX79 ◆ Voltage 9

SEMICONDUCTORS

1N914	5	BC182L	12
1N4001	5	BC184	11
1N4002	5	BC184L	12
1N4004	7	BC212	11
1N4007	9	BC212L	12
1N4148	4	BC214	11
1N5402	15	BC214L	12
2N2369	21	BC547	13
2N2646	46	BC548	11
2N2926G	13	BC549	12
2N3053	19	BC557	15
2N3054	55	BC558	15
2N3055	55	BCY70	15
2N3702	9	BCY71	15
2N3704	9	BD131	39
2N3705	10	BD132	39
2N3773	297	BD139	39
2N3819	22	BD140	39
2N3820	39	BFR80	333
2N3904	9	BFX85	29
2N5457	39	BFY50	17
2N5459	35	BFY51	17
40673	88	BRY39	50
BC107	14	BSX20	21
BC108	14	CL8960	2850
BC108C	14	TIP31	48
BC109	14	TIP32	54
BC109B	19	TIP41C	76
BC109C	20	TIP42C	78
BC148	10	TIP2955	75
BC158	10	TIP3055	60
BC177	17	TIS43	36

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CAPACITORS

Electrolytic Axial — Order Code
−10% to +50% Tol. — Cap 010 ◆ µF

µF \ V	10	25	40	63
1.0				9
1.5				9
2.2				9
3.3				9
4.7				9
6.8			9	10
10		8		10
15	8		9	11
22		8		13
33	8		9	
47		8	11	13
68	9			
100		9	13	
150	9	10		31
220	13		26	36
330			30	40
470		23	32	47
680	21	30	39	54
1000	26	30	59	
1500	35	39		
2200	42			

Polyester Radial Leads — Order Code
Dipped Type, C280/352 Style — Cap 352
Moulded Type, 10.2mm Pitch — Cap 360
◆ Value

µF	352	360	µF	352	360
.001		7	.1	7	9
.0015		7	.15	8	10
.0022	6	7	.22	9	11
.0033	6	7	.33	11	
.0047	6	7	.47	14	
.0068	6	7	.68	17	
.01	6	8	1.0	21	
.015	6	8	1.5	30	
.022	6	8	2.2	35	
.033	6	8			
.047	6	8			
.068	7	8			

Electrolytic Radial Leads — Order Code
−10% to +50% Tol. — Cap 034 ◆ µF

µF \ V	10	16	25	35	40	50	63
.47							7
.68							7
1.0							7
1.5							7
2.2							7
3.3							7
4.7					7		8
6.8			7			8	9
10		7			8		9
15		7	8			9	11
22	7	8			9	11	
33		8	9		11		
47	8	9		11			
68		8	11				
100	9						
150	11						

D.I.L. Sockets

8 Pin Low Profile Socket Tin	12	DIL SKT 8
14 Pin Low Profile Socket Tin	14	DIL SKT 14
16 Pin Low Profile Socket Tin	16	DIL SKT 16

P.C.B. Components

Dalo Pen, Blue Ink, Slow Drying 69

RESISTORS — Order Code

Carbon Film, Fixed

0.25W, E24 Values 1R0-10M, 5% Tol. 100/100 (Mult 10/Value)	2 each	Res RD¼
0.5W, E12 Values 1R0-4M7, 10% Tol.	3 each	Res RD½ ◆ Value

Metal Film, Fixed

0.5W, E24 Values, 5R1-1M, 2% Tol.	8 each	Res MR30
2.5W, E12 Values, 10R-27K, 5% Tol.	16 each	Res PR52 ◆ Value

Metal Glaze, Fixed

0.5W, E24 Values, 1M-33M, 5% Tol.	16 each	Res VR37 ◆ Value

Skeleton Presets, Miniature — Order Code

0.1W, E3 Values, 100R-1M, Lin. Vertical Mounting	8	Min. Preset V
0.1W, E3 Values, 100R-1M, Lin. Horizontal Mount	8	Min. Preset H ◆ Value

Skeleton Presets, Standard

0.3W, E3 Values, 100R-4M7, Lin. Vertical Mounting	11	Std. Preset V
0.3W, E3 Values, 100R-4M7, Lin. Horizontal Mount	11	Std. Preset H ◆ Value

Potentiometer, Rotary

0.5W, E3 Values, 1K-2M2 Lin.	39	Ro Pot Lin
0.25W, E3 Values, 4K7-2M2 Log.	39	Ro Pot Log ◆ Value

Potentiometer, Slider

0.5W, E3 Values, 2K2-470K Lin.	45	Sl Pot Lin
0.25W, E3 Values, 1K0-1M0 Log	48	Sl Pot Log ◆ Value

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MAINS TRANSFORMERS — Order Code

Secondaries may be connected in series or parallel to give wide voltage range
Primaries 0-220, 240V

6VA Clamp Type Construction 235 each
Approx 16% Regulation F C 54, H36, W35

0-4.5V, 0-4.5V Secondaries — Trans 6VA
0-3V, 0-6V
0-12V, 0-12V
0-15V, 0-15V
0-20V, 0-20V

20VA – Clamp Type Construction 360 each
Approx 16% Regulation F C 70, H48, W46

0-4.5V, 0-4.5V Secondaries — Trans 20VA
0-6V, 0-6V
0-12V, 0-12V
0-15V, 0-15V
0-17.5V, 0-17.5V
0-20V, 0-20V

Plastic Boxes — Boss Industrial Mouldings
Moulded Box and Close Fitting Flanged Lid
ABS Box, C/W Brass Bushes, and Lid In Orange

		Order Code
L112 W62 D31	99	Case BIM2003 OR
L150 W80 D50	131	Case BIM2005 OR
L190 W110 D60	223	Case BIM2006 OR

Plastic Boxes with Metal Lids
Recessed Top Box
ABS Base, C/W Brass Bushes, In Orange
1mm Aluminium Top Panel Finished Grey

		Order Code
L85 W56 D29	112	Case BIM4003 OR
L111 W71 D42	150	Case BIM4004 OR
L161 W96 D53	208	Case BIM4005 OR

Diecast Boxes
Diecast Box and Flanged Lid
Aluminium Box and Lid in Natural Finish

		Order Code
L113 W63 D31	120	Case BIM5003 NA
L152 W82 D50	216	Case BIM5005 NA
L192 W113 D61	334	Case BIM5006 NA

VERO ELECTRONICS PRODUCTS

2.5" x 5" .1" pitch Veroboard	71	200-21069J
3.75" x 5" .1" pitch Veroboard	79	200-21072D
2.5" x 1" .1" pitch Veroboard (5)	85/Pack	200-21076C
3.75" x 5" .1" pitch Plain Board	68	200-21078H
5.82" x 2.9" .1" pitch V-Q DIP Board	135	200-21084E
Spot Face Cutter	107	203-21013A
Pin Insertion Tool for .040 type pin	147	203-21015F
DS Pins .040 (100)	44/Pack	200-21087G
SS Pins .040 (100)	44/Pack	200-21017B
Verowire Kit (1-pen, 2-wire, 25-comb)	484/Kit	200-21341D
Verowire Combs (25)	109/Pack	200-21339F
Verowire Wire (2)	109/Pack	200-21340G

SWITCHES — Order Code

Miniature Toggle — Honeywell

SPDT		67	SW 8A1011
SPDT	C/Off	81	SW 8A1021
SPDT	Double Bias To Centre	90	SW 8A1041
DPDT		99	SW 8A2011
DPDT	C/Off	111	SW 8A2021

Miniature Push — C & K

SP	Push To Make, Momentary	62	SW 8531
SP	Push To Break, Momentary	62	SW 8533

G.M.T. ELECTRONICS KITS

FULL TELETEXT KIT (freestanding unit – no internal connection to T.V.)	£199.00
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PAL ENCODER MODULATOR KIT	£ 22.90
DOPPLER RADAR ALARM KIT	£ 44.90
F.E.T. POWER AMPLIFIER OUTPUT MODULE KIT	£ 27-[illegible]
ONE AMP POWER SUPPLY MODULE KIT - FIVE VOLTS	£ 6-00
ONE AMP POWER SUPPLY MODULE KIT - TWELVE VOLTS	£ 7-50
MODEL INERTIA CONTROLLER MK I - SLOT RACER	£ [illegible]-00
MODEL INERTIA CONTROLLER MK II - TRAIN HAND UNIT	£ 25-00
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Superb quality, low noise, low distortion sustain unit equal to the very best commercial models. Suits all guitars. Glassfibre p.c.b.

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You've seen the reviews...you've heard the excitement...now make the kit!

This is the ZX80. 'Personal Computer World' gave it 5 stars for 'excellent value.' Benchmark tests say it's faster than all previous personal computers. And the response from kit enthusiasts has been tremendous.

To help you appreciate its value, the price is shown above with and without VAT. This is so you can compare the ZX80 with competitive kits that don't appear with inclusive prices.

'Excellent value' indeed!

For just £79.95 (*including* VAT and p&p) you get everything you need to build a personal computer at home...PCB, with IC sockets for all ICs; case; leads for direct connection to a cassette recorder and television (black and white or colour); *everything!*

Yet the ZX80 really is a complete, powerful, full-facility computer, matching or surpassing other personal computers at several times the price.

The ZX80 is programmed in BASIC, and you can use it to do quite literally anything from playing chess to managing a business.

The ZX80 is pleasantly straightforward to assemble, using a fine-tipped soldering iron. It immediately proves what a good job you've done; connect it to your TV...link it to an appropriate power source*...and you're ready to go.

Your ZX80 kit contains...
- Printed circuit board, with IC sockets for all ICs.
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- New rugged Sinclair keyboard, touch-sensitive, wipe-clean.
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- FREE course in BASIC programming and user manual.

Optional extras
- Mains adaptor of 600 mA at 9 V DC nominal unregulated (available separately–see coupon).
- Additional memory expansion boards allowing up to 16K bytes RAM. (Extra RAM chips also available–see coupon).

*Use a 600 mA at 9 V DC nominal unregulated mains adaptor. Available from Sinclair if desired (see coupon).

The unique and valuable components of the Sinclair ZX80.

The Sinclair ZX80 is not just another personal computer. Quite apart from its exceptionally low price, the ZX80 has two uniquely advanced components: the Sinclair BASIC interpreter; and the Sinclair teach-yourself BASIC manual.

The unique Sinclair BASIC interpreter offers remarkable programming advantages:
- **Unique 'one-touch' key word entry: the ZX80 eliminates a great deal of tiresome typing. Key words (RUN, PRINT, LIST, etc.) have their own single-key entry.**
- Unique syntax check. Only lines with correct syntax are accepted into programs. A cursor identifies errors immediately. This prevents entry of long and complicated programs with faults only discovered when you try to run them.
- Excellent string-handling capability–takes up to 26 string variables of any length. All strings can undergo all relational tests (e.g. comparison). The ZX80 also has string input–to request a line of text when necessary. Strings do *not* need to be dimensioned.
- Up to 26 single dimension arrays.
- FOR/NEXT loops nested up to 26.
- Variable names of any length.
- BASIC language also handles full Boolean arithmetic, conditional expressions, etc.
- Exceptionally powerful edit facilities, allows modification of existing program lines.
- Randomise function, useful for games and secret codes, as well as more serious applications.
- Timer under program control.
- PEEK and POKE enable entry of machine code instructions. USR causes jump to a user's machine language sub-routine.
- High-resolution graphics with 22 standard graphic symbols.
- All characters printable in reverse under program control.
- Lines of unlimited length.

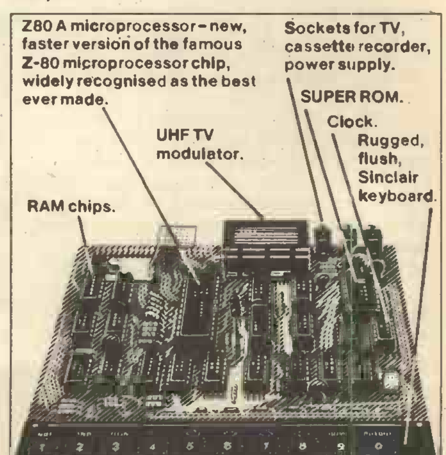
Fewer chips, compact design, volume production–more power per pound!

The ZX80 owes its remarkable low price to its remarkable design: the whole system is packed on to fewer, newer, more powerful and advanced LSI chips. A single SUPER ROM, for instance, contains the BASIC interpreter, the character set, operating system, and monitor. And the ZX80's 1K byte RAM is roughly equivalent to 4K bytes in a conventional computer–typically storing 100 lines of BASIC. (Key words occupy only a single byte.)

The display shows 32 characters by 24 lines.

And Benchmark tests show that the ZX80 is faster than all other personal computers.

No other personal computer offers this unique combination of high capability and low price.



PE VOLUME 16 No. 9 SEPTEMBER 1980

VALUE

NEXT month your copy of PE will cost 65p. Value for money? We think so, but we are operating in one of the few areas of technology which has been characterised by falling prices over the years.

Back in November 1964 (Vol. 1 No. 1) PE was 2/6d or 12½p in modern terms. Next month PE will cost more than five times that price. An Armstrong AM-FM Tuner Amplifier advertised in that first issue cost just £37.10.0 and 37 feet of solder was 5/-; no VAT to add on in those days! So, although the price of technology has fallen, a five times increase on the cover price does not seem wildly out. Add to that the fact that the issues were then a smaller size and yes, we do still think PE is good value.

Fortunately, it would appear that many of you concur with our views as PE has been privileged to boast the highest total sales of any British electronic constructors' magazine for the past three years; we still hold that position. This boast is based on Audit Bureau of Circulation figures of total copies **sold.**

OFFERS

As we have pointed out in the past, we believe our special offers give excellent value for money; this issue carries a double autoranging multimeter offer (page 57) and a corrected re-run of our Casio watch offer. There were some errors in the original Casio offer so we have published corrections and re-run it. If you took advantage of the previous offer, or if you are interested in a Casio watch at discount, turn to page 65.

FREE

Next month you will also get a free *Transistor Identichart* (see page 63) with your issue and November will carry another free chart. We have plenty of exciting projects planned for future issues and are anticipating other special giveaways and offers.

As we have said, PE is number one and we intend to stay there.

RECESSION

The country may be in a period of recession but we believe that this will only increase activity in the hobby electronics field. If you can build a project for half the cost of a commercial unit, it could make all the difference. To those that read more than do, perhaps being forced into something by economics will prove to be very enjoyable.

Even in these dark days when we are regularly fed on the alarming jobless figures and listen with dismay to reports of school leavers without jobs, the electronics industry in general continues to thrive. It is interesting to note that recent issues of such publications as *Computer Weekly* continue to be fat with job advertisements. There is much to encourage youngsters to take up electronics!

Mike Kenward

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Technical Queries

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

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

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

Back Numbers

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

Binders

Binders for PE are available from the same address as back numbers at £4·30 each to UK or overseas addresses, including postage and packing, and VAT where appropriate. Orders should state the year and volume required.

Subscriptions

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

Market Place

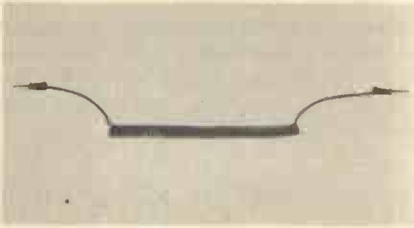
Items mentioned are usually available from electronic equipment and component retailers advertising in this magazine. However, where a full address is given, enquiries and orders should then be made direct to the firm concerned. All quoted prices are those at the time of going to press.

by David Shortland and Jasper Scott

COILY JUMPERS

The range of EZ test hooks, with their 'hypodermic' finger action, has been further extended by coil jumper leads.

To allow greater flexibility of movement, when making test connections, EZ Hooks are being introduced joined by a p.v.c. coil cord—gauge 22SWG 26 × 36—which will expand



from closed position of 180 to 900mm. The various size Hooks (44, 57 and 127mm) are all available in ten colour-coded colours connected by self-coloured cord. Further information on the entire range of EZ Hooks is available from: **British Central Electrical Co. Ltd. (International Division), Unit 10, Carvers Industrial Estate, Southampton Road, Ringwood, Hants. BH24 1JS (04254 4617).**

FABULOUS FRED

A new electronic entertainments centre which looks as if it will be fun for adults as well as children is now available from Optim Toys.

Fabulous Fred incorporates ten different electronic games which use a sound generator as well as a visual display. The nine-note keyboard can be used as a simple organ, and the memory allows tunes of up to 50-note length to be keyed in and played back.

Other games include 'Space Attack', 'Submarine Hunt', and 'Catch the Comet'. 'Baseball' and 'Roulette' are more complicated and involve the use of a board and betting chips.

Fabulous Fred should be available from many toy shops at around £25.

DIRECT TO WIRE

A new Direct to Wire Kit which offers 1,000 connections has been introduced by Verospeed.

Based on the GTH contact patented by BICC-Burndy, the kit includes eight types of connector interlinked with M100 10 way ribbon cable, supplied on two reels, and a selection of pre-stripped ribbon cable in various lengths. Gas tight connections are achieved by direct insertion of tinned, stranded or solid conductors into the contact assemblies, thus precluding the use of noble metals and making considerable cost savings.

The kit offers the Research and Development Engineer the ability to incorporate the same products that are used in production and eliminates the need for value engineering.

Verospeed stock all replacement parts, which are also available individually. The kit is priced at £39·95, and is available direct from: **Verospeed Ltd., Stansted Road, Boyatt Wood, Eastleigh, Hants. SO5 42Y (0703 618525).**

COMPUTER ACCESSORIES

A new microcomputer case which is suitable for the UK101, Superboard and Nascom 2 has just been introduced by Microtype. Known as the Model 3, it succeeds Microtype's previous model and is considerably larger than other cases on the market, with space for expansion boards, fan ventilation or other additions. Made in black ABS plastic, the Model 3 can be sprayed with cellulose based car paints if a different colour is required. A pre-cut keyboard panel is available for UK101, Superboard and Nascom 2 and a blank panel is available for those with 'homebrew' computers.

The price for the Model 3 is £29·90 including VAT and postage.

Also available from Microtype is their Stak-Pak, a very neat cassette filing and storage system which should solve your program storage problems. The Stak-Pak consists of drawer sections in black plastic which lock together to form miniature cabinets of almost any height. Each drawer holds two cassettes and comes complete with index cards as well as two cassettes each loaded with 12 minutes of Agfa tape.

The price for five Stak-Pak drawer sections is £6·60 including VAT & postage.

Microtype, PO Box 104, Hemel Hempstead, Herts. HP2 7QZ.

RECHARGEABLE BATTERIES

If you're fed up with constantly having to replace the batteries in your portable radio or electric shaver, you may be interested to know that a range of rechargeable cells from the Furukawa Battery Co. is now available from Marshalls, together with a range of constant current chargers made by Friemann & Wolf.

The Nickel-Cadmium cells which are of the sealed sintered-plated type come in three different sizes, equivalent to HP7, HP11, and HP2 dry batteries. In normal use, a life of roughly 500 charge/discharge cycles may be expected.

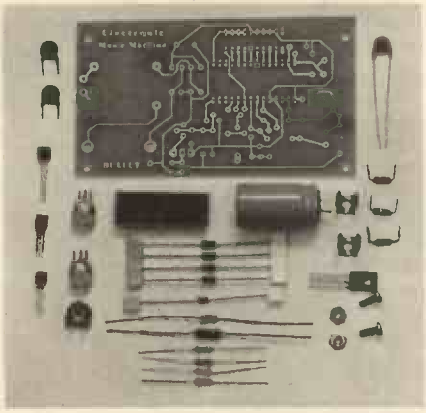
The Friemann & Wolf (FRIWO) chargers are available in two basic types, both being double insulated and meeting SEMCO, NEMCO and DEMCO standards. The smaller of the two, the Penlight 4, accommodates up to four HP7 size cells, and maintains a charge rate of 50mA nominal. All three sizes of cell can be charged using the larger Combibox FW611, and the charge current can be switched from 50mA to 120mA to give overnight recharging for each size.

Prices for the cells and chargers are as follows: S101 (HP7)—£0·98; sub C (HP11)—£1·75; sub D (HP2)—£1·95; Penlight 4—£5·50; Combibox FW611—£13·25. Further information is available from:

A. Marshall (London) Ltd., Kingsgate House, Kingsgate Place, London NW6 4TA.

MACLIN ZAND

Two new kits from Maclin Zand feature an electronic music generator and a sound effects unit. The music generator which can be used as a doorbell, toy or music box is preprogrammed to play 25 songs and three chime sequences. The song memory is an integral part of the chip and therefore cannot be reprogrammed.



The sound effects board has been designed around the SN76477 sound generator and includes a noise generator, VCO, noise filter, mixer, attack/decay circuit, audio amplifier and control circuitry. A prototype area is provided on the p.c.b. for experiments and among the many sounds available are one-shot controls for gun shots, explosions etc., bird sounds, sirens, race car crashes, steam trains, etc.,

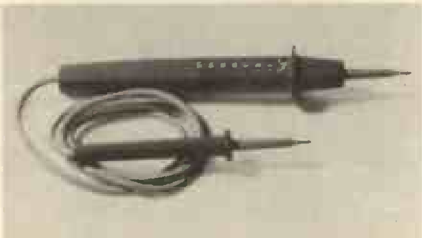
The music generator is priced at £9·95 and the sound effects board is £14·99. Both prices exclude VAT and p&p.

Maclin Zand Ltd., 38 Mount Pleasant, London WC1X 0AP.

DOUBLE POLE TESTER

A range of pocket sized double pole testers is now available from Branco Tools Ltd.

The cheapest of the range is the Volt Check, which indicates a.c. and d.c. voltages between 4·5V and 415V and indicates d.c. polarity. In the middle of the range is the Multi Check which checks continuity between 0 and 20kΩ and the direction of semiconductors, as well as indicating voltages within the same range as that of the Volt Check.



Pictured above is the Master Check, which measures d.c. and a.c. voltages in seven steps from 6V to 415V and indicates polarity. Prices range from £4·30 for the Volt Check to £14·24 for the Master Check. Further information on the whole range of testers is available from:

Branco Tools Ltd., 7 Birchway, Prestbury, Cheshire SK10 4BD (0625 828478).

FUEL METERS

Two new petrol consumption meters are now available from Enviro-Systems in kit form. The FSX20 provides a system which will give an instantaneous digital readout of MPG, with a choice of two update frequencies to suit individual driving conditions, automatic clear-down under idling and simple owner calibration facility, which means the system is suitable for most vehicles with carburettor fuel systems and cable driven speedometer. A petrol injection option is available to compensate for fuel returned to the tank.

The FSX10 provides a total gallons used read-out, and the overall fuel consumed with the average MPG. This kit requires a fuel sensor input only.

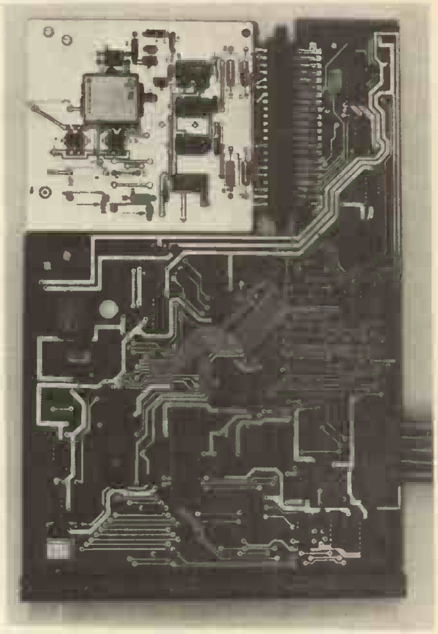
Both kits are suitable for 12V negative earth vehicles only and come complete with digital transducers, p.c.b.s and all components. Construction and installation instructions are provided and a technical back-up service is available.

The FSX20 is priced at £47·50, the FSX10 is £34·80 and the petrol injection option is £65·90.

Enviro-Systems, Hampsfell Road, Grange-over-Sands, Cumbria LA11 6BE.

NASCOM MEMORY

Microdata Computers are now offering a combined bubble memory and real time clock board which can be plugged into the standard 77-way NASBUS. The capacity is 92,304 bits and the initialisation routines and operating system are supplied in a 2708 EPROM. They may be relocated anywhere within the RAM area and will operate with the NAS-SYS, T2, T4 and B-Bug monitors. Organised as 144 minor loops of 641 bits each, the average access time to the first bit of data is 4 milliseconds.



The real time clock has a deac battery back up, the capacity is sufficient to power the CMOS clock chip for approximately 12 months in the absence of system power.

The price of the complete board is £750 excluding VAT and p&p.

Microdata Computers Limited, Belvedere Works, Bilton Way, Pump Lane, Hayes, Middlesex.

SUPERPET

Commodore's new '8000 Series' system which has been nick-named the SUPERPET, consists of an 80-column version of the popular 32K PET. Text editing and report formating are faster and easier with the new wide screen display and the 8032 provides a resident operating system with expanded commands and functions for arithmetic, editing and disk management. For data input/output applications, an 8-bit parallel Port and an IEEE-488 instrumentation bus are provided. The 8032 includes a 73-key full business style keyboard and is priced at £895 plus VAT.

Also available is the new 8050 dual drive floppy disk which has been designed to complement the 8032. The 8050 incorporates all the existing features of the current disk unit, but provides more powerful software capabilities and a one megabyte capacity.

The 8050 which is priced at £895 plus VAT utilises five ¼" diskettes and Micropolis drives.

Commodore Business Machines Limited, Information Centre, 360 Euston Road, London (01-388 5702).

Semiconductor UPDATE...

FEATURING NSC800 74LS610 MA537

R. W. Coles

COMPATIBLE MICRO (NSC 800)

All you microprocessor fans who have plumped for the Intel 8080 family as your "pin-up" chip, need not worry about the obsolescence of all that hardware and software knowledge you have amassed. Many of you may have already upgraded to the Z80 processor from Zilog, and gained those by now well-known benefits of a more powerful instruction set, more CPU registers, and on-chip refresh for dynamic memories. Going from the 8080 to the Z80 is easy because the 8080 instructions are a sub-set of the Z80 codes and most 8080 programs will run immediately on the Z80 with no alterations, an important advantage while system software is costing more than system hardware in many situations.

Intel's own improved 8080, the 8085, takes a different line by keeping an almost identical instruction set with only limited enhancements while reducing system hardware complexity and the need for peripheral devices by providing more "on-chip" functions such as clock oscillator, bus controller, serial I/O, and several levels of direct-vector interrupt inputs. The 8085 also runs from a single 5 volt supply, like the Z80 but unlike the 8080, and it runs faster than both the 8080 and the Z80. The extra on-chip functions provided by the 8085 need extra pins which are not normally available within the limitations of a 40 pin package. Intel solved this problem by multiplexing the 8 data bus lines so that they also carry the 8 low order address bits during certain sections of an instruction cycle, as flagged by the ALE (Address Latch Enable) output. The L in ALE means, of course, that the availability of address information on the bus for only a limited period has to be overcome by latching this information externally. This need is normally satisfied by the use of special 8085 peripheral chips such as the 8155 RAM/IO/TIMER chip, and the 8355 ROM/IO chip which have internal address latches.

In short, you have a choice for 8080 upgrade. Choose either the big system power of the Z80 or the compact simplicity of the 8085 and its multiplexed bus.

Well, anyway, you *did* have to choose until recently, before National introduced the NSC800, a chip which must make all '80 fans drool with anticipation! Taking compatibility one stage further, National have made their new processor emulate *both* the 8085 *and* the Z80 by combining the power of Z80 instruction set with the simplicity of the 8085 bus. As if that in itself were not sufficient, National have also made other improvements to rectify some of the difficiencies of it's ancestors.

The most fundamental change is in the semiconductor technology used, NMOS for the 8080, Z80, and 8085 and a new CMOS process called P²CMOS for the NSC800. The advantage here is the wide supply voltage range possible (3 to 12 volts) and the very low power consumption which makes battery operation a real possibility. Despite its low power consumption the new chip will run as fast as the Z80 even to the extent of having a 4MHZ high speed version, the NSC800A which equates to the Z80A.

One problem with the Z80 is that the useful on-chip refresh for dynamic memories has only a 7-bit counter, and this makes it difficult to use with the coming generation of 64K RAMs which need 8 bits. The NSC800 overcomes this shortcoming by providing the eighth bit.

So far as I know, this device is not widely available yet, but when it is, it must surely become the eighth bit standard for future designs.

MAP CHIP

Still on the subject of microprocessors, it seems that the 64K address space of most micros, which has always seemed so huge that one could never imagine having the funds to fill it, is about to become *too small!*

The reason is that memory is getting cheaper and cheaper, and soon it will take just eight 16 pin chips to give a system all the memory it can address, thanks to the 64K dynamic RAM devices now becoming available from Motorola, Texas Instruments and others. The effects this plentiful memory will have on system software and programming in general will be far-reaching, but down at the hardware level there will be the problem of how to address more than that restrictive 64K.

One possible solution is now available from Texas instruments in the form of a family of "Memory-mapper" devices which can be used to increase the memory space of, say, a 6800 or 8080 microprocessor to an incredible 16 megabytes! Now even if 64K RAM chips drop in price to £10 each, a quick sum reveals that to fill that space you would need to raise over £20,000 for memory alone, so it seems likely that the problem has been solved for all time!

The new devices, part of the Low Power Shottky TTL family and coded 74LS610 to 74LS613, provide an extra eight bits of addressing to give a total of 24 for most micros. Address expansion is achieved by using the top four bits of the standard address bus to select one of sixteen twelve bit registers within the map chip. The contents of the selected register provide twelve further address bits to give the total of twenty-four required, effectively splitting the memory map up into 4096 pages each of 4096 words. The registers within the mapper have to be loaded under software control of course, and this makes the expansion scheme less "transparent" to the programmer than a conventional twenty-four bit address counter. Since most programmers interact with their system via system software, however, this need not be a problem in day to day usage. A likely technique would be to load the registers with the addresses of consecutive 4K blocks to provide a single 64K 'Environment'. When more memory is needed, for a second user for example, system software would reload the registers to access further 64K blocks. A total of 256 blocks are available, although it is most unlikely that all this space would be needed in any practical system.

The attraction of these devices is really that they will allow the upgrading of an "old fashioned" eight bit system to suit future system software. Whether it will be better to throw the old eight bit chips away and go for one of the new sixteen bit devices such as the Z8000 or the 8086 which can already access more memory via an expanded address counter, remains to be seen.

The new devices run from standard TTL supplies and are housed in forty pin packages.

BIG IMAGE (MA537)

I realize that my offerings so far this month are not the sort of devices which the average reader is likely to be able to (or want to!) rush out and buy just yet. My final offering is even more exotic I am afraid, but nevertheless it does provide a fascinating glimpse of the capabilities of a British electronics firm, and a hint of what the future holds for us. After all, today's exotic device is tomorrow's 'jelly-bean' part!

The device in question is made by GEC and coded the MA537, and it is a complete solid state TV image sensor in a very tiny package. On the face of it, it appears that this device opens the door to tiny video cameras no bigger than, say, an instamatic, with full 625 line capability and a performance approaching that of conventional camera tubes. Combine a device such as with the LED and LCD image displays currently under development, and it seems likely that the whole concept of television and home video recording will be revolutionised within the next decade.

The MA537 is a CCD or 'Charge Coupled Device' image sensor which has an 8·5mm by 6·4mm sensor surface covered with an array of 576 by 385 photo detectors, all on one chip of silicon. The chip is split into two roughly equal sections, one being used for image sensing and the other half for storage. The image sensor provides a basic Z88 line picture, with each line resolvable into 385 'pixels' or picture points, but by means of an ingenious trick with the clocking of the CCD image registers the number of lines is effectively doubled to provide compatibility with the interlaced 575 line image used in the so-called 625 line system. (The other lines are never displayed and form part of the field blanking interval.) The store half of the array is also photo sensitive but is normally shielded from any illumination and used as a buffer to aid the transfer of data out of the device. Left unshielded, however, it can be used to provide a full-frame mode for enhanced resolution in special applications. In the normal mode, line image information is shifted out via a 400 element CCD analogue shift register, the extra 15 elements being available to provide a black reference level for each line.

The MA537 is packaged in a 30 pin flatpack and would probably cost an arm and a leg at present, but come the revolution . . .

Nice try G.E.C., but now how about a colour version?

Countdown

Edtech Aug. 19–21. Holland Park School, London. **C1**
Personal Computer World Show Sept. 4–6 Cunard Hotel, Hammersmith, London. **M**
Laboratory Sept. 9–11. Grosvenor Ho., Park Lane, London. **E**
Intron 80 Sept. 9–11. RDS, Simmonscourt Pavilion, Dublin. **V**
West of England Electronics Exhibition Sept. 9–11. Bristol Exhibition Centre. **Q**
Electrathon (Lucas battery vehicle race) Sept. 13, 1980. Fashioned on last year's event, this "whispering Grand Prix" is a contest for *home made* electric vehicles. It will again be held at Donington Park Race Circuit, nr. Derby. Details: ✆ 021-554 5252.
Avionics (symposium) Sept. University of Surrey. **S1**
Emix (Electronic Measuring Instruments Exhibition) Sept. 30, Oct. 1–2. Post House Hotel, Southampton. **I**
BEX (Business Equipment Exhibition) Oct. 1–2. The Guildhall, Plymouth. **K**
Emix Oct. 7–8. Centre Hotel, Newcastle. **I**
Emix Oct. 14–15. Guildhall, Cambridge. **I**
Drive Electric October 14–17. Wembley Conf. Centre, London. organiser: ✆ 01-834 2333.
BEX Oct. 15–16. Assembly Rooms, Edinburgh. **K**
Engineering Ireland Oct. 15–18. Leopardstown Exhibition Centre. **V**
Testmex (exhibition and conference) Oct. 28–30. Wembley Conference Centre. **T**
Viewdata Exhibition for Professional & Business People Oct. 29–31. West Centre Hotel, London. **Z1**
Compec Nov. 4–6, Olympia. **Z1**
BEX Nov. 5–6. Sophia Gardens, Cardiff. **K**
Semiconductor International 80 Nov. 25–27. Metropole Convention Centre. **T1**
Breadboard Nov. 26–30. Royal Horticultural Halls, Westminster. **T**
Microsystems 81 (exhibition and conference) March 11–13, Wembley Conference Centre, London. **Z1**
Inspex 1981 March 16–20. NEC Birmingham. **Z1**
Computer Graphics 1981 April 28–30. The Barbican Centre, London **O**
Entertainment 81 May 9–17 (weekly mornings trade only). NEC Birmingham. **B2**
Components 81 (Electronic Components Industry Fair) June 9–12, 1981. Earls Court, London. This show will alternate yearly with *Electronics*, now the IEA amalgamation with Electrex has ceased. **I**
Solar Energy Exhibition Aug. 23–28, 1981. Brighton. **M**
International Business Show 1981 October 20–29. NEC Birmingham. **A2**
Electronics 82 (formerly IEA, but now sub-titled International Electronics, Control and Instruments Exhibition) May 24–28, 1982. NEC. This show will alternate yearly with *Components* now that the IEA/Electrex amalgamation has ceased. **I**

E Evan Steadman. ✆ 0799 22612
I ITF. ✆ 021-705 6707
K Douglas Temple Studios, 1046 Old Christchurch Rd., Bournemouth.
M Montbuild. ✆ 01-486 1951
O Online Conferences. ✆ 0895 39262
Q Exhibitions For Industry Ltd. ✆ 08833-4371
T Trident International Exhibitions. ✆ 0822 4671
V SDL Exhibitions, 68 Fitzwilliam Square, Dublin, Ireland.
C1 Stereoscopic Television Ltd., 41/43 Charlbert St., St. John's Wood, London NW8 6JN. ✆ 01-722 4139
S1 Society of Electronics & Radio Technicians, 57–61 Newington Causeway, London SE1 6BL. ✆ 01-403 2351
T1 Kiver Communications U.K., Millbank House, 171/185 Ewell Road, Surbiton, Surrey KT6 6AX
Z1 IPC Exhibitions Ltd., 40 Bowling Green Lane, London EC1R 0NE. ✆ 01-837 3636
A2 Hart Browne & Curtis Ltd., 29 Sackville Street, Piccadilly, London W1X 1DB. ✆ 01-439 8556
B2 Brintex Exhibitions Ltd., 178–202 Great Portland Street, London W1N 6NH. ✆ 01-637 2400

POINTS ARISING

ACORN REVIEW *(August 1980)*

Acorn Computers Limited are the suppliers of the Acorn modular system, peripherals and software reviewed last month. Science of Cambridge are not connected with this product and were incorrectly referred to. We apologise for any inconvenience caused.

COMPUKIT UPDATE *(June 1980)*

There is an error in Fig. 1 showing the software Baud rate circuit around IC57. RTS from IC14, pin 5, should go to IC57 pin 5 and *not* pin 4. On IC57, pins 3, 4 and 6 go to 0V.

P.E. DMM *(July 80)*

In Fig. 5 the component overlay shows R6, 7, 8 (lower left) incorrectly numbered. They should be R9, 10, 11 respectively.

MICROPROMPT *(July 1980)*

Line 40 in Le Passe-Temps should read: **DIMS (44)**, etc., Line 830 should read: **T(I) = T(I)** + etc.,

CONSTANT CURRENT SOURCES *(August 1980)*

There are some ommisions in Fig. 4. D9 and D13 are BZY 88s, D10 is a BZY 88 5V1. TR2 is a 2N3055 and C4 is 100n.

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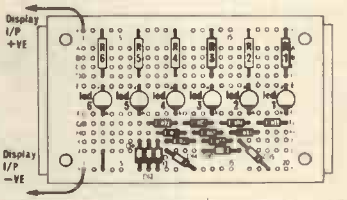

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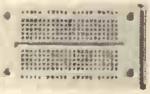
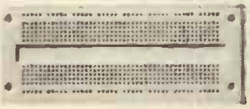
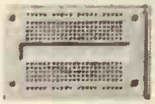


EXP 300 £5.75 The most widely bought bread-board in the UK. With 550 contact points, two 40 point bus-bars, the EXP 300 will accept any size IC and up to 6 x 14 pin DIPS. Use this breadboard with Adventures in Microelectronics.

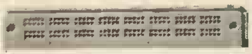
EXP 600 £6.30 Most MICROPROCESSOR projects in magazines and educational books are built on the EXP 600.



EXP 650 £3.60 Has ·6" centre spacing so is perfect for MICROPROCESSOR applications.



EXP 4B £2.30 Four more bus-bars in "snap-on" unit.



The above prices are exclusive of P&P and 15% VAT.

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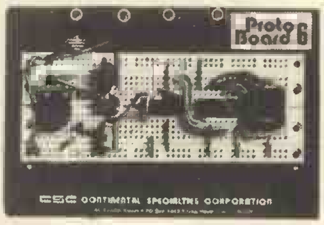

PB6 Kit, 630 contacts, four 5-way binding posts accepts up to six 14-pin Dips.

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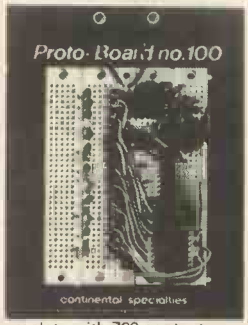

PB 100 Kit complete with 760 contacts accepts up to ten 14-pin Dips, with two binding posts and sturdy base. Large capacity with Kit economy.

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INDUSTRY NOTEBOOK

By Nexus

Climatic Change

After more than a year of Conservative government led by Mrs Thatcher there is still plenty of opportunity and, indeed, reason for vigorous debate in her economic policy and where it is leading. And not least in industry in general and the electronics industry in particular.

Electronics companies are having mixed results. Some are doing well, some less well. But this has always been the case whatever government has been in power. Of course trading conditions are tough and are likely to worsen. All the more reason to work harder to succeed. It is fact, not fancy, that hard working companies staffed by well motivated people have succeeded through good times and bad, and under Labour as well as Conservative governments. Racal and GEC are two prime examples.

What Mrs Thatcher and her colleagues are attempting is to change the attitude of organisations and people. To encourage them to face a real world rather than a dream world. Of course it is a tough policy and very unpleasant medicine.

It may not succeed. There are plenty of people about who hope it won't, some actively working against the policy. There are signs, however, that despite the nasty medicine and its direct and side effects, the majority believe it needs taking in the hope of a cure.

Subsidies

One of the attitudes which the Government is attempting to change is that of the begging bowl. It has long been my conviction that the practice of direct government hand-outs has done more harm than good to the electronics industry. It has always encouraged sloth. Why spend your own time and money on developing a new product when a government has promised to support it?

So the long delays start, fatal in a fast-moving industry like electronics. First the debate on the amount, then the allocation of funds (too little, too late is always the industry response), the formation of committees, further debate, the start of the programme, the work put in hand, by which time the market has been missed.

This is not to say that private venture, putting your money where your mouth is, is universally successful. There is the sad story of Martello, the privately developed long range three-dimensional defence radar from Marconi Radar Systems. This was a contender for the NATO installations in Scotland. The NATO nations in this case were paymasters and, looking for the best buy, chose a US General Electric system as meeting all the technical requirements at the lowest cost. Marconi investment in Martello has been reported as being £10 million and, as Martello sales prospects are now bleak, it looks as if Marconi Radar will lose money as well as prestige on the project.

The reaction was predictable. Cries of 'foul' from Marconi Radar. Hidden subsidies were suggested from the US Government who had largely or totally paid for the radar development and had already ordered similar models to equip a US Air Force radar chain in Alaska.

And yet within the same GEC-Marconi Electronics group of companies there is brisk overseas trade with, for example, the Clansman military radio funded entirely in its development and early production phases by the British taxpayer through the Ministry of Defence. There are plenty of other Ministry-funded projects in the Group which will be offered at attractive prices to overseas buyers. Even a version of the new air interception radar now in an advanced development stage for the Royal Air Force air-superiority F2 Tornado fighter.

When we look at Plessey we find not only more Clansman radios of Plessey manufacture going overseas but also versions of multi-million pound Ptarmigan military truck radio and Wavell data processing systems on offer, all funded from public money.

The fact is that we all play the same games and you can't win 'em all. Martello was a private gamble that so far hasn't come off.

In respect of subsidies in general the so-called 'hidden' subsidy of defence equipment funding has been of great benefit to the electronics industry. Defence electronics has always been the forcing ground for advanced technology since the initiation of radar development in the late 1930s. Anyone privileged to see the avionics fit of the Tornado aircraft, or the Mk2 maritime reconnaissance Nimrod or airborne early warning (AEW) Nimrod can see this is as true today as ever it was.

Such projects, distasteful as they may be in some circles, keep the Marconi's, Plesseys, Ferrantis and Cossors in the forefront of electronic skills and large scale project management and are a far more effective way of supporting the industry than the direct subsidy. At the end of the day you at least see something for your money and with good prospects of overseas sales to friendly countries.

Racal-Decca

When David Elsbury joined Racal as a line test engineer back in 1956, straight out of national service in the Royal Air Force, he may have been ambitious but he could hardly have dreamed that one day he would be Chairman and Chief Executive of the Decca Group, now re-named Racal-Decca.

Elsbury, still a young 44-year-old, has long been tipped as the natural successor to Ernest Harrison who has led Racal to the top ranks in electronics with an unparalleled growth and export record. Now he is faced with the most challenging task of his career. Can Elsbury inject Racal go-go into ailing Decca? A spectacular instant turnround of fortune cannot be expected. But Elsbury-watchers, including Harrison himself, have every confidence that he can and will succeed.

Dave Elsbury's move to his new office at Chessington has opened the way to further well-deserved promotion for other Racal stars such as Gerry Whent and Bill Blake within Racal Tacticom and Racal Communications.

Among the flood of recent Racal announcements one is deserving of special mention. This is Racal-Redac's entry into the MPU business. Up to now Racal-Redac's computer-aided design (CAD) systems have been based on bought-in computers married to Racal-Redac software. The new low-cost (£20,000) Cadet printed circuit board design system is based on microprocessors and will be built entirely in-house. Such is the confidence of Eric Wolfendale, Racal-Redac's managing director, that he has put down a production line for 250 systems, an unprecedented figure for this type of equipment.

Plessey Success

Plessey Semiconductors, often the subject of ridicule in the past, had a record year in 1979/80 with 47 per cent increase in sales and excellent growth in the U.S.A. and Japanese markets. Almost 50 per cent of all production is now exported as a result of an intensive export drive. Turnover, at £19 million, is still modest by world semiconductor industry standards but an increase to £25 million in the current financial year has been forecast by a newly confident Ken Bradshaw, sales director.

Plessey Semiconductors will get some extra business through an agreement with the Canadian company Mitel on manufacture of ISO-CMOS circuits, as will GEC-Marconi. The ISO-DMOS integrated circuit is a refinement of CMOS and is particularly applicable to the telecommunications industry. The BPO has set up a pilot plant at the Telecom Research Centre and will establish an industry standard for the devices. While it is understood that main production from Marconi and Plessey will be for Britain's telephone network there will also be applications in other equipment for general sale.

DISCO DESK

THIS series describes a discotheque control desk intended for use with high power, high fidelity sound systems. Whilst it is primarily intended for mobile work, it is also eminently suited to permanent installation in clubs, and can be readily modified for recording and broadcasting, e.g: Hospital radio.

BLOCK DIAGRAM

Referring to Fig. 1, the disc signal is equalised in two stages in order to achieve an excellent overload margin, good noise performance and low distortion. The disc input stage provides moderate gain and RIAA cut. VR_A doubles as an output attenuator and as a preset balance control. After the mode selection switch and crossfader, RIAA bass boost is applied to the signal. The line signal does not require this boost and it would normally be necessary to operate an 'RIAA equalisation cancel' switch whilst crossfading from a disc to a line source. This can be an awkward operation under the pressure of a live performance, therefore the line input features RIAA bass cut, which eliminates the need for such a switch. The line input is buffered and applied to the mode switch via a fader and a passive equalisation network, which closely matches the bass portion of the RIAA record characteristic. The use of two stage disc equalisation and preamplification ensures that the op-amps always have plenty of loop gain, hence ensuring low distortion.

Part 1

BEN DUNCAN

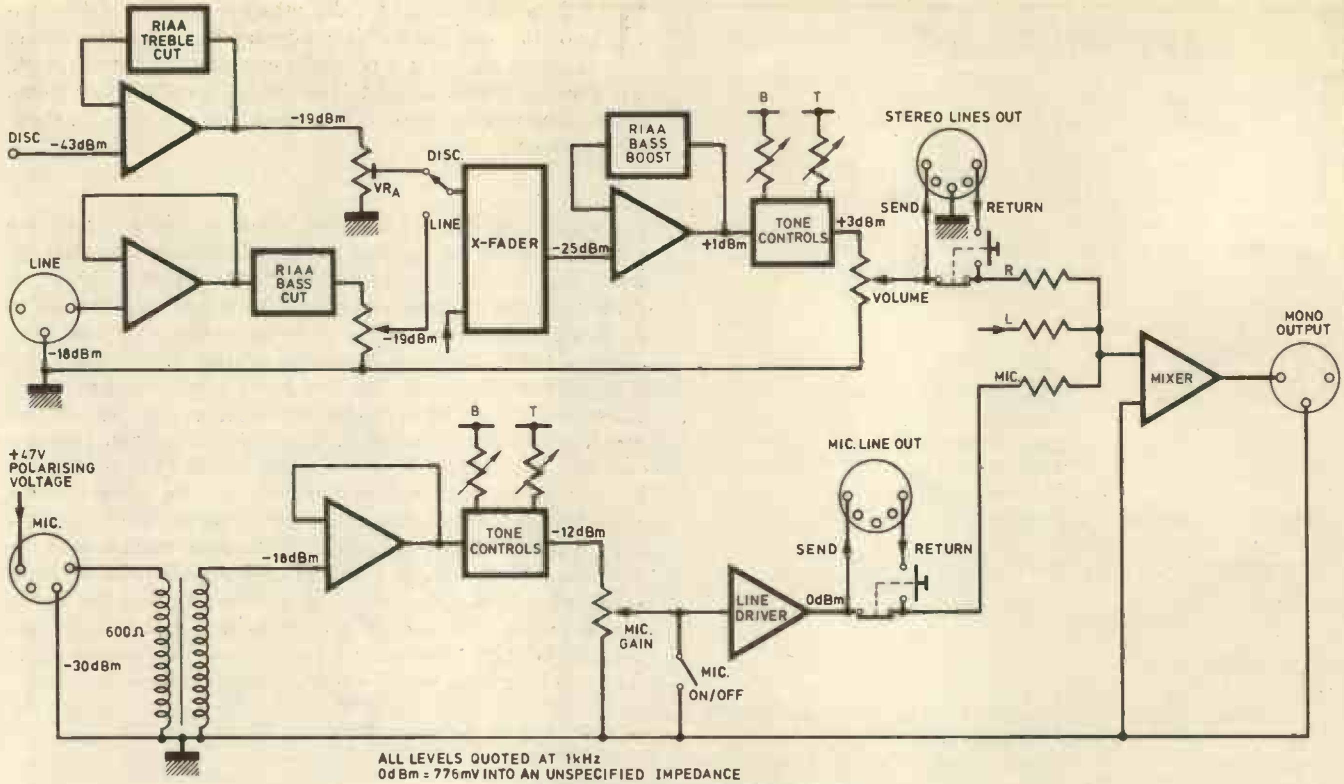
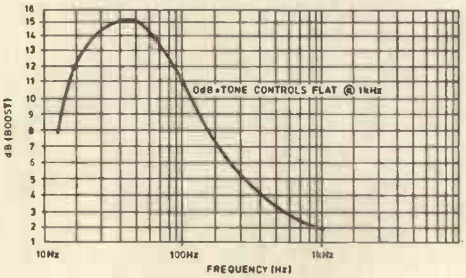


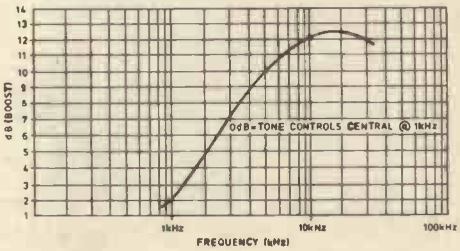
Fig. 1. Block diagram of main circuitry

In a design of this nature, the tone control characteristics can be emphatic without embarrassing consequences. For instance, the very low hum level makes possible a bass boost characteristic which approximately compensates for typical loudspeaker deficiencies. This permits the reproduction of low bass at lifelike levels, assuming that suitable loudspeakers and low rumble turntables are available. The plentiful bass boost is also helpful when 'thin' recordings are encountered; EP singles are often lacking in the lowest bass notes. The bass boost curve rolls off sharply below the audio band in order to minimise the amplification of rumble. Further rumble filtering is provided in the preceding stage. The treble control provides moderate boost and cut over a wide band of frequencies, without excessive midrange or high treble boost. The commonly encountered 20dB boost at 18kHz is simply not required in a good sound system, and readily causes amplifier or horn overload and 'tinny' treble; deficiencies above 10kHz usually indicate worn discs or stylii, or an inadequate loudspeaker system. Most of the distortion in the disc and line channels is generated in this stage.

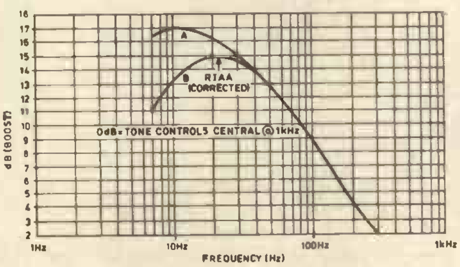
The tone control stage feeds the send-return socket via the volume control. In its normal position, the send-return switch allows the signal to pass directly to the mono output, via the mixer, and also out of the 'send' pins on the socket. Thus both mono and stereo outputs are provided simultaneously. Depressing the send-return switch forces the signal to pass via auxiliary equipment and allows the signal to return by closing the switch in series with the 'return' pins on the send-return socket. Finally, the stereo music lines are mixed down to mono, together with the microphone signal, by a unity gain mixer.



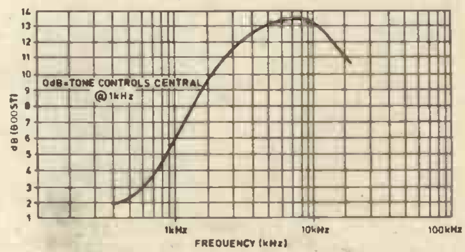
(Left) Mic bass boost curve
(Right) Disc treble boost curve



Response Curves



(Left) Disc bass boost curve
(Right) Mic treble boost curve



SPECIFICATIONS

Disc

Input impedance	47k
Sensitivity $\pm\frac{1}{2}$dB	−43dBm at 1kHz ref 0dBm out (5·5mV)
Hum	−80dB, unweighted
Noise	−70dB, unweighted, 20Hz to 20kHz
Frequency response	12Hz–25kHz at −3dB points
Input overload margin 41dB	
Distortion, harmonic at +10dBm,	30Hz—0·06%
	1kHz—0·01%
	10kHz—0·03%

Line inputs

Input impedance	100k
Sensitivity $\pm\frac{1}{2}$dB	−18dBm at 1kHz ref. 0dBm out (100mV)
Hum	−105dB unweighted
Noise	−76dB, unweighted, 20Hz to 20kHz, 600 ohm input load
Frequency response	30Hz–50kHz at −3dB points
Input overload margin 38dB	
Distortion, harmonic at +10dBm,	30Hz—0·06%
	1kHz—0·008%
	10kHz—0·03%

Microphone

Input impedance	600 ohms
Sensitivity	−30dBm at 1kHz ref. 0dBm out (25mV)
Hum	−93dB, unweighted
Noise	−80dB (unweighted), 20Hz–20kHz, 200 ohm input load
Frequency response	32Hz–22kHz at −3dB points
Input overload margin −40dB	
Distortion, Harmonic at +10dBm,	30Hz—0·01%
	1kHz—0·02%
	10kHz—0·1%

General

Slew rate, all stages	⩾5·5V/µs
Distortion, any input,	⩽0·1% at 10dBm, 30Hz–18kHz
Output clip level	+20dBm

Mono and mic outputs provide 0dBm at 100 ohm source impedance and will drive 600 ohm lines at +20dBm

Stereo lines provide 0dBm at 350 ohm source impedance

Tone controls & RIAA equalisation matched to within $\frac{1}{2}$dB

0dBm = 776mV into an unspecified impedance

COMPONENTS

Card 1

Resistors

R1–4	47k
R5–8	7k5
R9–12	470R
R13–16	560R
R17–20	100k

(All $\frac{1}{2}$ watt *metal oxide*, 2%)

Potentiometers

VR1–4	22k enclosed cermet (RS components type 186–198)
VR5–8	1k dual log (Rivlin CS60 type, Maplin order code HB 00A)

Capacitors

C1–4	1µ polycarbonate
C5–8	22p ceramic
C9–12	10n polycarbonate
C13–16	6n8 polycarbonate
C17–20	680n polycarbonate
C21–24	22µ 25V PC mounting electrolytic
C25–28	470n polyester, C 280AE series
C29–32	22p ceramic
C33–36	18n polycarbonate
C37–38	100µ, 40V axial electrolytic
C39–40	100n polyester, C280AE series

Semiconductors

IC1–IC8 NE5534N or NE5534AN, 8 pin d.i.l. version

Miscellaneous

SKT1, 2—XLR 3 pin female sockets (Maplin BW90X)
SW1, 2—Miniature toggles (RS components type 316–973)
"Copper-clad single-sided epoxy-glass p.c.b. board incorporating 0·1" pitch edge connector (RS type 434–150)
8 × 8 pin d.i.l. sockets
185 × 90mm aluminium screen, 22 s.w.g.

Facilities and functions (see numbered photo)

Music

Two stereo disc inputs from internal turntables A & B **(1–2)**
A+B line and disc inputs selected by rotary switches **(A&B)**
Two stereo line inputs from female XLR's A & B **(3–4)**
Internal preset disc balance controls
Line input level controls **(5–6)**
Line input earth-isolation switches **(7–8)**
Slider crossfading between line & disc in any of 4 combinations **(9)**
Bass, treble and volume controls **(10–12)**
Music send-return socket provides stereo lines at 0dBm **(13)**
Music send-return switch activates stereo return for insertion of graphic equalisers, limiters, expanders, etc. **(14)**
Music 'cancel' switch for audience participation and emergency announcements **(15)**

Microphone

Capacitor microphone input (Readily modified for moving coil microphones) from female XLR **(16)**
Bass and treble controls specially contoured for vocal applications **(17–18)**
Microphone gain control and on-off switch **(19–20)**
XLR send-return socket providing (mono) microphone output at 0dBm for routing to vocals amplifier **(21)**
Microphone send-return switch activates return for insertion of graphic equaliser, special effects, etc **(22)**

Output

XLR mono output from stereo lines and microphone line via a unity gain mixer. This output can be exclusively microphone *or* music if required, by depressing appropriate send-return switch. Also XLR stereo music output. **(23)**

Auxiliary

Output and PFL monitoring, the latter switchable to all music inputs **(24–25)**
Monitor level control **(26)**
4 watts into 4 ohms monitor amplifier, for phones or monitor speaker, with short circuit and thermal protection **(27)**
A & B cueing indicators (yellow panel l.e.d.s) illuminate when disc modulation begins or line input exceeds an equivalent threshold **(28–29)**
Left and Right peak indicators (Red panel l.e.d.s) are set to illuminate at the nominal r.m.s. input level of the systems power **(30–31)**, e.g: 500mV, whilst VU meters provide the desk 0dB reference across the stereo lines **(32–33)**
Autofader on-off switch and locking panel-presets for depth, rate and sensitivity adjustments **(34–37)**
Remote push button turntable start switches and turntable lamp switches. Jack socket sound-to-light modulator output **(38–42)**
High reliability remote power supply with comprehensive protection.

MICROPHONE CHANNEL

The microphone input is designed for the Calrec CM654 capacitor microphone but input stage modifications are given to cover the majority of moving coil and capacitor microphones, including those which are balanced or phantom powered. A good vocals microphone is essential for discotheque applications, where 'close miking' is the rule. All cardiod microphones provide strongly accentuated low bass under these conditions. Windshields help, but microphones intended for vocal applications often incorporate compensation for 'close miking'. This virtually eliminates 'pop' and other explosive breath sounds and minimises the input transformer's overload margin requirements. A discotheque microphone may also be required to handle SPLs in excess of 100dB if the operator shouts; capacitor microphones are particularly suited to handling high SPLs with low distortion.

Most of the distortion in the microphone channel is generated by the input transformer, but it is predominantly 2nd harmonic and quite inaudible under normal conditions. The input stage has unity gain in order to avoid overloading the tone control stage, bearing in mind the high outputs produced by close miking. The tone controls have been contoured as far as possible to suit vocals requirements, ie: for frequencies between 100Hz and 10kHz. The fundamentals of male and female speech lie around 130Hz and 200Hz respectively. These low frequencies provide the voice with body and character whilst the harmonics, particularly those around 1kHz–3kHz are essential for intelligibility.

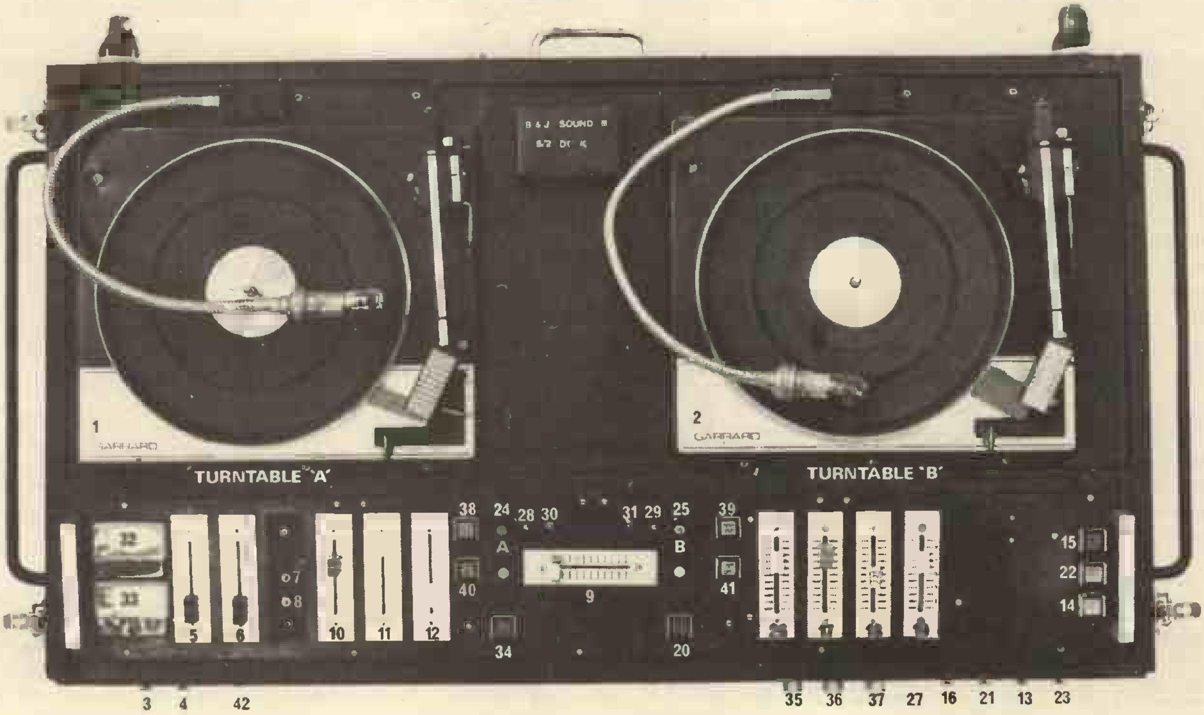
With this in mind, the treble boost curve has been contoured to give relatively large amounts of boost around these latter frequencies, thus allowing vocals to 'cut through' if desired. It is difficult using the Baxandall network to bring the maximum boost up to the fundamental frequencies of the human voice. Maximum boost occurs, therefore around 50Hz but in practice the characteristic is satisfactory provided a vocally compensated microphone is used.

The microphone signal passes to a line driver, capable of providing some +20dBm into a 600 ohm load, via a gain control and the on-off switch. The microphone send-return switch is wired in the same manner as that previously described, and finally the microphone line feeds the mono mixer.

ANCILLARY FUNCTIONS

The auxiliary functions are shown in Fig. 2. The autofader drives an f.e.t. which shunts the music lines; attenuator VR_A controls the fade depth. VR_C and VR_B adjust the sensitivity (i.e. microphone level required to trigger) and the fade-up rate of the circuit respectively. S_A disconnects the f.e.t. when the autofader is not required. A four way switch selects the right hand disc and line inputs for PFL (pre-fader listen) monitoring. In turn, a two way switch selects either PFL or output monitoring. A 4 watt amplifier is provided to drive either headphones or a monitor loudspeaker.

The cue l.e.d.s allow discs to be lined up rapidly and without the use of headphones. VR_D is set to discriminate between rumble and music modulations on typical discs. The VU meter driver preset is normally set such that 776mV on the stereo lines gives an 0 VU reading, though this is not conventional practice in broadcast sound equipment. The peak indicator switches on its associated l.e.d. for a few hundred milliseconds whenever a signal peak exceeds the nominal input sensitivity of the power amplifiers, eg: 500mV



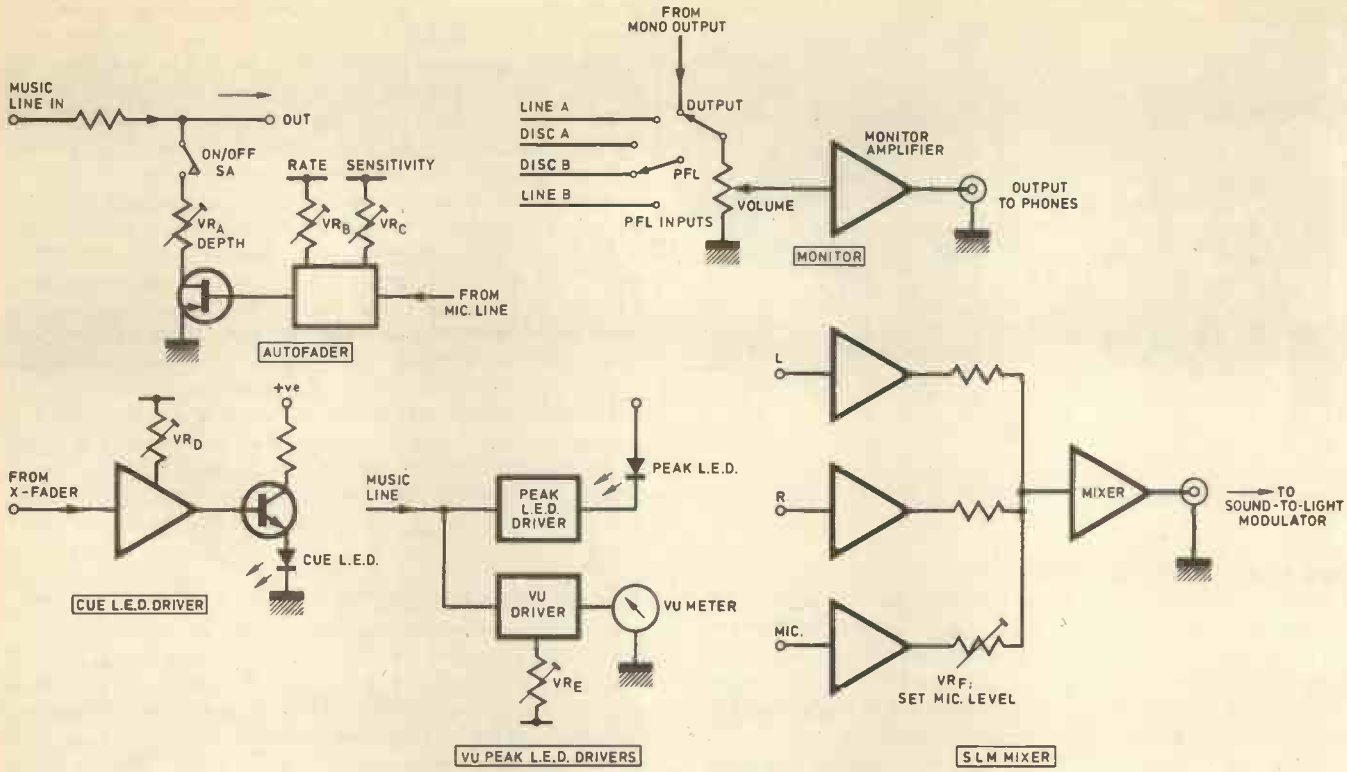


Fig. 2. Block diagram of auxiliary functions

(−3½Bm). In this way, they warn that the power amplifiers are being driven close to clipping.

The 'sound-to-light mixer' provides a +10dBm output for lighting effects. The microphone level in the mix is adjusted to match the level of the music signals under normal 'miking' conditions by means of preset VR_F.

CONSTRUCTION

Apart from the monitor amplifier, all the circuitry is contained on four pluggable cards; this greatly simplifies construction and debugging. Fig. 3 will be found helpful as construction progresses, as it shows how the circuitry on each card is interconnected. The power supply, whilst sophisticated, is simple to construct and is unlikely to require debugging. For this reason it will be presented later. For initial tests, ±15V and +12V supplies are required. To test individual cards, very little current is required (<100mA) and batteries are quite adequate if a good bench power supply is not available.

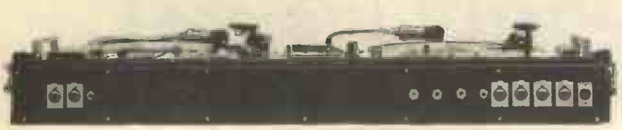
All the audio circuitry is built around the Signetics NE5534 op amp. This was introduced to Britain some 18 months ago and is truly described as 'high performance' in that it is the first op amp to approach the performance of the best discrete circuits. As a result, it has found wide acceptance in professional audio equipment. It has pin compatibility with the 741C and features internal compensation for gains in excess of 10dB. However, the addition of a small compensation capacitor ensures stability without compromising performance in the audio band. The low noise version, designated 'NE5534AN' is expensive but may be used to advantage in the disc input stage if desired.

The NE5534N, like the 741 is a hardy bi-polar device and does not require special handling precautions. However, it is not as cheap as the 741 and when the cards are initially tested it is wise to substitute the latter.

CARD 1

This card contains the disc and line input stages. With reference to Fig. 4, R1 provides the input bias current for IC1 and also the standard load for a magnetic cartridge. At high frequencies, the gain of IC1 falls to unity, therefore external compensation (C5) is required. R5 and R9 provide a gain of 24dB and together with C9 also furnish RIAA treble cut. However, in the series feedback configuration used here, the gain of IC1 cannot fall below unity. Thus R13 and C13 are required to maintain treble cut at high frequencies. The electrolytic capacitor C21 has significant reactance above 1kHz and therefore C17 is added to ensure good treble response. Wherever possible throughout the audio circuitry non-electrolytic coupling capacitors have been specified for this reason. VR1 doubles as a preset balance control and output attenuator as previously described.

IC5 provides unity gain and C33 with the crossfinder provides bass cut which closely complements the RIAA bass boost characteristic. For optimum screening and RF1 suppression all the disc inputs have independent 0V connections and are quasi-balanced. This procedure is not so important at line input levels, and the 0V connection for each stereo line input is commoned at the XLR input connector in any case. Panel mounted earth isolation switches are provided on these inputs to facilitate the control of hum loops. The supply rails adjacent to *each* op amp are



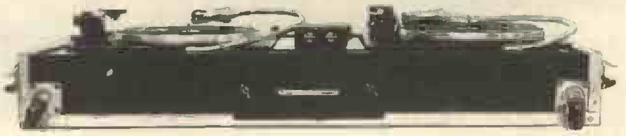
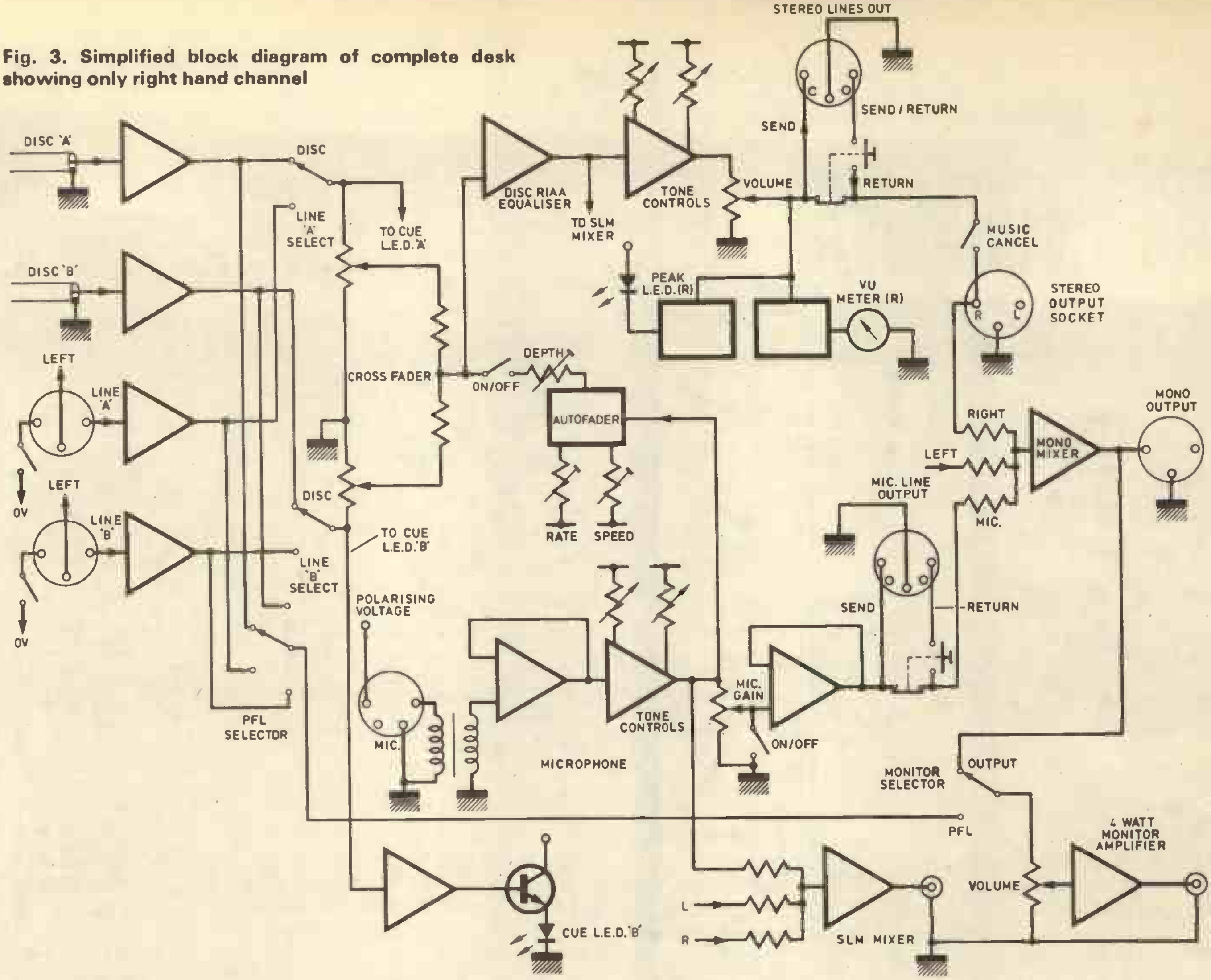
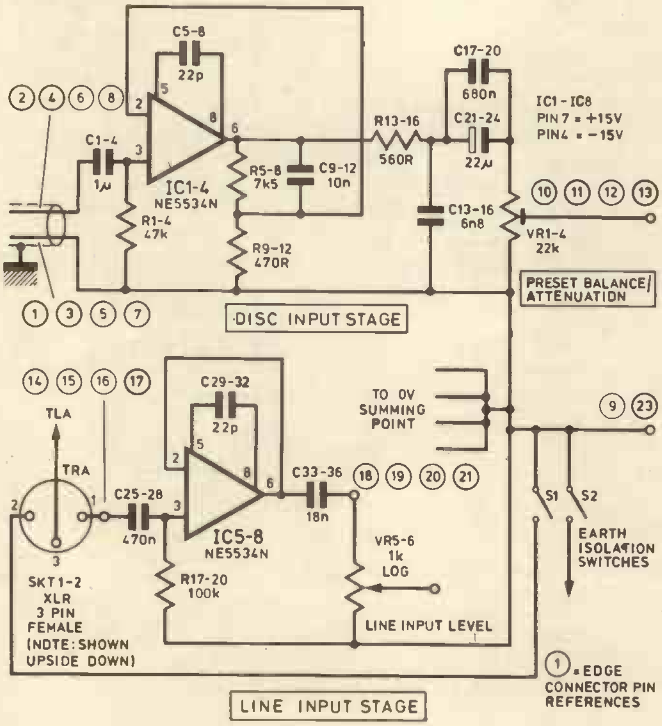
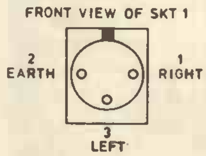


Fig. 3. Simplified block diagram of complete desk showing only right hand channel







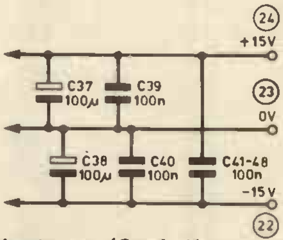


Fig. 4. Disc and line input stages (Card 1), socket detail and line decoupling

CARD 1

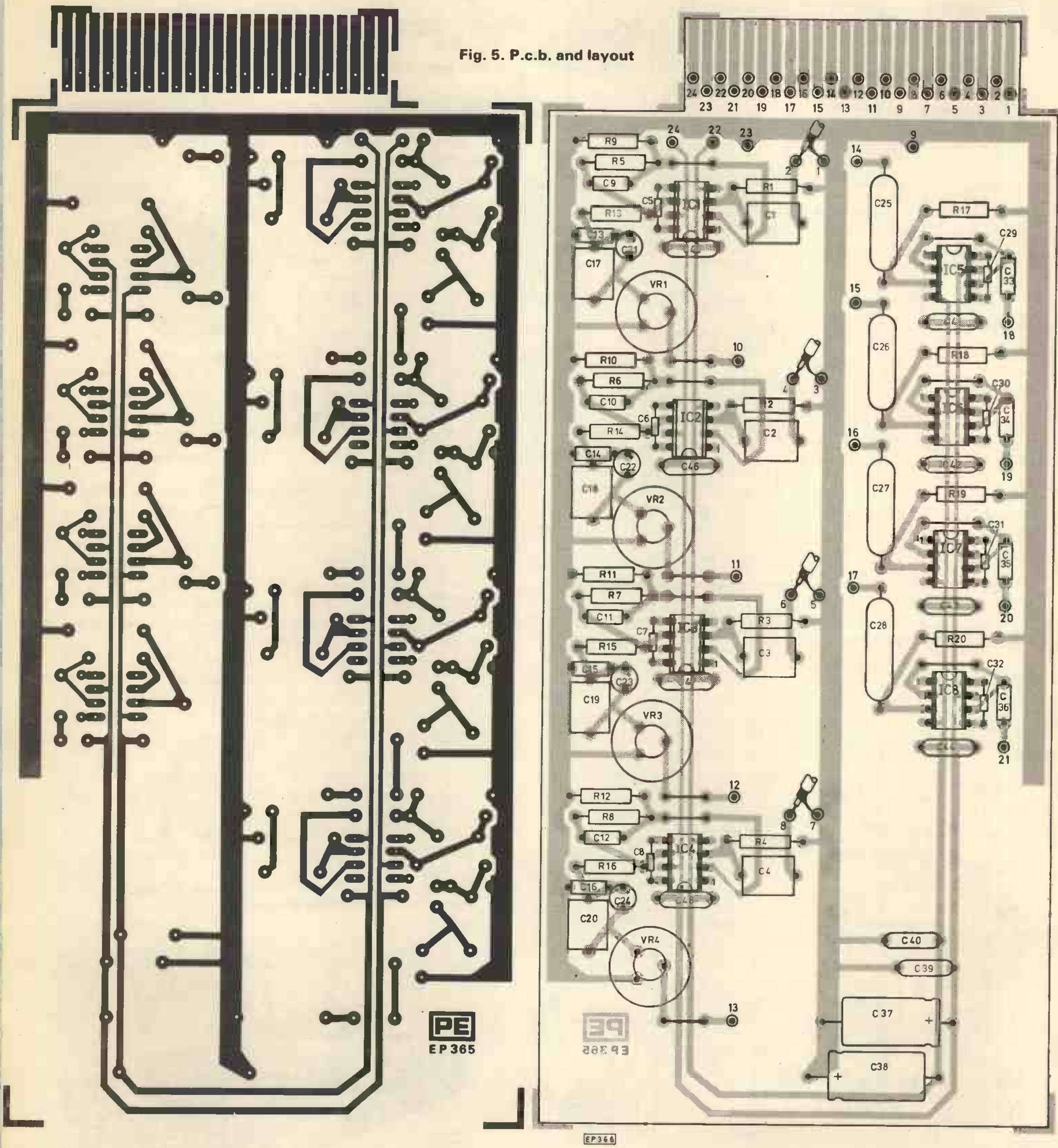


Fig. 5. P.c.b. and layout

Card 1 Edge Wiring

There are two line and disc (T and D) inputs, named A + B, and each has a left (L) and a right channel (R).

For turntable "A", the inputs are D_{RA} + D_{LA}

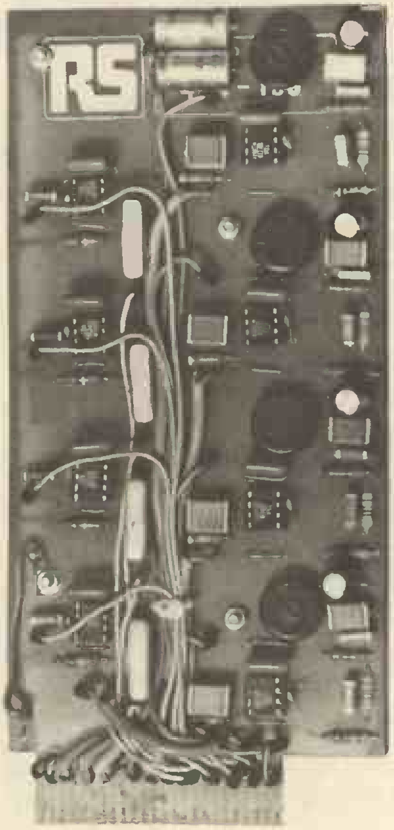
For turntable "B", the inputs are D_{RB} + D_{LB}

For line input "A", the inputs are T_{RA} + T_{LA}

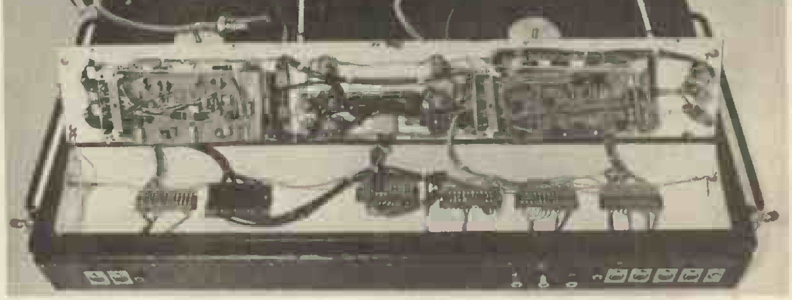
For line input "B", the inputs are T_{RB} + T_{LB}

Disc input earth connections are designated OV together with the appropriate code.

Pin No.	Connection	
1	OV, D_{RA}	Disc inputs from magnetic cartridge
2	Live, D_{RA}	
3	OV, D_{LA}	
4	Live, D_{LA}	
5	OV, D_{RB}	
6	Live, D_{RB}	
7	OV, D_{LB}	
8	Live, D_{LB}	
9	OV Summing point	
10	D_{RA}	Disc outputs to mode switches
11	D_{LA}	
12	D_{RB}	
13	D_{LB}	
14	T_{RA}	Line inputs. (OV via S1/S2 to pin 9)
15	T_{LA}	
16	T_{RB}	
17	T_{LB}	
18	T_{RA}	Line input amplifier outputs to mode switches
19	T_{LA}	
20	T_{RB}	
21	T_{LB}	
22	—ve, 15V	To power supply busbars
23	OV	
24	+ve, 15V	



Showing a completed Card 1 and below a desk with the board assembly lid pulled back



decoupled at high frequencies for stability (C41 etc) and additional capacitors (C37–40) are provided to attenuate common mode RF1 and to decouple the supply rails at audio frequencies.

CARD 1 LAYOUT

The physical layout of Card 1 is shown in Fig. 5. The copper clad board specified in the components list must be cut to size. Note that the card aperture is not symmetrical and marking out and cutting should be done from the *copper side* of the board if the aperture position is to correspond to Fig. 4. Accurate cutting is facilitated by using a jigsaw fitted with a very fine blade, together with an $\frac{1}{8}$in strip of straight aluminium as a guide along the inside of the cutting line.

The 24 edge connector strips should be covered with enamel paint to protect it during etching; paint is more consistent than etch resistant ink over such large areas. The p.c.b. pins are wired direct to the edge connector pins by 7/0.2 cable, except for pins 1–8 which require screened cable, and pins 9 and 23, which should be brought to the edge connector with 16/0.2 cable to ensure a low impedance connection. Because the edge connector pins are cramped, all the leadout wires should be sleeved. Apart from allowing a high component density, 'hard wiring' in this fashion permits control over stray capacitance which cannot be achieved first go with 24 parallel p.c.b. tracks!

When the board is completed, scrape away excess flux, using methylated spirits as a solvent, together with a stiff brush where necessary.

Check carefully for errors, then load the 8 sockets, preferably with 741s. Note that the op amps belonging to the line inputs face in the opposite direction to those handling the disc inputs. Short all the inputs to OV and apply ±12V or ±15V via 100R current limiting resistors in each supply rail. If the supply current exceeds 30mA (741s) or 70mA (NE5534s), disconnect the supply and look for errors. If all is well, load the card with NE5534s and reconnect the supply. Then check the offset voltages at pin 6 on the i.c.s; note that a carelessly placed probe may prove fatal to the devices here. If the offset voltage is greatly in excess of 300mV, disconnect and check again for errors, or for floating inputs. Finally, reconnect the supply and check the polarity of the offset at pin 6 on I.Cs 1–4. Then reorientate C21–24 if necessary. The screen can then be added (Fig. 5) and Card 1 is now completed. The same constructional and setting up procedure applies to the remainder of the cards; remember to allow for notably lower power consumption however on Card 2, and to short all inputs to the OV rail.

Next Month—more circuits.

PROGRAMMABLE SOUND GENERATOR

D.COUTTS

THE GENERAL INSTRUMENT AY-3-8912 Programmable Sound Generator was designed to produce a variety of complex sounds under software control. By using a register stack the processor can load values into the sound chip and then carry on with other tasks while the sound is being generated.

It is easy to interface the i.c. with the UK101 and to add sound to your BASIC programs by means of the POKE command.

BLOCK DIAGRAM

Fig. 1 is a block diagram of the 8912 i.c. There are three tone generators and a noise generator. The three tones can be fed out to outputs A, B and C. The noise can be added to any or all of the tones, or it can be output instead of a tone. The amplitudes of the noise and tones can be set to one of sixteen fixed values, or they can be varied by means of an envelope generator. The envelope generator amplitude modulates the outputs and can be set for various options of fast or slow attack and decay, single shot or repeat, etc. allowing a wide variation of sounds. The three outputs are logarithmic.

PSG REGISTER ARRAY

Fig. 2 shows the register array in detail. Register Ø and register 1 are cascaded to give a 12-bit word which sets the period of tone A, the top 4 bits of register 1 not being used and the bottom 4 bits forming bits 8, 9, 10 and 11 of the 12-bit word. The register can be set to any value between 1 and 4095 decimal. As the clock is divided by 16 before being fed to the tone generator, the output frequency is:

$$f = \frac{F_{clock}}{16 \times R}$$

where R lies between 1 and 4095. Registers 2, 3 and 4, 5 similarly control tone generators B and C. Register 6 is used to control a pseudo random noise generator. Only the bottom 5 bits are used, and again, the clock is divided by 16 before being fed to the noise generator.

Register 7 is the output control register. Bits 6 and 7 should always be set to one as we are outputting data to the PSG (Programmable Sound Generator). Setting bit Ø low will enable tone A to be output to channel A. If at the same time bit 3 is set low the noise generator will be mixed with tone A. If bit Ø is now set high only noise will be output on channel A. Likewise bits 1 and 4 control tone B and noise to channel B, and bits 2 and 5 control tone C and noise to channel C. Remember it requires a low or Ø to select a tone or noise, for example, writing 254 decimal to register 7 selects tone A.

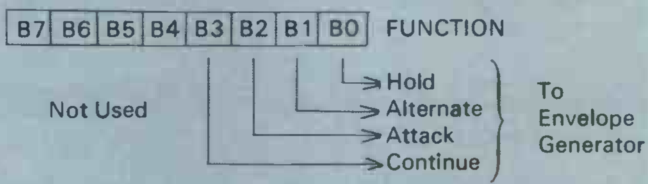
Register 8 is used to set the amplitude of channel A in the fixed output level mode. Bits 5, 6 and 7 are not used. If bit 4 is set to Ø then the output amplitude is set at one of sixteen fixed levels by means of bits Ø to 3. If bit 4 is set to a '1', however, bits Ø to 3 have no effect and the output amplitude is set by the envelope generator. Registers 9 and 1Ø are used similarly for channels B and C. Registers 11 and 12 are cascaded to give a 16-bit word to set the envelope period. The clock is divided by 256 before being fed to the envelope control, so with a 2MHz clock we can get a period range of about 0·1Hz to 7800Hz.

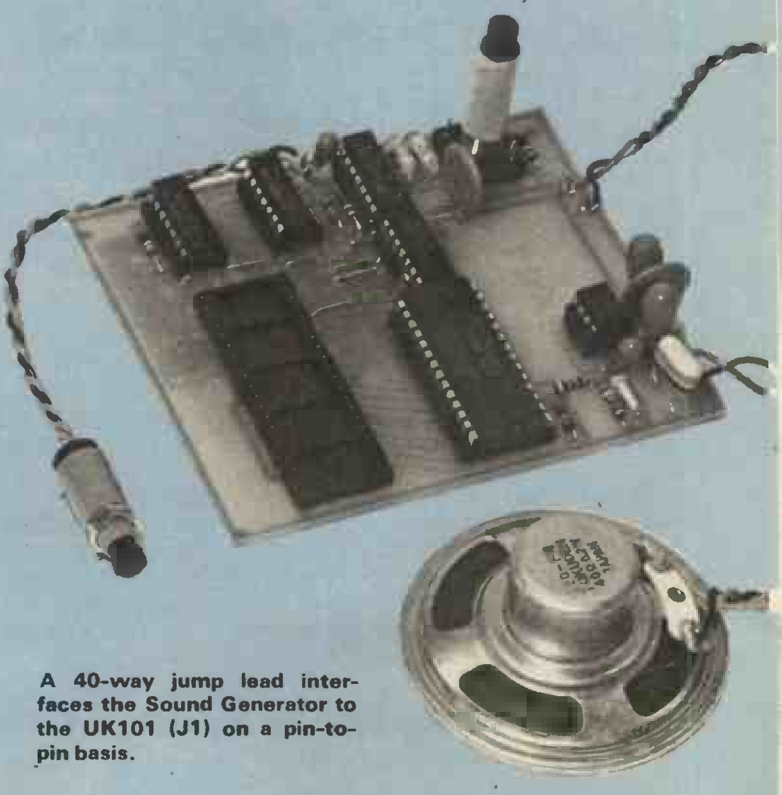
Register 13 determines the shape/cycle of the output as follows.

The envelope generator further counts down the envelope frequency by 16, producing a 16-state per cycle envelope pattern as defined by its 4-bit counter output, E3, E2, E1, EØ. The particular shape and cycle pattern of any desired envelope is accomplished by controlling the count pattern (count up/count down) of the 4-bit counter and by defining a single-cycle or repeat-cycle pattern.

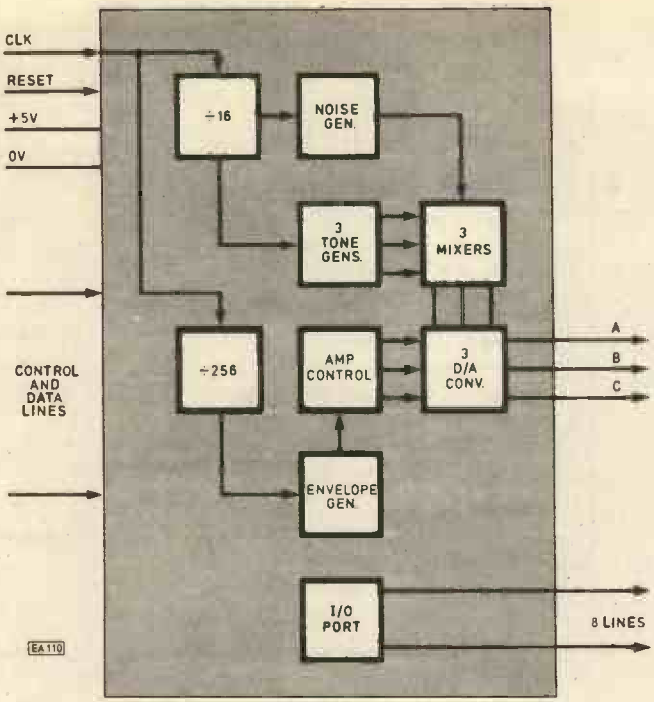
This envelope shape/cycle control is contained in the lower 4 bits (B3–BØ) of register 13. Each of these 4 bits controls a function in the envelope generator, as illustrated in the following:

Envelope Shape/Cycle Control Register (R13)





A 40-way jump lead interfaces the Sound Generator to the UK101 (J1) on a pin-to-pin basis.



The definition of each function is as follows:

Hold When set to logic 1, limits the envelope to one cycle, holding the last count of the envelope counter (E3–E0 = ØØØØ or 1111, depending on whether the envelope counter was in a count-down or count-up mode, respectively).

Alternate When set to logic 1, the envelope counter reverses count direction (up-down) after each cycle.

NOTE: When both the Hold bit and the Alternate bit are ones, the envelope counter is reset to its initial count before holding.

Attack When set to logic 1, the envelope counter will count up (attack) from E3, E2, E1, EØ = ØØØØ to E3, E2, E1, EØ = 1111: when set to logic Ø, the envelope counter will count down (decay) from 1111 to ØØØØ.

Continue When set to logic 1, the cycle pattern will be as defined by the Hold bit. When set to logic Ø, the envelope generator will reset to ØØØØ after one cycle and hold at that count.

To further describe the above functions could be accomplished by numerous charts of the binary count sequence of E3, E2, E1, EØ for each combination of Hold, Alternate, Attack and Continue. However, since these outputs are used (when selected by the Amplitude Control registers) to amplitude modulate the output of the Mixers, a better understanding of their effect can be accomplished via a graphic representation of their value for each condition selected, as illustrated in Fig. 3.

Register		BIT B7	B6	B5	B4	B3	B2	B1	B0
R0	Channel A Tone Period	8-BIT Fine Tune A							
R1						4-BIT Coarse Tune A			
R2	Channel B Tone Period	8-BIT Fine Tune B							
R3						4-BIT Coarse Tune B			
R4	Channel C tone Period	8-BIT Fine Tune C							
R5						4-BIT Coarse Tune C			
R6	Noise Period				5-BIT Period Control				
R7	Enable	IN/OUT IOB	IOA	C	Noise B	A	C	Tone B	A
B8	Channel A Amplitude				M	L3	L2	L1	L0
R9	Channel B Amplitude				M	L3	L2	L1	L0
R10	Channel C Amplitude				M	L3	L2	L1	L0
R11	Envelope Period	8-BIT Fine Tune E							
R12		8-BIT Coarse Tune E							
R13	Envelope Shape/Cycle					CONT.	ATT.	ALT.	HOLD.
R14	I/O Port A Data Store	8-BIT PARALLEL I/O on Port A							

Fig. 2. Register array of AY-3-8912

```
10   R = 61680 : V = 61681
20   FORT = 0 TO 14 : X = INT
     (RND(5)*255) + 1
25   IF  RND(9)<.5  THEN
     POKER,7 : POKEV,248
26   IFRND(4)<.5   THEN
     POKER,1 : POKEV,0
30   GOSUB 1000
40   NEXT
50   FORT = 1 TO 5000 : NEXT
60   Y = INT (RND(7)—15):
     FOR T = 1 TO 255:
     POKER,Y POKEV,T
70   NEXT
75   FORT = 255 TO 1 STEP —
     1 : POKER,Y : POKEV,T
76   NEXT
80   GOTO 20
1000 POKER,T:   POKEV,X:
     RETURN
```

Let the Sound Generator create its own sounds with this random program. Push it through a power amplifier for maximum effect.

Register 14 is the output port. Writing data to this register outputs it on pins 7 to 14 of the AY–3–8912.

CIRCUIT DIAGRAM

Fig. 5 shows the circuit diagram of the unit. IC3a and b provide a 1 to 2MHz clock to the PSG. IC3c and IC4a provide a reset to the chip, R2 and C3 providing power on reset. The three output channels of the 8912 are mixed together and are amplified by IC6. The UK101 data lines DØ to D7 are fed to pins 28 to 21 of IC5. Pins 7 to 14 of IC5 are the output port lines from register 14.

Two addresses are used to load the PSG, FØFØH and FØF1H. IC1 decodes when address bits 2^4 to 2^7 and 2^{12} to 2^{15} are high. IC2 decodes when address bits 2^1 to 2^3 and 2^8 to 2^{11} are low and R/$\overline{W}$ is low. Address bit 2^0 goes to IC4C. When you write to address FØFØH pins 18 and 20 of IC5 go high and the data on the data lines is written into an address latch in the PSG, i.e. if you write Ø to FØFØH the address latch in the PSG points to register Ø. If you now write to address FØF1H then the data on the data lines will be written into the register pointed to by the address latch, i.e. if you write 128 to FØF1H then 128 will be written into the register pointed to by the address latch, in this case register zero.

CONSTRUCTION

Construction is straightforward using the circuit diagram, Fig. 5 and component layout, Fig. 7. Fit the wire links followed by the sockets (it is advisable to use sockets with CMOS and MOS devices). Fit the resistors and capacitors then fit the coil former L1 and wind on 60 turns of 30 SWG enamelled wire. fit two cores into L1. A Molex plug can be fitted to the output port if it is needed. Fit wires for reset switch S1 and for the speaker. Add wires for 0V and +5 volts. If preferred the +5 volts could be brought in from the UK101 via the spare pin on J1 (pin 11). The p.c.b. is connected to the UK101 via a 40 to 40 pin jumper cable.

If IC6 and IC7 are not fitted in the UK101 it will be necessary to fit two dil plugs in place of them, wired as shown in Fig. 8.

TESTING THE UNIT

Check the p.c.b. very carefully for any solder splashes causing shorts. Fit the i.c.s, connect the unit to the UK101 via a 40-way jumper cable and power up.

As stated previously, writing a number between 0 and 14 to address FØFØH (DECIMAL 61680) will set up an address latch in the i.c. to point to one of the registers RØ to R14. If you then write to address FØF1H (61681 DECIMAL) you can write data into the appropriate register.

Load the following program:

```
1Ø    POKE  6168Ø,Ø     (POINT TO REGISTER Ø)
2Ø    POKE  61681,255   (LOAD 255 INTO REG. Ø
                          (TONE))
3Ø    POKE  6168Ø,7     (POINT TO REG. 7)
4Ø    POKE  61681,254   (SELECT REG. Ø TO O/P)
5Ø    POKE  6168Ø,8     (POINT TO REG. 8)
6Ø    POKE  61681,15    (SELECT O/P AMPLITUDE)
1ØØ   END
```

and run.

This outputs a single tone. To add noise change line 40 and ADD 70 and 80:

```
4Ø    POKE  61681,246   (SELECTS TONE AND
                          NOISE ON A)
7Ø    POKE  6168Ø,6     (SELECTS REG. 6)
8Ø    POKE  61681,1     (ENTERS NOISE VALUE)
```

and run.

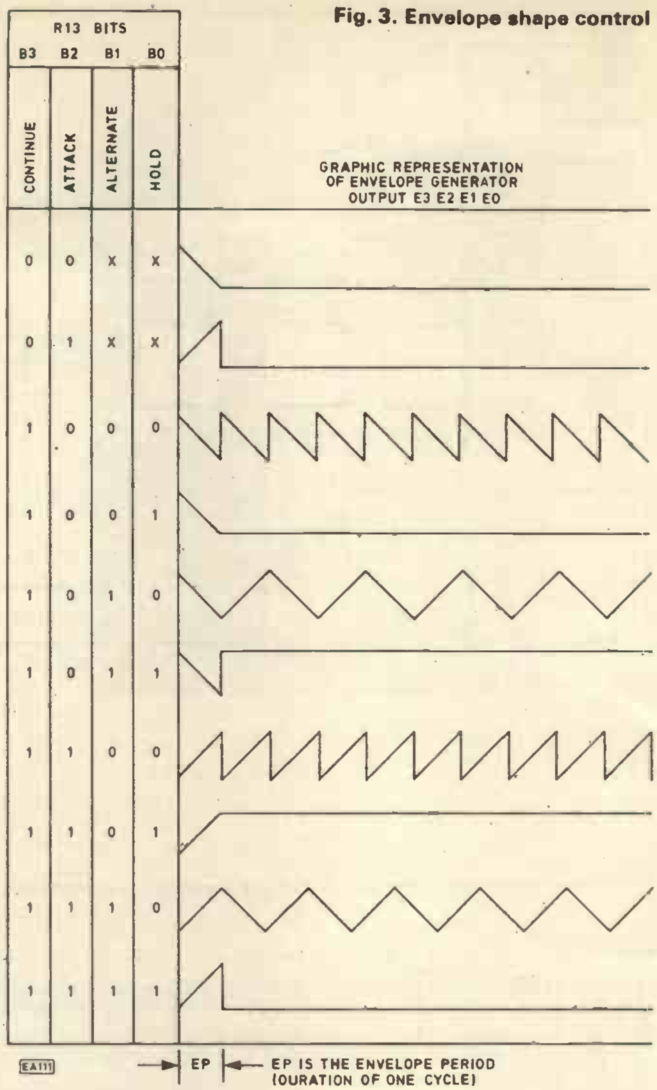
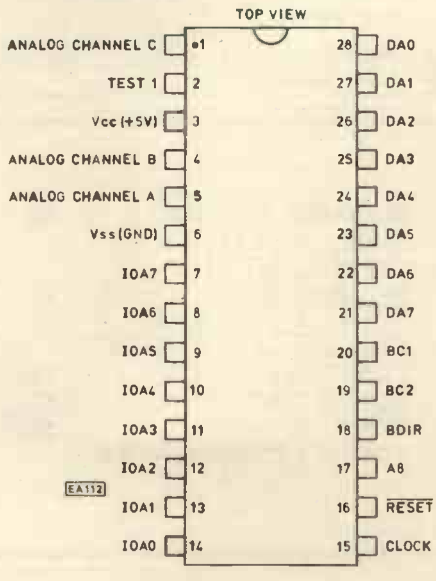


Fig. 3. Envelope shape control

Fig. 4. AY-3-8912 pin-outs



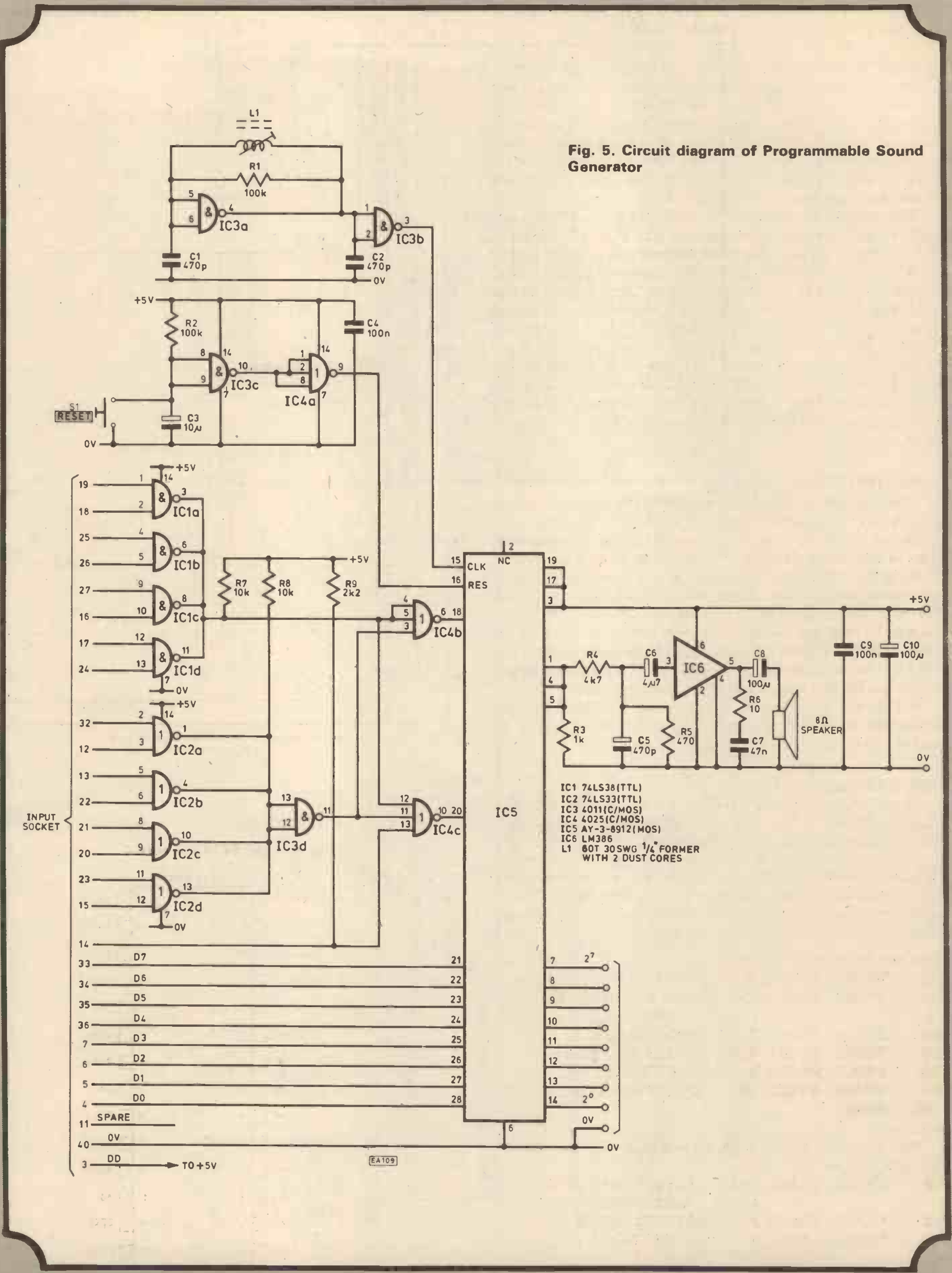


Fig. 5. Circuit diagram of Programmable Sound Generator

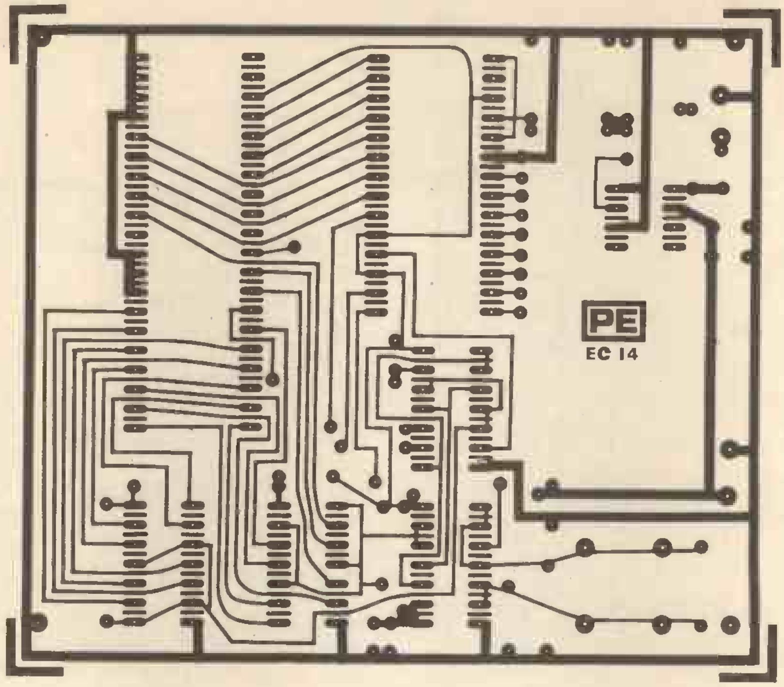
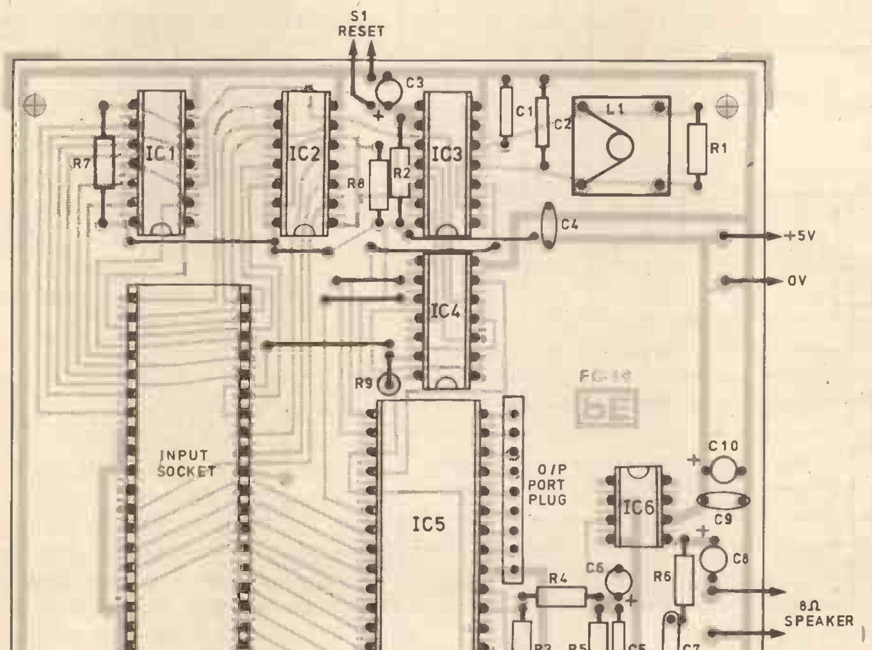


Fig. 6. Printed Circuit layout (actual size)

Fig. 7. Component layout



COMPONENTS . . .

Resistors

R1, R2	100k (2 off)
R3	1k
R4	4k7
R5	470
R6	10
R7, R8	10k (2 off)
R9	2k2

Capacitors

C1, C2, C5	470p (3 off)
C3	10µ tant,. 10V
C4, C9	100n (2 off)
C6	4µ7 tant. 10V
C7	47n
C8, C10	100µ tant. 10V (2 off)

Integrated Circuits

IC1	74LS38
IC2	74LS33
IC3	4011
IC4	4025
IC5	AY-3-8912
IC6	LM386

Miscellaneous

L1	RS coil former: 228-090 + 2 cores: 228-107
S1	SPST push button
Speaker	8Ω

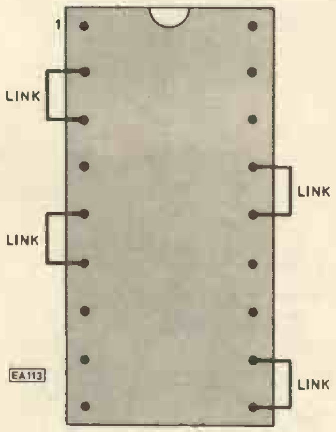


Fig. 8. Blanking plugs for IC6 and IC7 sockets on the 101

To check envelope shapes clear above program by typing NEW.

Enter the following:

```
1Ø     POKE  6168Ø, 1
2Ø     POKE  61681, 2
3Ø     POKE  6168Ø, 7
4Ø     POKE  61681, 254
5Ø     POKE  6168Ø, 8
6Ø     POKE  61681, 31
7Ø     POKE  6168Ø, 12
8Ø     POKE  61681, 64
9Ø     POKE  6168Ø, 13
1ØØ    POKE  61681, Ø
11Ø    END
```

and run.

Change line 1ØØ

```
1ØØ    POKE  61681, 4
```

and run.

Change line 1ØØ

```
1ØØ    POKE  61681, 8
```

and run.

By referring to Fig. 3 you can check out all the waveforms by altering line 1ØØ.

Sweep frequency effects. Enter the following program:

```
1Ø     LET    A = 1ØØ          (INITIALISE A)
2Ø     POKE   6168Ø, 2
3Ø     POKE   61681, A         (LOAD A INTO REG. 2)
4Ø     POKE   6168Ø, 7
5Ø     POKE   61681, 253       (SELECT CHAN. B O/P)
6Ø     POKE   6168Ø, 9
7Ø     POKE   61681, 15        (SELECT FULL AMP. O/P)
8Ø     LET A = A+2
9Ø     IF A < 2ØØ GO TO 2Ø
1ØØ    GO TO 1Ø
```

and run. You get a decreasing sweep frequency.

Change the following lines:

```
1Ø     LET A = 2ØØ
8Ø     LET A = A–2
9Ø     IF A > 1ØØ GO TO 2Ø
```

and run. You get an increasing sweep frequency.

That checks out the unit. As you can see there is plenty of scope to add sound effects to your program. Short bursts of noise sound like gun shots, larger bursts sound like explosions. Tones can be played and the 3 channels allow chords to be output. All it takes is practice.

The unit may be fitted in a small case on its own or it may be mounted inside the computer case, as it is quite small.

```
10 INPUT "REGISTER"; R
20 INPUT "CONTENT"; C
30 POKE 61860, R: POKE 61681, C
40 GOTO 10
```

Learning to drive the sound generator will be much assisted by using the above program. You can load any register with any value directly, and discover how various control signals translate into actual sound. If you get in a pickle, push the reset button and start again.

UK101–TELEPRINTER INTERFACE

BY J. J. TREVILLION

THIS interface allows the use of a *surplus* teleprinter with the UK101 or similar 6502 microprocessor based machine. To constructors on a restricted budget, this is a practical alternative to an expensive line-printer, accepting such disadvantages as the low rate of print, the restricted character set and the noisy mechanism.

A simple hardware addition is used, connected directly to the UK101 bus expansion socket, whilst the software has been designed for ease of use. Description centres on the use of a CREED Type 54 teleprinter, which the author purchased relatively cheaply from a local surplus equipment dealer, although there is no reason why the interface could not be used with other 50 baud, solenoid operated teleprinters, with a minimum of modification.

HARDWARE

The author's teleprinter is fitted with a 240 volt synchronous motor which is to be preferred since it requires no setting up of speed. The teleprinter is operated by a solenoid which requires a drive of ±35mA for MARK/SPACE. This is obtained in the circuit of Fig. 1 by switching the polarity of 24 volts across the solenoid using a relay. This voltage is *high* to allow the inclusion of a series resistor, R2, to maintain the switching speed of the solenoid, due to its relatively high inductance. The relay is driven by direct memory-mapped software control, such that writing to address F100 sends a MARK, and F101, a SPACE.

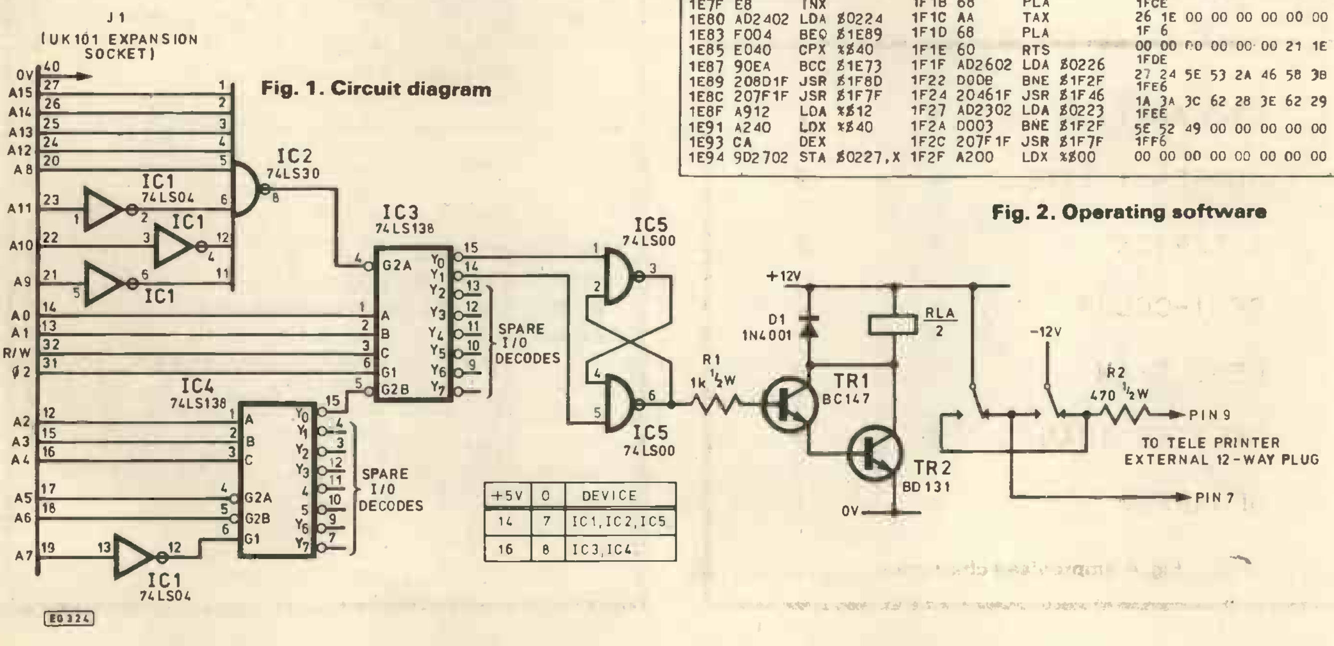
Power for the additional logic can just be derived from the UK101 five volt supply, since only an additional 20mA will be drawn by the low-power schottky devices.

No constructional details, or circuits of the ±12 volt supply, are given since these are not critical.

SOFTWARE

A disassembled listing of the program (produced via the described interface) with a hexadecimal dump of the look-up tables used by the program, is shown in Fig. 2, whilst the flowchart of Fig. 3 makes the listing understandable.

The program is located in the last 512 bytes of RAM of a UK101 containing 8K of RAM, and uses RAM between addresses 0222 and 0266 for temporary storage. The program can



+5V	0	DEVICE
14	7	IC1, IC2, IC5
16	8	IC3, IC4

Fig. 1. Circuit diagram

```
1E00 48      PHA
1E01 A900    LDA %$00
1E03 8D2302  STA $0223
1E06 8D2402  STA $0224
1E09 A91D    LDA %$1D
1E0B 8D1A02  STA $021A
1E0E A91E    LDA %$1E
1E10 8D1B02  STA $021B
1E13 8A      TXA
1E14 48      PHA
1E15 98      TYA
1E16 48      PHA
1E17 20461F  JSR $1F46
1E1A 4C661E  JMP $1E66

1E1D 202DBF  JSR $BF2D
1E20 48      PHA
1E21 AD0502  LDA $0205
1E24 D002    BNE $1E28
1E26 68      PLA
1E27 60      RTS
1E28 68      PLA
1E29 D8      CLD
1E2A C900    CMP %$00
1E2C F0F9    BEQ $1E27
1E2E C90A    CMP %$0A
1E30 F0F5    BEQ $1E27
1E32 8D2202  STA $0222
1E35 48      PHA

1E36 8A      TXA
1E37 48      PHA
1E38 98      TYA
1E39 48      PHA
1E3A AD2202  LDA $0222
1E3D C920    CMP %$20
1E3F D006    BNE $1E47
1E41 207B1F  JSR $1F7B
1E44 4C0C1F  JMP $1F0C
1E47 C909    CMP %$09
1E49 D017    BNE $1E62
1E4B AD2302  LDA $0223
1E4E C940    CMP %$40
1E50 F014    BEQ $1E66

1E52 207B1F  JSR $1F7B
1E55 EE2302  INC $0223
1E58 A907    LDA %$07
1E5A 2D2302  AND $0223
1E5D D0EC    BNE $1E4B
1E5F 4C191F  JMP $1F19
1E62 C90D    CMP %$0D
1E64 D046    BNE $1EAC
1E66 AD2402  LDA $0224
1E69 F01E    BEQ $1E89
1E6B 20461F  JSR $1F46
1E6E 207F1F  JSR $1F7F
1E71 A200    LDX %$00
1E73 BD2702  LDA $0227,X

1E76 8E2202  STX $0222
1E79 20A21E  JSR $1EA2
1E7C AE2202  LDX $0222
1E7F E8      INX
1E80 AD2402  LDA $0224
1E83 F004    BEQ $1E89
1E85 E040    CPX %$40
1E87 90EA    BCC $1E73
1E89 208D1F  JSR $1F8D
1E8C 207F1F  JSR $1F7F
1E8F A912    LDA %$12
1E91 A240    LDX %$40
1E93 CA      DEX
1E94 9D2702  STA $0227,X

1E97 D0FA    BNE $1E93
1E99 8E2302  STX $0223
1E9C 8E2402  STX $0224
1E9F 4C191F  JMP $1F19
1EA2 C912    CMP %$12
1EA4 F003    BEQ $1EA9
1EA6 CE2402  DEC $0224
1EA9 4C4B1F  JMP $1F4B
1EAC A200    LDX %$00
1EAE AC2302  LDY $0223
1EB1 BDDC1F  LDA $1FDC,X
1EB4 F01E    BEQ $1ED4
1EB6 CD2202  CMP $0222
1EB9 D014    BNE $1ECF

1EBB E8      INX
1EBC BDDC1F  LDA $1FDC,X
1EBF 992702  STA $0227,Y
1EC2 EE2402  INC $0224
1EC5 E8      INX
1EC6 BDDC1F  LDA $1FDC,X
1EC9 8D2202  STA $0222
1ECC 4CD41E  JMP $1ED4
1ECF E8      INX
1ED0 E8      INX
1ED1 E8      INX
1ED2 D0DD    BNE $1EB1
1ED4 AD2202  LDA $0222
1ED7 C961    CMP %$61

1ED9 900A    BCC $1EE5
1EDB C97B    CMP %$7B
1EDD B006    BCS $1EE5
1EDF 38      SEC
1EE0 E920    SBC %$20
1EE2 8D2202  STA $0222
1EE5 C941    CMP %$41
1EE7 9036    BCC $1F1F
1EE9 C95B    CMP %$5B
1EEB B032    BCS $1F1F
1EED AE2602  LOX $0226
1EF0 F00B    BEQ $1EFD
1EF2 20711F  JSR $1F71
1EF5 AE2302  LDX $0223

1EF8 D003    BNE $1EFD
1EFA 207F1F  JSR $1F7F
1EFD AD2202  LDA $0222
1F00 38      SEC
1F01 E940    SBC %$40
1F03 0A      ASL A
1F04 AA      TAX
1F05 CA      DEX
1F06 BD961F  LDA $1F96,X
1FD9 204B1F  JSR $1F4B
1F0C EE2302  INC /0223
1F0F AD2302  LDA $0223
1F12 C940    CMP %$40
1F14 9003    BCC $1F19

1F16 4C661E  JMP $1E66
1F19 68      PLA
1F1A A8      TAY
1F1B 68      PLA
1F1C AA      TAX
1F1D 68      PLA
1F1E 60      RTS
1F1F AD2602  LDA $0226
1F22 D00B    BNE $1F2F
1F24 20461F  JSR $1F46
1F27 AD2302  LDA $0223
1F2A D003    BNE $1F2F
1F2C 207F1F  JSR $1F7F
1F2F A200    LDX %$00

1F31 BD961F  LDA $1F96,X
1F34 F009    BEQ $1F3F
1F36 E8      INX
1F37 CD2202  CMP $0222
1F3A F0CA    BEQ $1F06
1F3C E8      INX
1F3D D0F2    BNE $1F31
1F3F 207B1F  JSR $1F7B
1F42 4C0C1F  JMP $1F0C
1F45 00      BRK
1F46 A96E    LDA %$6E
1F48 8D2602  STA $0226
1F4B A207    LDX %$07
1F4D 0A      ASL A

1F4E 9006    BCC $1F56
1F50 8D00F1  STA $F100
1F53 4C591F  JMP $1F59
1F56 8D01F1  STA $F101
1F59 205F1F  JSR $1F5F
1F5C CA      DEX
1F5D D0EE    BNE $1F4D
1F5F A00A    LDY %$0A
1F61 48      PHA
1F62 A9C8    LDA %$C8
1F64 8D2502  STA $0225
1F67 CE2502  DEC $0225
1F6A D0FB    BNE $1F67
1F6C 88      DEY

1F6D D0F3    BNE $1F62
1F6F 68      PLA
1F70 60      RTS
1F71 A9D0    LDA %$00
1F73 8D2602  STA $0226
1F76 A97E    LDA %$7E
1F78 4C4B1F  JMP $1F4B
1F7B A912    LDA %$12
1F7D D0F9    BNE $1F78
1F7F A90A    LDA %$0A
1F81 204B1F  JSR $1F4B
1F84 A232    LDX %$32
1F86 205F1F  JSR $1F5F
1F89 CA      DEX

1F8A D0FA    BNE $1F86
1F8C 60      RTS
1F8D A922    LDA %$22
1F8F 204B1F  JSR $1F4B
1F92 A208    LDX %$08
1F94 D0F0    BNE $1F86

1F96
2D 62 3F 4E 3A 3A FF 4A
1F9E
33 42 25 5A 40 2E 18 16
1FA6
38 32 07 6A 28 7A 29 26
1FAE
2E 1E 2C 1A 39 0E 30 36
1FB6
31 76 34 2A 27 52 35 06
1FBE
37 72 3D 3E 32 66 2F 5E
1FC6
36 56 2B 46 22 52 23 5A
1FCE
26 1E 00 00 00 00 00 00
1F 6
00 00 00 00 00 00 21 1E
1FDE
27 24 5E 53 2A 46 58 3B
1FE6
1A 3A 3C 62 28 3E 62 29
1FEE
5E 52 49 00 00 00 00 00
1FF6
00 00 00 00 00 00 00 00
```

Fig. 2. Operating software

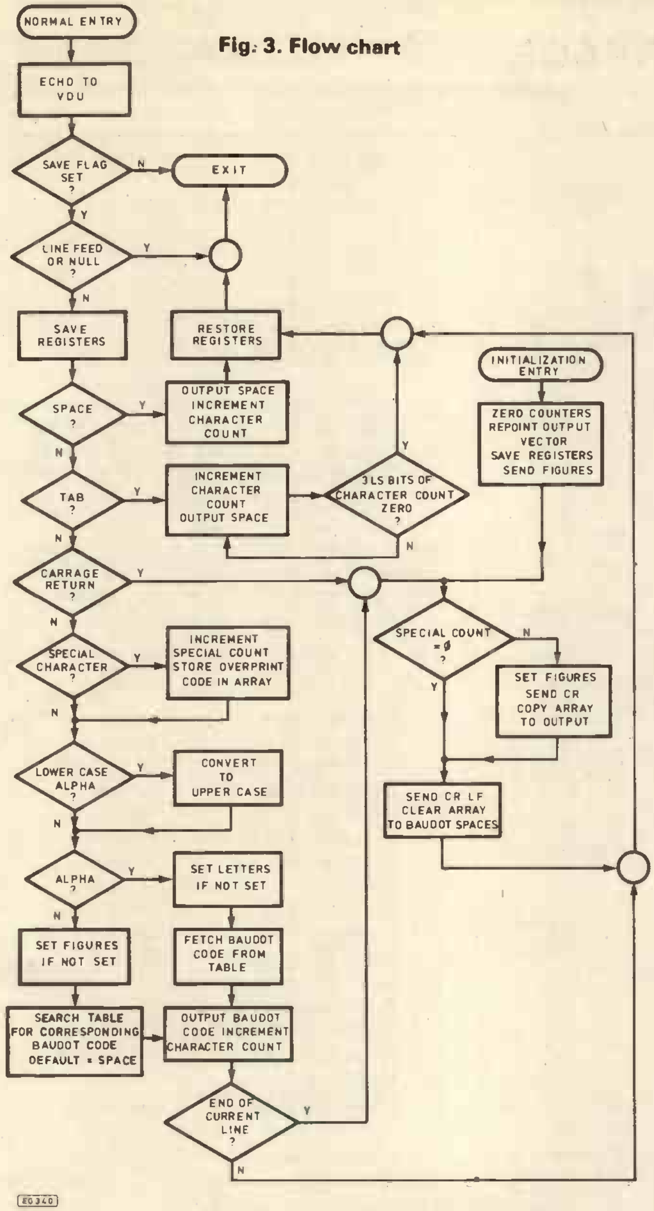


Fig. 3. Flow chart

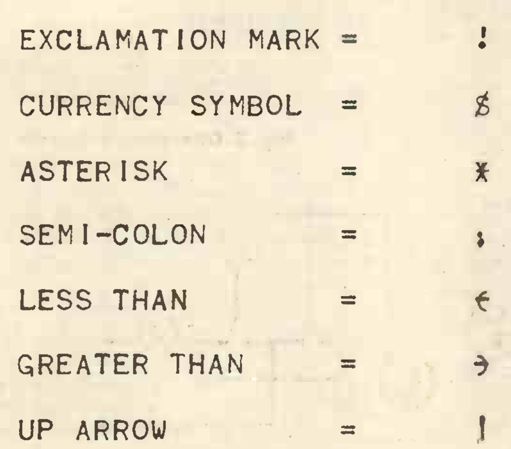


Fig. 4. Improvised characters

easily be relocated for machines with less memory, and it is worth considering storing the routines in EPROM for convenience.

The routines provide the required ASCII to BAUDOT conversion by the use of a look-up table. A second table is used to increase the limited BAUDOT character set by *overprinting* BAUDOT characters. The characters so produced are demonstrated in Fig. 4, the overprinting being achieved by storing the BAUDOT codes to be overprinted in an array (0227 to 0266) and copying them at the end of a line of text.

Other features of the software include automatic lower case to upper case conversion, and the simulation of the TAB function (CONTROL I) to aid formating.

A memory map of the program, including the entry points for useful subroutines, is shown in Table 1.

BASIC OPERATION

The software has been designed so that with a change to the UK101 output vector, address 021A, the teleprinter can be brought into use. Thereafter the output is controlled by the SAVE flag, address 0205, with output directed to the teleprinter only when the flag is set.

The initialisation subroutine provides a routine to change the output vector, clear the temporary storage used by the program, and position the teleprinter at the start of a new line.

At the beginning of a BASIC program, with the printer routines loaded and protected, the procedure to output to the teleprinter would be:

1 POKE 11,0 : POKE 12,30 : X = USR(X) : REM INITIALISATION
2 POKE 517,1 : REM SET SAVE FLAG
3 REM ALL OUTPUT NOW GOES TO TELEPRINTER AND VDU.

In machine code applications the procedure is also simple:

JSR $1E00 For initialisation.

Thereafter:

JSR $1E1D Outputs the ASCII character in the accumulator to the VDU and, if the SAVE flag is set, to the teleprinter. ★

Table 1. Memory map.

ADDRESS	FUNCTION
0222	Accumulator Temporary Store.
0223	Character Count.
0224	Overprint Character Count.
0225	Delay Counter.
0226	Figures Case Flag.
0227	Array Of Overprint BAUDOT Character Codes. (64 Locations.)
1F96	Start of Main Look-Up Table. (Terminated by 00.)
1FDC	Start of Overprint Table. (Terminated by 00.)
ADDRESS	**SUBROUTINE**
1E00	Initialisation Routine.
1E1D	Main Printing Routine.
1F46	Send FIGURES Case & Set Figures Flag.
1F4B	Output BAUDOT Code In Accumulator.
1F5F	2 milli-second Delay.
1F71	Send LETTERS Case & Clear Figures Flag.
1F7B	Output Space.
1F7F	Output Carriage Return.
1F8D	Output Line Feed.

MICRO PROMPT

The hardware and software exchange point for PE computer projects

EXPANDING GROUP

We have received the first newsletter proper from the UK101 User Group, which is accumulating members in the British Isles and overseas.

The group is doing some important work now, such as investigating the "sticking" FRE function, which Adrian Waters, the club organiser points out, is the tip of a serious ice berg concerning string data storage. A complex sound board is nearing completion, whilst behind the scenes the program library is swelling with games and educational software, and new languages such as PILOT.

The Newsletter, ROM, carries software news, hardware modifications, useful ROM and RAM locations, i.e. routine entry points, and a problem page. Equipment reviews are to become a regular feature.

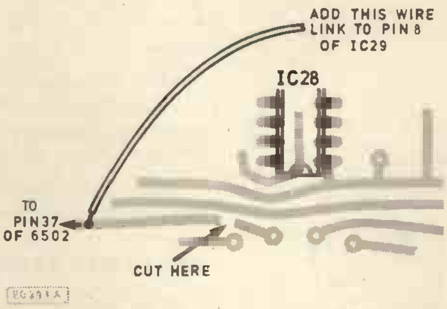
There is no entry fee, and the subscription for six months membership is £2·50, which should be made payable to Adrian Waters, at: 117 Haynes Rd., Hornchurch, Essex.

The following hardware modification was supplied by the 101 User Group, the details having originated from club member *Mr. R. Freeman*.

2MHz conversion

In the normal machine, the clock frequency of 1MHz is presented at pin 37 of the 6502 chip by the B output pin of IC29. Because the 6502 can accept a faster clock, many members have increased the speed of their machines by the following modification:

The 2MHz signal can be obtained from pin 8 of IC29 and applied to the 6502 by the ØØ line at pin 37. The conversion can be implemented by cutting the track of the p.c.b. as shown in Fig. 1 and substituting the new link. Many members have included a changeover switch, although this cannot be used whilst the machine is working, without getting "hung up".



MODEM TO TANDY?

Sir—Firstly, thank you for an excellent magazine, it rivals any we have in the States.

Secondly, I picked up a copy of your February 1980 issue and am very interested in the Modem article by K. Amor. After much difficulty I also obtained part 2 in the March issue—expecting to learn how to connect this System to my Tandy TRS-80 16K Level II—only to be very disappointed. I would be very interested in any information you or your readers might have to offer. I would also be interested in exchanging hardware and software with any of your readers. Thank you.

From the desk of Bryan McPhee,
Capt., USAF,
2742 Virginia Trail,
Browns Mills,
N.J. 08015, U.S.A.

SHIFTY CHARACTERS

Sir—The following useful feature of the UK101 is not mentioned in your series of articles or the instruction manual:

With Shift Lock up, the keyboard returns lower case letters. To input a few upper case letters or figures, press L.H. Shift and the key for the character required (ie. L.H. Shift cancels the effect of Shift Lock being up).

To obtain the normally shifted characters (eg. ") then press R.H. Shift and the appropriate key.

Please continue to publish the very useful articles in Micro Prompt on this excellent machine.

K. W. Lambert,
Halesowen,
W. Midlands.

Sorry, we thought people knew—Ed.

GET KEY FOR UK101

To get a key from the keyboard without stopping the program, as in the input statement, run the following program, then each time you require a "Get Key" statement write:

(Line number) A$ = "Space" : POKE 11, 34 : POKE 12, 2 : X = USR(X)

After this line A$ will be a space unless a key was pressed, in which case A$ will be equal the character of the key which was pressed.

Any $ variable can be used, including array's. This can be used to replace the 'GET A$' statement as used on the PET. To set up the subroutine:

```
10 FOR A = 546 to 597
20 READ B : POKE A, B : NEXT
30 DATA 169, 2, 32, 190, 252, 32
40 DATA 198, 252, 208, 7, 10, 208
50 DATA 245, 169, 32, 208, 28, 74
60 DATA 32, 200, 253, 152, 133, 252
70 DATA 10, 10, 10, 56, 229, 252
80 DATA 133, 252, 138, 74, 32, 200
90 DATA 253, 24, 152, 101, 252, 168
100 DATA 185, 207, 253, 160, Ø, 41
110 DATA 127, 145, 105, 96, Ø
```

Once run this program can be erased if required.

J. L. Brice, Ashford, Kent.

ERROR MESSAGE ERROR

Sir—I am a UK101 user who has, like many, been frustrated by the rather graphic error messages. The result of this has been the following short program to produce "standard" Microsoft BASIC error messages:

Enter monitor
type ·0222/29 (carriage return)
7A "
AC "
2D "
BF "
Reset and enter BASIC.
Type: **POKE 538, 34 : POKE 539, 2**

All error messages will then be standard. The program works by masking off the most significant bit of all characters printed. The BASIC stored messages all have the MSB set on the last character, and it is the omission of an instruction to clear this bit which caused the original error messages. Considering the complexity of the BASIC, such an omission in the error routine is understandable, but I hope this will be corrected.

New error messages	
Syntax error	SN error
Double dimension	DD error
Division by zero	1Ø error
Undefined statement	US error
Undefined function	UF error
Bad subscript	BS error
Long string	LS error
Out of memory	OM error
Overflow	OV error
Continue error	CN error
String tempories	ST error
Type mismatch	TM error
Next without FOR	NF error
Function call error	FC error
Illegal direct	ID error
Out of string space	OS error
Out of data	OD error

D. J. Anderson,
London.

MAP READING

Sir—You may wish to pass on to your readers an error discovered in the memory map of the UK101, found whilst implementing an 6821 I/O port, at a dedicated address.

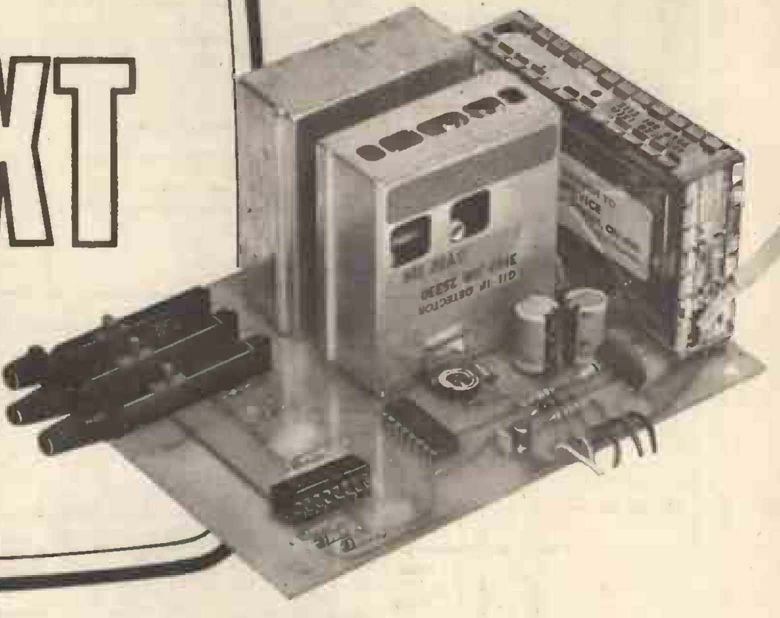
The ACIA which resides at FØØØ—FØØ1 is due to page select decoding repeated at a further 127 locations through Hex page FØ. The memory map should thus be amended to show that ACIA resides from FØØØ—FØFF.

Readers might also like to note that an unbuffered data bus, terminates in a patch pad with 0.1 inch pitch spacing, to the left of the AC1A chip i.c. 14. This can only be used with selectable tristate logic, but as most 6502 compatible support devices have this facility, the cost of the AT28's may be saved.

M. C. Mannering,
Walthamstow.

PE TELETEXT with INFRA-RED REMOTE CONTROL

David Shortland



PART 2... TUNER & DECODER

IN common with all teletext decoders, the Mullard module requires a high quality video signal from which the information is extracted. Since most readers will have little or no experience of working at TV i.f. frequencies (around 40MHz) and insufficient test equipment, the use of a pre-aligned signal section becomes almost mandatory. The solution chosen is shown in block diagram form in Fig. 2.1.

The tuner is the Mullard U321 which is specifically designed for use in the UK. It features a PIN diode attenuator to provide very good signal handling when the signal from the aerial is too large and the a.g.c. system comes into operation. It is used by several TV setmakers and is thus readily available.

The i.f. section is that used in the Philips G11 TV chassis and comprises two modules which are soldered directly onto the p.c.b. The i.f. output from the tuner is applied to pin 1 of the vision selectivity module (VSM). This, as its name implies, carries out the required bandshaping to produce the correct response as determined by the specification of the broadcast signal in the UK. The output from this module is applied to pin 1 of the vision detector module (VDM). This detects the signal to produce a video output; generates an automatic frequency control (a.f.c.) signal which is externally added via R31 to the tuning voltage to counteract any tuning drift; generates an a.g.c. current which is applied to both the vision selectivity module and to the tuner; filters to the 6MHz intercarrier sound signal which is added to the modulator since the video signal is stripped off this inside the module. Other filtering which is performed by this module is not of interest to us.

Turning our attention to the circuit diagram shown in Fig 2.2, it can be seen that the way the tuner and two modules are interconnected forms an extremely simple i.f. section with very few peripheral components. It runs from the stabilised +12V rail which is decoupled at r.f. and I.f. by R29, C11 and C13. The a.g.c. signal to the tuner is decoupled by C14 and C12 and current limited by R32. As mentioned earlier, a.g.c. is applied to both the i.f. pre-amplifier and to the tuner. The latter control signal is delayed, i.e., a.g.c. is gradually applied to the i.f. section first and when this reaches a certain point it is then also applied to the tuner. This point is called the a.g.c. takeover point and is determined by the setting of VR1 in conjunction with D1.

The a.f.c. signal from pin 7 of the VDM is added to the tuning voltage via R31. Resistors R33 and R34 determine the quiescent voltage (around 5·7V).

Turning our attention to IC1, this is a b.c.d. to 1 or 10 decoder/varicap driver which is operated from the stabilised 33V rail. Only four of the available channels are used in our design. The i.c. decodes the four-bit word according to the table below:

A	B	C	D	O/P
0	0	0	0	1
0	0	0	1	2
0	0	1	0	3
0	0	1	1	4
0	1	0	0	5
0	1	0	1	6
0	1	1	0	7
0	1	1	1	8
1	0	0	0	9
1	0	0	1	10

When a channel is decoded, the output of the SL470 goes high and connects the appropriate tuning potentiometer to the +33V stabilised supply. The tuning voltage is applied to the varicap diodes in the U321 tuner via R30.

The SL470 is driven by the buffer IC3 (4050).

SETTING UP

It is imperative that no attempt is made to adjust any of the coils in the tuner or modules. In fact the only adjustment to be made is the a.g.c. crossover point. This is done by tuning into a station and adjusting VR1 until the picture becomes slightly noisy (snow). The control is then backed off until the noise disappears and then backed off a little more from that point.

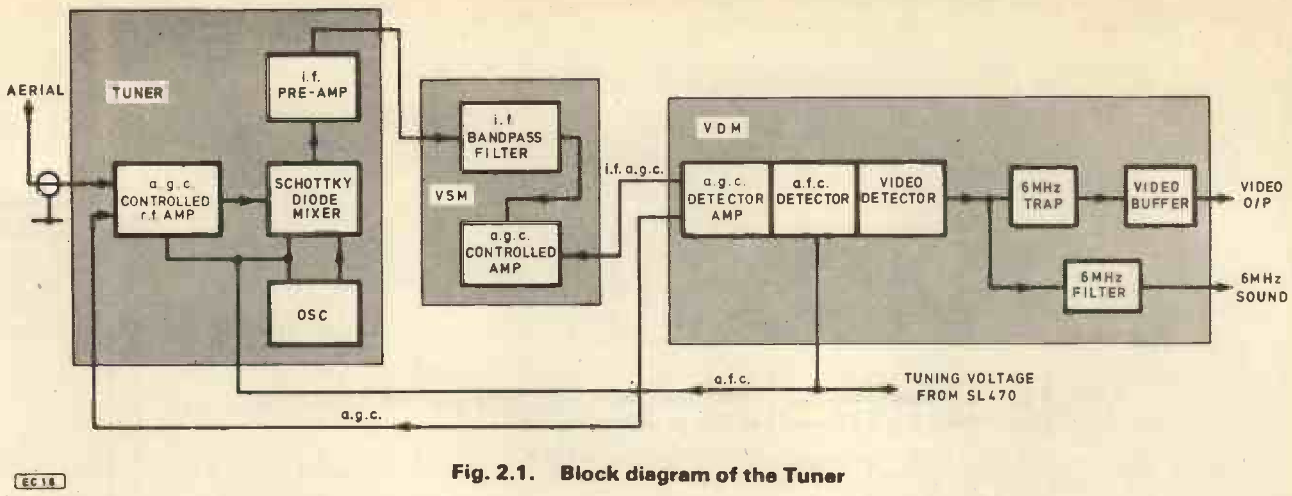


Fig. 2.1. **Block diagram of the Tuner**

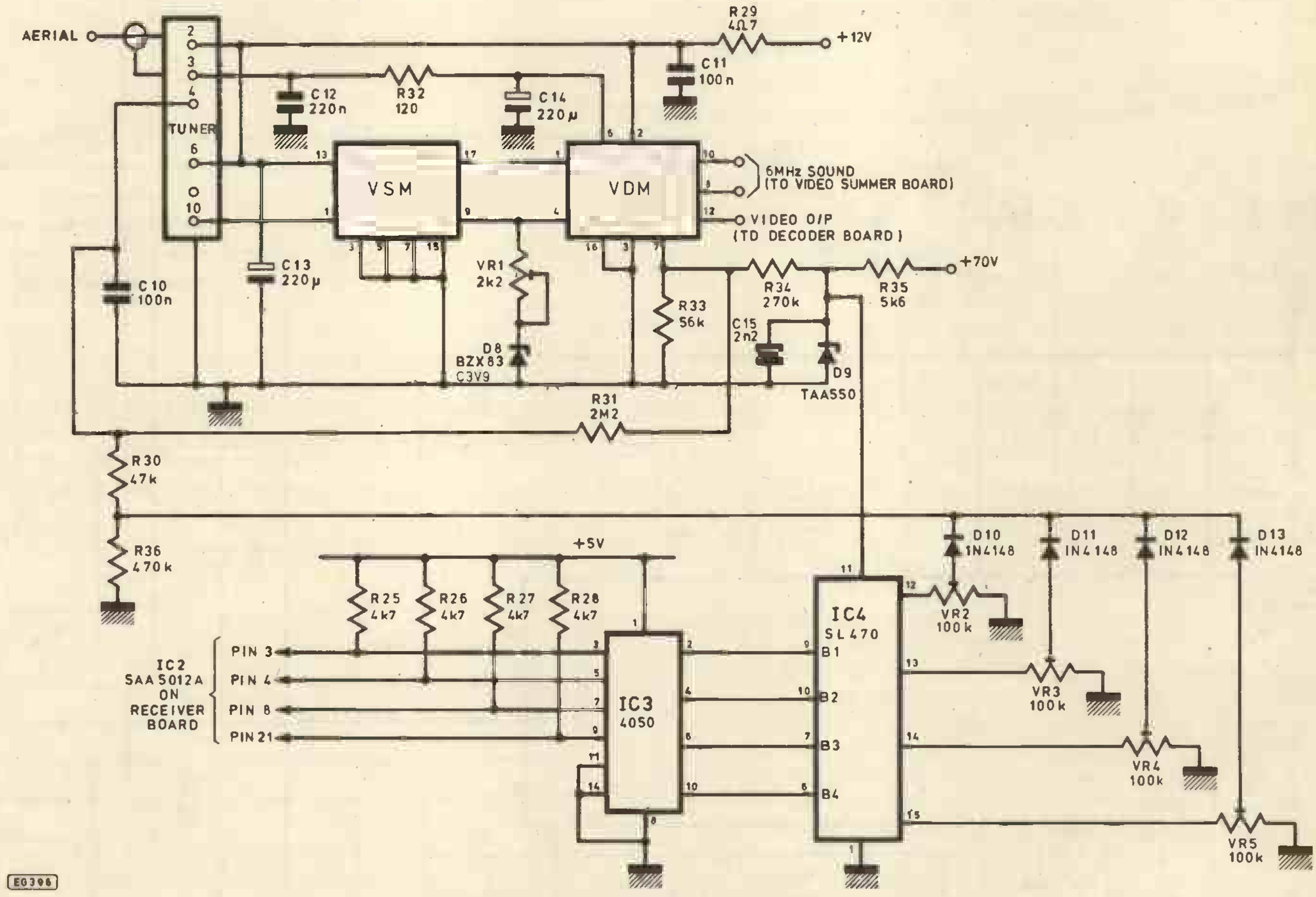


Fig. 2.2. **Circuit diagram of the Tuner Circuit**

CONSTRUCTION

The p.c.b. design for the tuner is shown in Fig. 2.3 with the component layout in Fig. 2.4. The smaller components should be mounted first and the tuner, VSM and VDM mounted last. There is a wire link which should be fitted near one end of IC4.

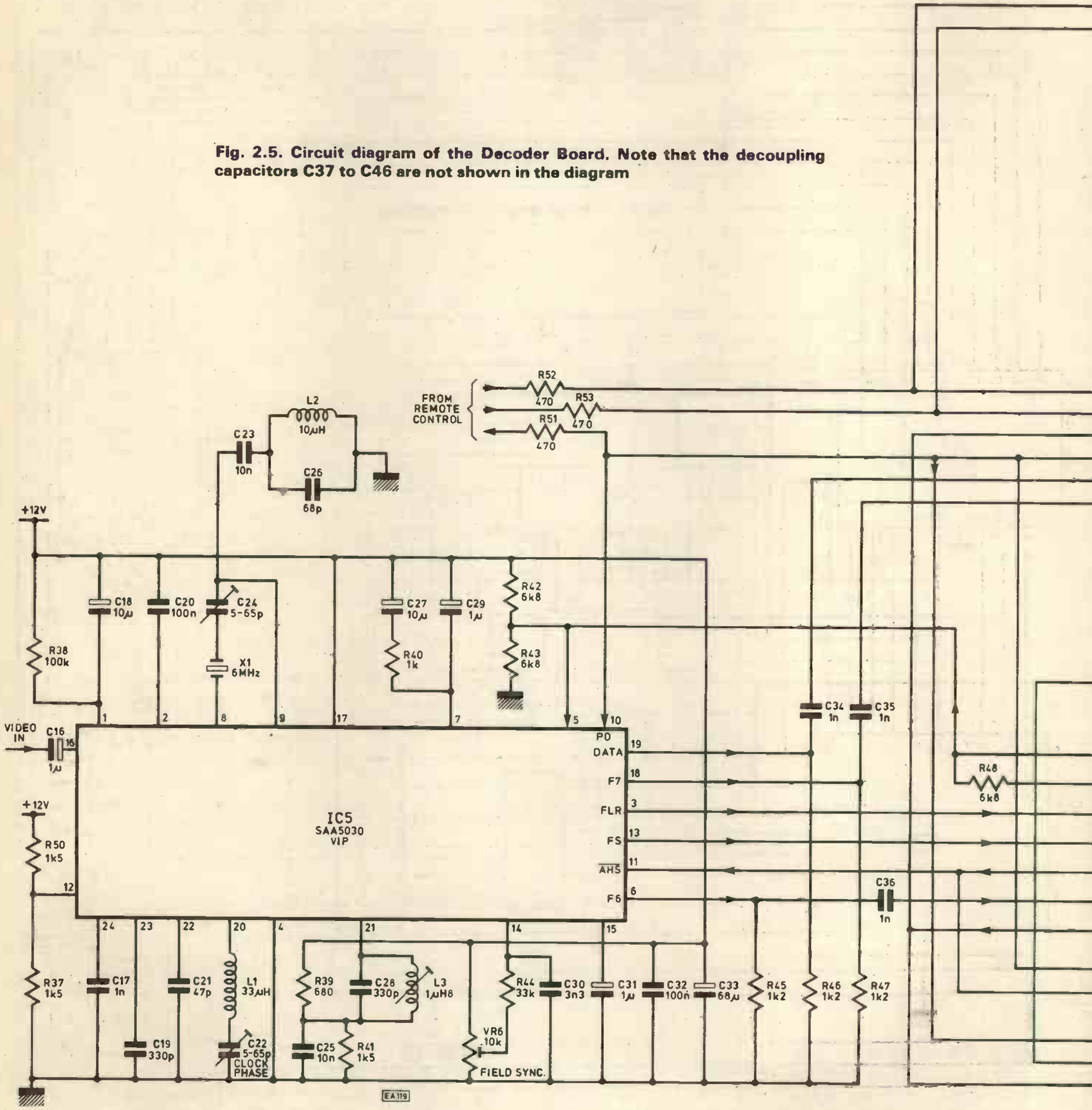
The eleven connections from the tuner can be wired using ribbon cable. After soldering check the board carefully for any solder splashes and if everything is alright insert the two i.c.s.

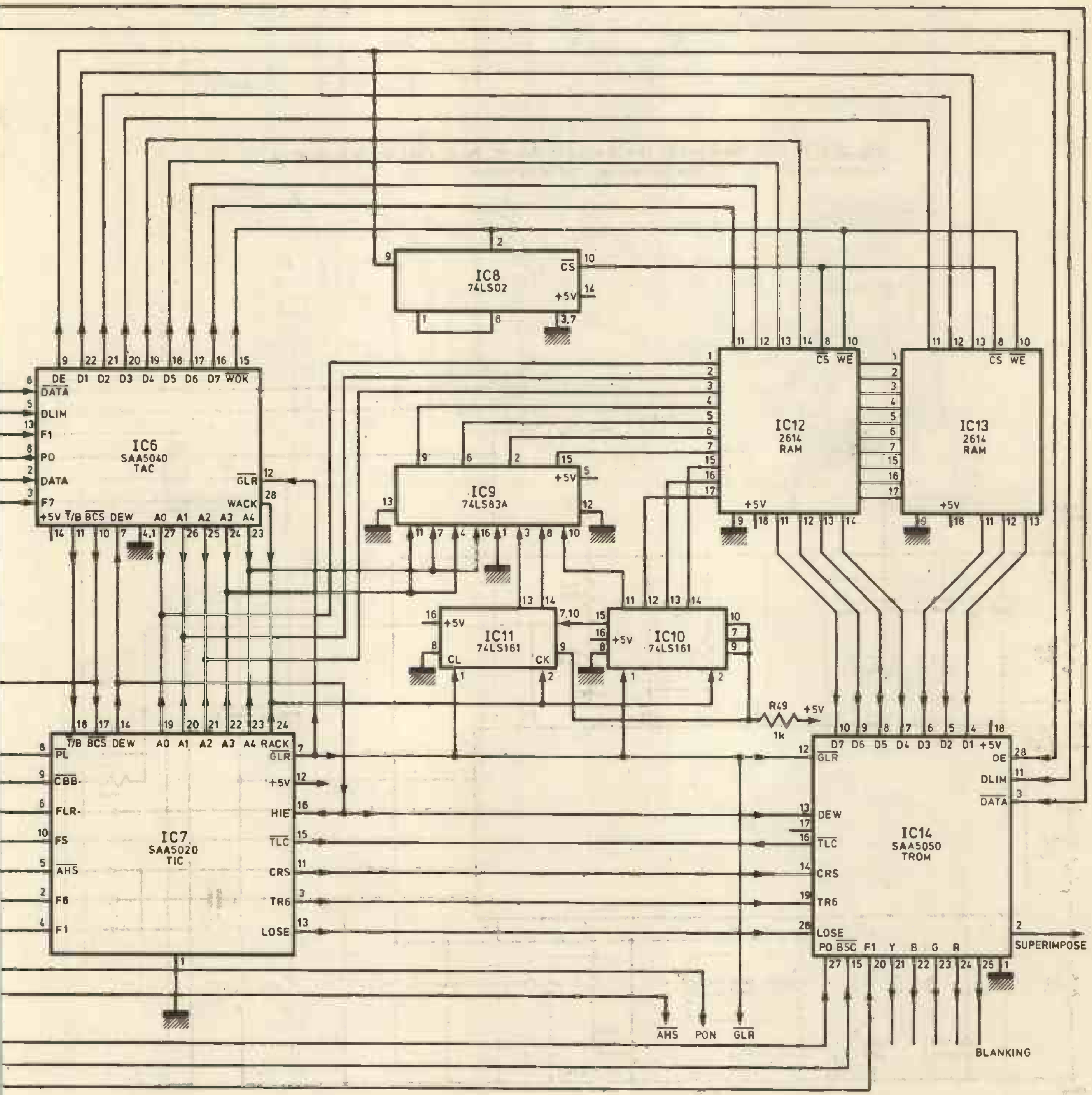
DECODER

The circuit diagram of the decoder unit is shown in Fig. 2.5. The decoder has been designed around four dedicated LS1 integrated circuits. The main functions of the four i.c.'s are:

SAA 5020 (TIC)	Timing chain
SAA 5030 (VIP)	Video input processor
SAA 5040 (TAC)	Teletext data acquisition and control
SAA 5050 (TROM)	Teletext ROM, character generator

Fig. 2.5. Circuit diagram of the Decoder Board. Note that the decoupling capacitors C37 to C46 are not shown in the diagram




IC6
SAA5040
TAC
DE D1 D2 D3 D4 D5 D6 D7 WOK
DATA
DLIM
F1
PO
DATA
F7
GLR
WACK
+5V T/B BCS DEW A0 A1 A2 A3 A4
IC7
SAA5020
TIC
T/B BCS DEW A0 A1 A2 A3 A4 RACK
PL
CBB
FLR
FS
AHS
F6
F1
GLR
+5V
HIE
TLC
CRS
TR6
LOSE
IC8
74LS02
CS
+5V
IC9
74LS83A
+5V
IC10
74LS161
+5V
IC11
74LS161
+5V
CL
CK
IC12
2614
RAM
CS WE
+5V
IC13
2614
RAM
CS WE
+5V
R49
1k
+5V
IC14
SAA5050
TROM
D7 D6 D5 D4 D3 D2 D1 +5V
GLR
DE
DLIM
DATA
DEW
TLC
CRS
TR6
LOSE
PO BSC F1 Y B G R
SUPERIMPOSE
AHS
PON
GLR
BLANKING

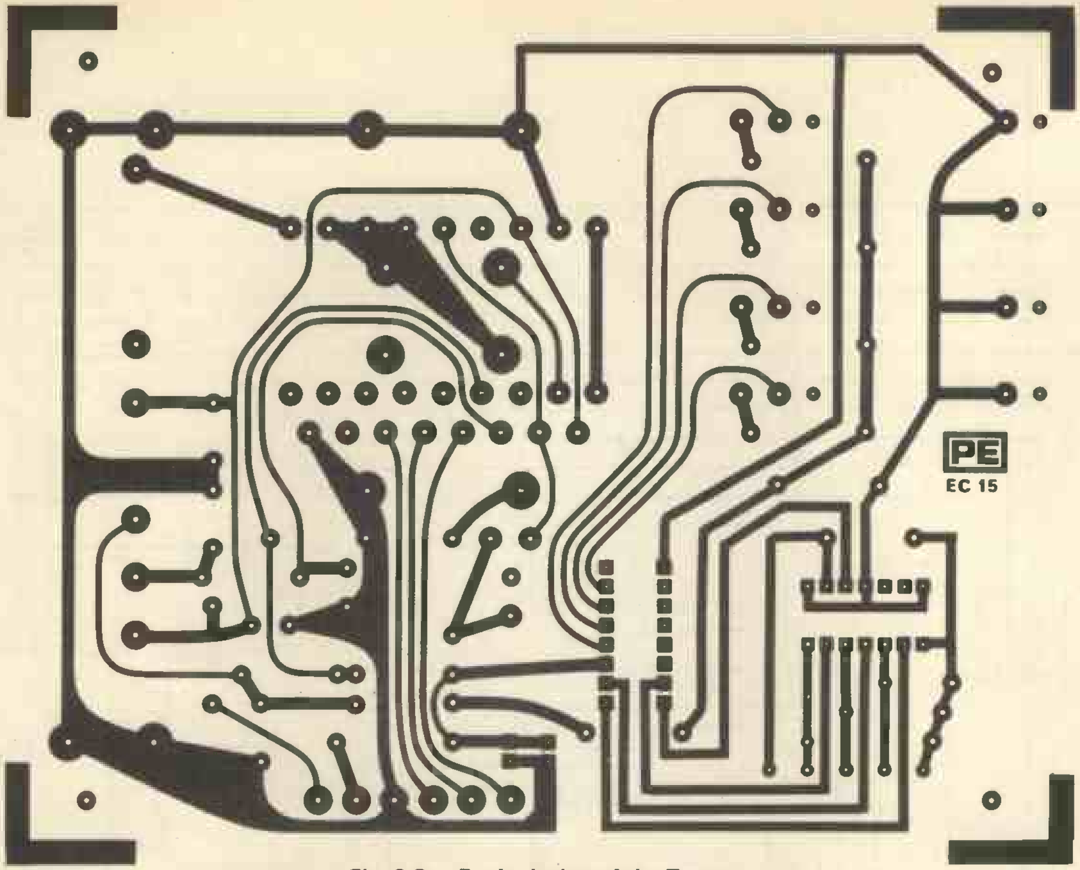


Fig. 2.3. P.c.b. design of the Tuner

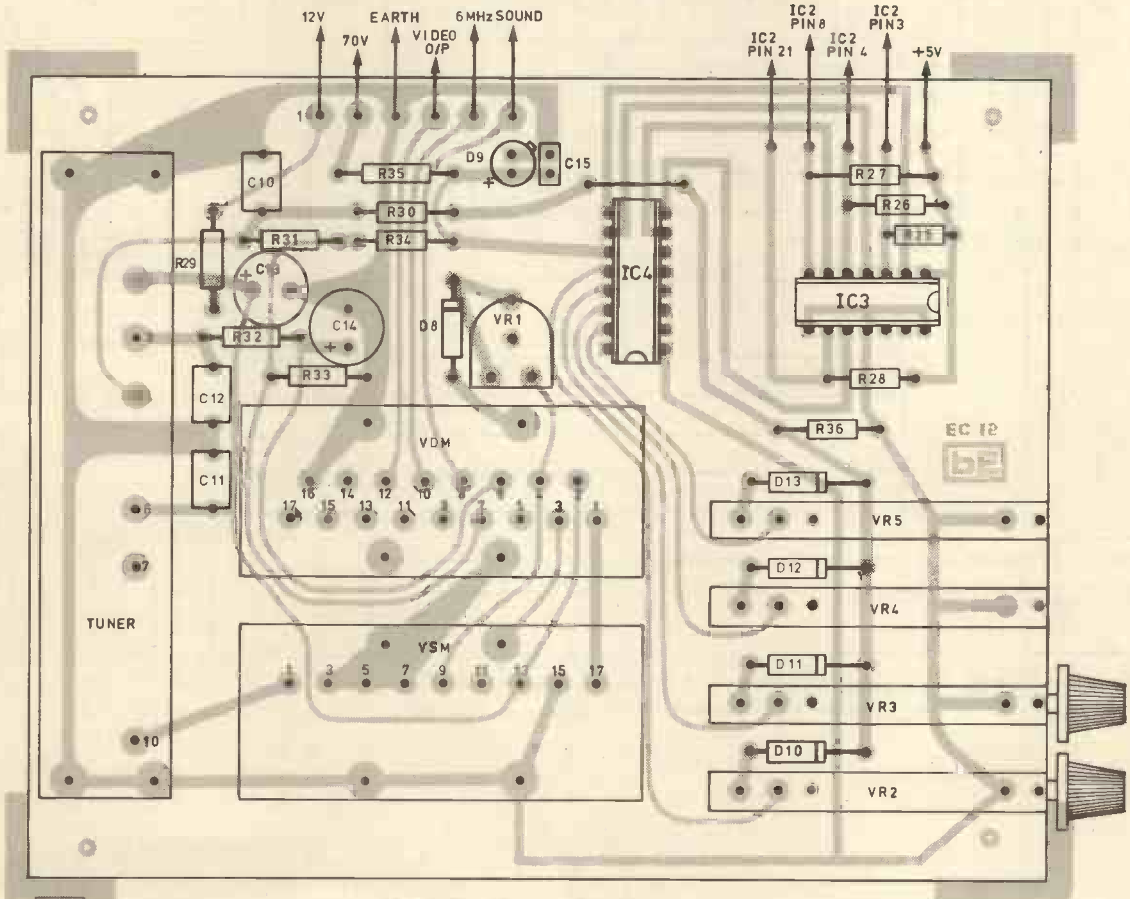


Fig. 2.4. Component layout

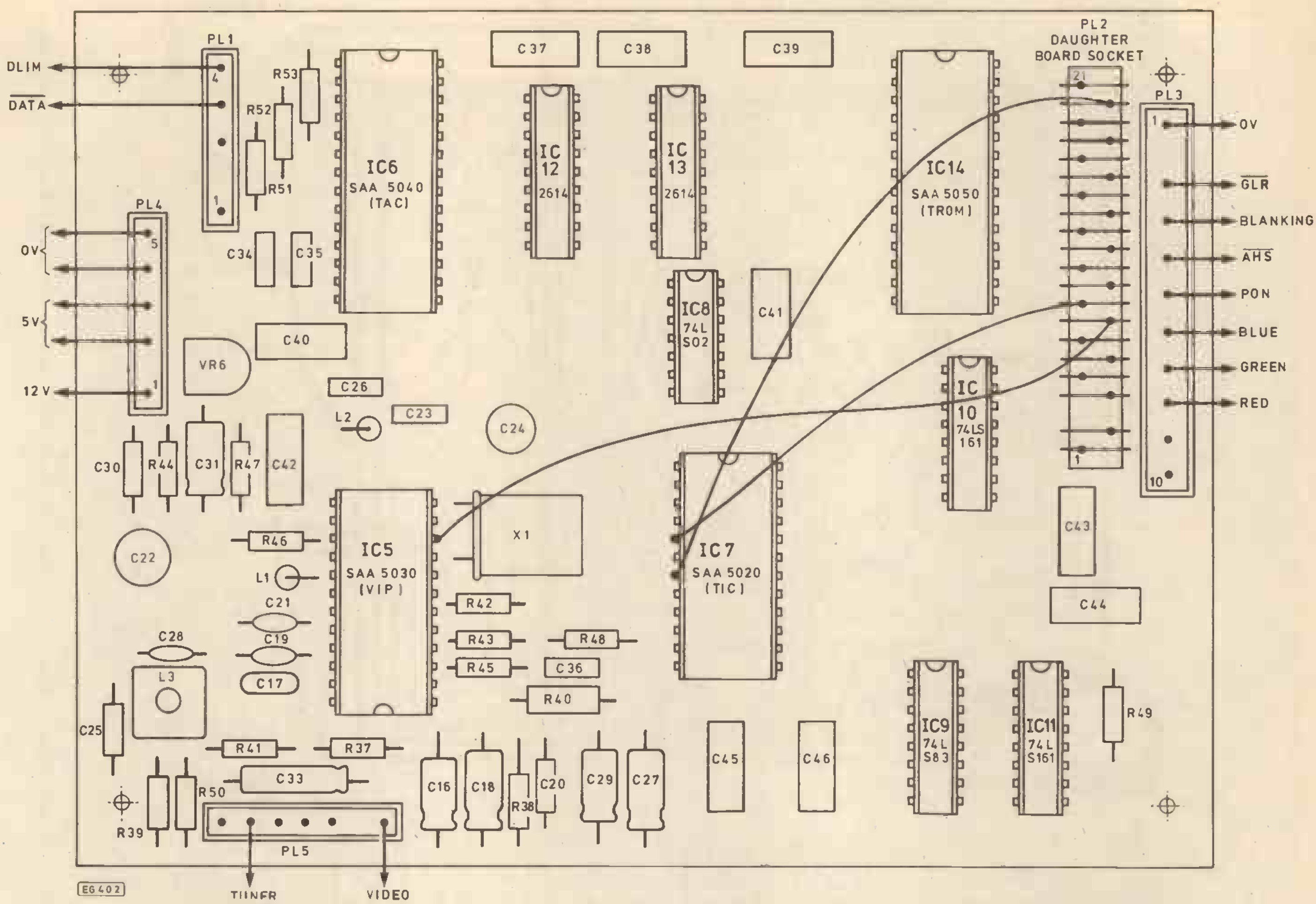


Fig. 2.6. Component layout of the Decoder Board. Note C32 is not used on the supplied board

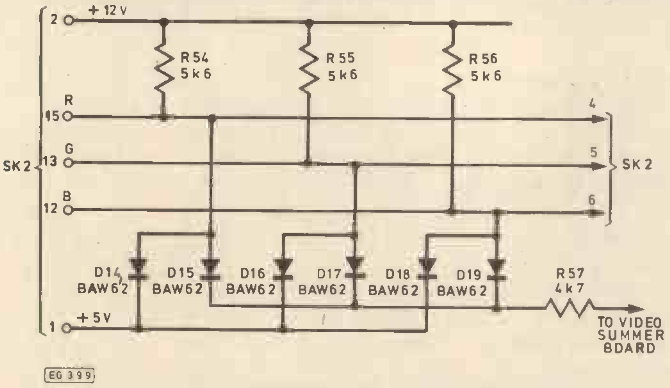


Fig. 2.7. Circuit diagram of the Daughter Board

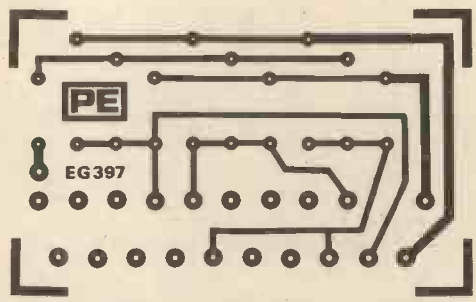


Fig. 2.8. P.c.b. design for the Daughter Board

COMPONENTS ... DAUGHTER BOARD

Resistors

R54, R55, R56	5k6 (3 off)
R57	4k7

Diodes

D14 to D19	BAW 62 (6 off)

Sockets

SK2	21-way socket
P.c.b.	

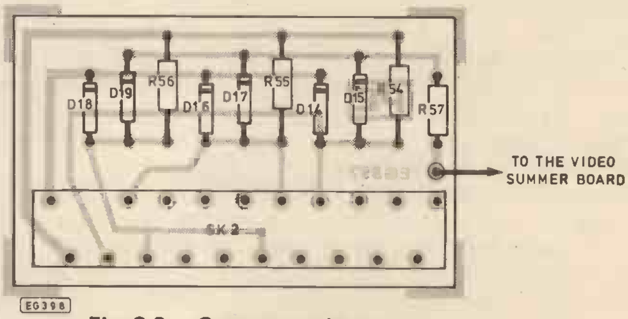


Fig. 2.9. Component layout

COMPONENTS ....

TUNER

Resistors

R25, R26, R27, R28	4k7 (4 off)
R29	4Ω7
R30	47k
R31	2M2
R32	120
R33	56k
R34	270k
R35	5k6 0·5W
R36	470k

All resistors ¼W 5% carbon except where otherwise stated.

Capacitors

C10, C11	100n (2 off)
C12	220n
C13, C14	220µ 16V (2 off)
C15	2n2

Semiconductors

D8	BZX 83 C3V9
D9	TAA 550
D10 to D13	IN4148 (4 off)
IC3	4050
IC4	SL470

Potentiometer

VR1	2k2 preset
VR2 to VR5	100k tuning pots (4 off)

Miscellaneous

Tuner 3113 108 6246
VSM 3113 108 25350
VDM 3113 108 25330
P.c.b.

DECODER

Resistors

R37, R41, R50	1k5 (3 off)
R38	100k
R39	680
R40, R49	1k (2 off)
R42, R43, R48	6k8 (3 off)
R44	33k
R45, R46, R47	1k2 (3 off)
R51, R52, R53	470 (3 off)

All resistors ¼W 5% carbon

Capacitors

C16, C29, C31	1µ 25V (3 off)
C17, C34, C35, C36	1n (4 off)
C18, C27	10µ 25V (2 off)
C19, C28	330p (2 off)
C20, C32	100n (2 off)
C21	47p
C22, C24	5–65p (2 off)
C23, C25	10n (2 off)
C26	68p
C30	3n3
C33	68µ 25V
C37 to C46	100n (10 off)

Semiconductors

IC5	SAA 5030
IC6	SAA 5040
IC7	SAA 5020
IC8	74LS02
IC9	74LS83A
IC10, IC11	74LS161 (2 off)
IC12, IC13	2614 (2 off)
IC14	SAA 5050

The TIC, TAC and TROM i.c.'s are MOS N-channel devices whereas the VIP is a monolithic bipolar type.

The decoder has two main functions: to extract the teletext data from the incoming video signal and to process it, writing the page data into memory this function uses the VIP and TAC chips. The second function is to convert the information in the memory into a video signal to display the text on the screen. The generation of characters is carried out by the TROM and the TIC provides all the timing signals from the TIC which are synchronised to the incoming video signal so that the text and television picture may be displayed together.

The video signal from the Tuner board is fed to pin 16 of the VIP via a coupling capacitor (C16). The VIP has two separate sections: a data retrieval section and a display clock generator.

The incoming video signal contains picture, sync and teletext data which is sliced and then the teletext information extracted. A clock signal is generated from the sliced data using the tuned circuit connected to pin 21. This signal (F7) is used to clock the data into the TAC chip.

The 6MHz clock oscillator (pins 8, 9) has its output (pin 6) taken to the TIC chip where it is used to provide a clock pulse every 64µs. This pulse is then passed back to the VIP where it is compared with the incoming line sync signals. This enables the timing system of the teletext display to be phase-locked with the incoming television picture signal.

TAC SAA5040

The principle function of the data acquisition section of the TAC is to process the teletext data so that it can be written into the memory. The control section of the TAC receives information from the remote control (pins 5, 6). This information is processed and then used to operate the various display functions of the decoder (i.e. time, page selection, status etc.)

The data acquisition section checks the incoming data from the VIP and any words having a single bit error are corrected. Address words having two bits wrong are rejected.

The input (pin 2) receives a serial data stream of teletext data from the 5030 the data rate is 6·9375 MHz. The information is clocked into the TAC (pin 3) by the clock output from the 5030.

The memory block which consists of two 1K x 4 static RAMs receives character data from pins 16 to 22 of the TAC. Whenever a character is written into memory, WOK (write OK) pin 15 is activated. After each character a clock signal WACK (write address clock) pin 28 is supplied to the address counters to address the next memory location.

The DEW (data entry window) signal from pin 14 of the TIC enables the TAC to operate in the data entry mode by enabling the data and row address outputs. The data acquisition circuits of the TAC are reset at the end of every line by a $\overline{\text{GLR}}$ (general line reset) pulse from pin 7 of the TIC.

The PO (picture on) output to the 5012A, 5030 and 5050 from the TAC is used to switch the television video on or off (a 'high' for picture on and a 'low' for picture off).

A 'high' DE (display enable) output to the TROM enables the teletext display whilst in its 'low' state the display is disabled.

The $\overline{BCS}$ (big character select) output to the 5020 and the 5050 is used to select the double height characters. A 'high' output is used for normal characters and a 'low' for double height characters.

The T/B (top/bottom) output to the 5020 (pin 18) selects whether a top or bottom half page is selected (a 'high' for top, and a 'low' for bottom).

The three state outputs for the memory addresses (pin 23 to 27) AO to A4 specify in which of the 24 screen rows the teletext data is to be written.

TIC SAA 5020

The 6MHz clock signal (F6), which is used to derive the basic timings from the teletext display, is fed to pin 2 of the TIC from pin 6 of the 5030. This signal is sub-divided by the TIC down to 25Hz, the frame rate of the television to generate all the timing signals for the teletext display.

The F1 output (pin 4) is a 1MHz clock signal for the TROM and the TAC chips. The television display is synchronised by the internally generated sync signal $\overline{AHS}$ (after hours sync) output from pin 5. The CRS (character rounding select) output signal is required for correct character rounding of the small characters within the character generator.

The internal data processing and sync circuits of the VIP are reset using the $\overline{CBB}$ (colour burst blanking). The internal control character flip-flops of the TROM chip are reset at the start of each display line by the LOSE (load output shift register enable) output from pin 13.

TROM SAA 5050

The basic input to the TROM is character data from the teletext page memory. This is in the form of a 7-bit code which is fed to pins 4 to 10. The TROM converts the data into a dot matrix pattern. The character generator ROM (4·3K bits) generates 96 alphanumeric and 64 graphic characters.

The video output signals consist of a monochrome output (pin 21) and red, green and blue signals (pins 24, 23, 22) which contain both character and background colour information. A blanking output signal is provided to blank out the television video when a newsflash or subtitle is displayed.

CONSTRUCTION

The decoder board is supplied ready built, tested and aligned. Before the board is installed the three wire links shown in Fig. 2.6. should be soldered. Check these wires carefully. The wiring for the decoder is also shown in Fig. 2.6. but it is recommended that constructors leave the wiring of the system until all the boards have been assembled.

DAUGHTER BOARD

The decoder board is interfaced to the video summer board via the interface circuit shown in Fig. 2.7. The RGB outputs from the TROM have pull-up resistors to 12V with catching diodes to prevent the outputs rising above 5V. These outputs are then diode ORed together and produce a current via R57 which is then added to the luminance channel at the delay line input on the summer board.

The daughter board is mounted on the p.c.b. shown in Fig. 2.8. with the component layout shown in Fig. 2.9.

NEXT MONTH: VIDEO SUMMER AND P.S.U.

PATENTS REVIEW...

Copies of Patents can be obtained from:
the Patent Office Sales, St. Mary Cray, Orpington, Kent. Price £1·25 each.

COBALT MAGNET ALTERNATIVES

There is now a serious world shortage of cobalt metal. This is largely due to the fact that cobalt is produced as a by-product of copper mining and most of the cobalt-copper ore mines are in Central Africa where the political situation is very unstable. The military and aerospace have first call on cobalt because it is an essential ingredient of high temperature alloys, as used for instance in jet engines. Loudspeaker manufacturers have for years used cobalt alloy magnets, for instance Alnico (aluminium-nickel-cobalt), because it offers high flux density. In turn this facilitates low leakage design by potting a compact magnet in a shield. In a colour TV set flux leakage sours the picture colours and hence potted cobalt magnets have been used almost exclusively in colour TV production. But the rising cost of cobalt has stimulated research into alternative approaches.

Two recent patents reflect this research and the worldwide trend away from cobalt as a magnetic material. UK patent application 2 031 247, filed under the New Laws by Hokuto Onkyo Co. Ltd. of Tokyo and dating from 3rd October 1978, contains a legally very broad claim to the basic concept of potting ferrite instead of cobalt. Figures 1 and 2 show known, but supposedly unsatisfactory, designs in which a ferrite magnet 10 is shielded by a pot or cup. Figure 3 shows the Onkyo design. Yoke 1 houses ferrite magnet 2. Pole 3 extends through a gap in the yoke 1 which also houses voice coil 5. The pole 3 has a cylindrical part 3a which merges into a tapered or frusto-conical part 3b. According to the rather vague wording of the patent this construction, along with the gap formed between pole cylinder 3a and yoke 1, decreases permeance between the pole and yoke. The greater the sectional area of the magnet the easier it is to keep the permeance low. The inventor claims that this decreased permeance reduces flux leakage, making the magnets suitable for use in a colour TV loudspeaker.

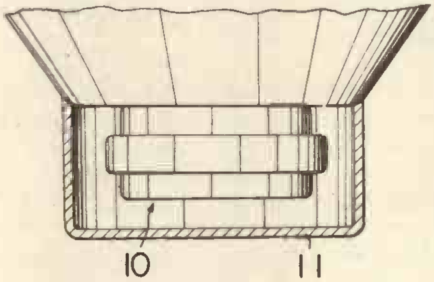


Fig. 1

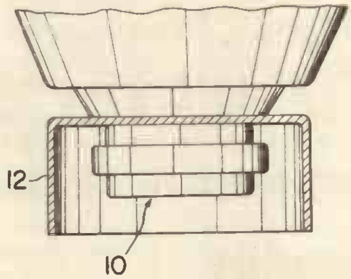


Fig. 2

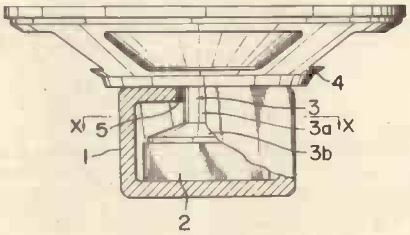


Fig. 3

A similar claim is made by a Danish inventor in UK patent application 2 034 154, (which was filed under the New Laws) and dates back to October 1978. Although the aim is the same the approach is different. Figure 4 shows a known Alnico design. Central rod 4 is a permanent Alnico magnet inside a cylindrical pot 6. The Alnico rod backs onto base disc 2 and pole disc 18. As the inventor points out, such a compact fully shielded design has been possible because the Alnico rod 4 can be small due to the high magnetic efficiency of cobalt-based materials. But ferrite is less efficient and this makes similarly compact designs of inadequate magnetic strength. The new design is shown in Figure 5. A large ring 4 of ferrite is housed in a pot 6 which is integrated with rear pole disc 2. Front pole piece 18 is slightly larger than the ring magnet 4 and the whole combination is mounted in a cup 22. An alternative design, based on a solid disc magnet 4 is shown in Figure 6. The point of the invention is that the voice coil 12 is of much larger diameter than usual. This enables the large ferrite magnet to be used inside a pot rather than around the voice coil as an annular magnet. Again the claim is to a loudspeaker with insignificant flux leakage.

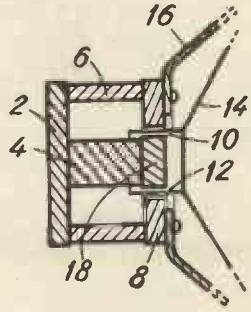


Fig. 4

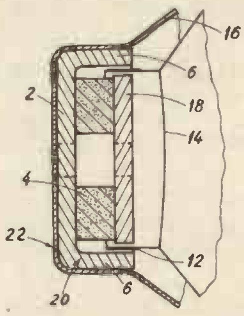


Fig. 5

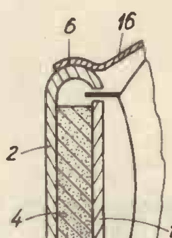


Fig. 6

LAST month the general principles of the GEB detector were explained, and construction of a machine began with a p.c.b. comprising power supply, auto-tuning and output stages. This month the remainder of the construction will be covered.

SEARCH COILS

It's best to begin by winding the search coils, which will be required for testing the front-end circuit board at various stages. The Magnum uses a pinpoint coil, for reasons explained last month; these are slightly harder to make than widescans but the results obtainable are well worth the effort. The coil assembly is based on a 10in dia. 'Melaware' plate, made from a very rigid plastic, obtainable from most stores selling picnic tableware.

The inside of the plate is thoroughly roughened with glasspaper to enable glassfibre resin to stick to it, and two 'L' shaped plastic brackets are bolted to the top as in Fig. 6. These were cut from a thick, strong square-shaped clip intended for mounting square section plastic drain pipes to exterior walls, obtained from a local builders' merchants. They are bolted to the plate with 2BA countersunk screws with the heads inside, so nothing protrudes to foul the coils. A hole is drilled just behind one of the brackets to allow a 4-core screened cable to pass through.

The two coils are wound on pins pushed into a suitable board. The larger transmitting coil is made with just five pins positioned as shown in Fig. 7a, on which 60 turns of 32 s.w.g. enamelled copper wire is wound. It can be tied temporarily with a few twists of wire and removed from the pins—this is fiddly but not too difficult—bent to the shape of Fig. 7b, and bound tightly with a spiral of thin bare wire such as 5 amp fusewire, leaving a loop near the lead wires for use as a connection. Remove the temporary ties as the binding proceeds. A strip of aluminium cooking foil is then wrapped over the bare wire to form a Faraday shield, and this is held in place with another tight binding of the bare wire. Note that both wire bindings and the foil *must* have a gap—this is most important, as if the Faraday shield were allowed to form a complete 'turn' around the circumference of the coil it would render it useless.

PICKUP COIL

The pickup coil is made in the same manner, consisting of 200 turns of 36 s.w.g. enamelled copper wire wound around 16 pins placed in a 4in diameter circle. Faraday shielding is fitted as on the transmitting coil, again with the all-important gap.

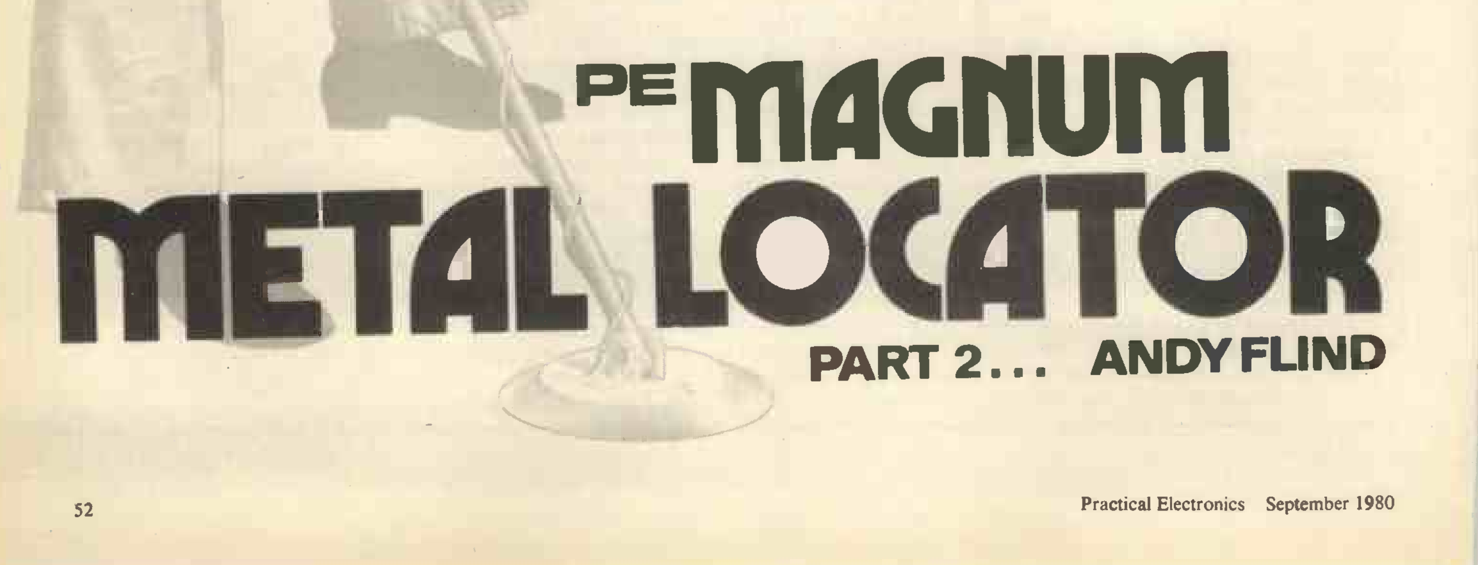
The transmitting coil can now be fixed in place on the former using a small quantity of fibreglass resin. A Holts' 'Fibreglass Repair Kit', obtainable from motoring accessory shops, was used in making the prototype. The coil is best fixed in stages, using clothes pegs and weights to keep it in place as necessary. Apply the resin with a soft brush and have a jar of cellulose thinners handy to dunk the brush into the moment it starts to 'gel'. Push the 4-core screened lead through the hole in the plate, connect the coil leads to two of the cores, and the Faraday shield to the screens. It can be difficult to keep the lead in place whilst the resin sets; one way of doing this is to drill two tiny holes on each side of it and secure it flat against the plate with a couple of twists of thin wire. The pickup coil is not fitted at this stage.

FRONT-END PCB

Start building the 'front-end' circuit board by fitting all the links. Then fit R1 to 3, C1, 2, and 26, D1, and TR1. Hook up the transmitting coil and apply power from the supply board. Continue using a resistor in series with the 18 volt battery in case any faults arise during tests, as described last month. The transmit oscillator should now be running, at between 15 and 16kHz. This can be checked by placing a radio tuned to a weak longwave station very close to the coil-faint whistles due to harmonics of the transmitted signal beating with station carries should be present. Faint is the word, however, as the Magnum's oscillator produces a very clean signal. This and other parts of the circuit can be more easily checked with a 'scope of course, but if you have one you'll probably have realised this anyway.

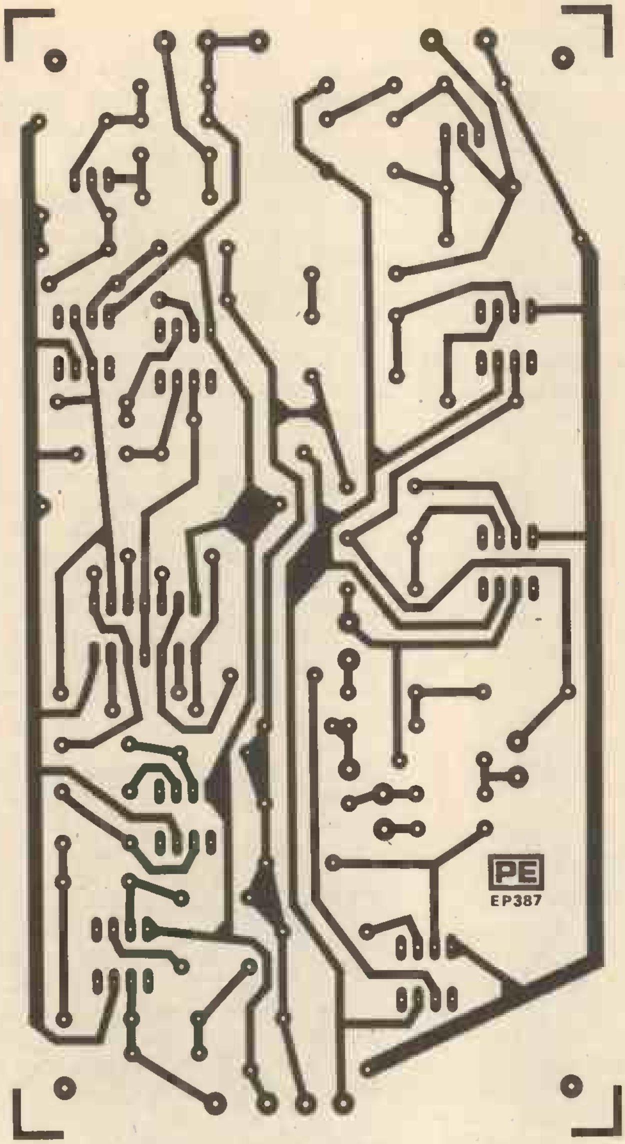
Next fit R4 to 13, C3 to 8 and IC1. Apply power and check that IC1's d.c. output voltage (at pin 6) is equal to 5·6V. Fit IC2, apply power and check IC2's d.c. output is 5·6V. Fit IC3, hook up VR1 across points I and J, VR2 across points G and H, and fit some lengths of wire so that point M may be shorted to points K or L, and short one of these. It doesn't matter which at this stage. Apply power and check that IC3's d.c. output (pin 6) is 5·6V. The output of IC2 should actually be switching from rail to rail at the oscillator's frequency but the average value of output should be 5·6V. A fault will usually result in its being fully driven to one of the supply rails, so this is a useful test. Check that settings of VR1 (M shorted to L) and VR2 (M to K) makes little or no difference to IC3's output voltage.

It might be of interest to explain that in the original design, the pots were connected directly as they are in this test, and a 2-way switch was fitted to M, K and L. This provides 'Ground Reject' (VR2) and 'Discriminate' (VR1). However, on the first beach outing it was found that the 'Beach Effect' could only be rejected with the 'Discriminate' control: a predictable effect since beaches are usually conductive. This prevented the discrimination from being used to reject foil, of which large amounts are to be found on most beaches. To overcome this problem the switching was

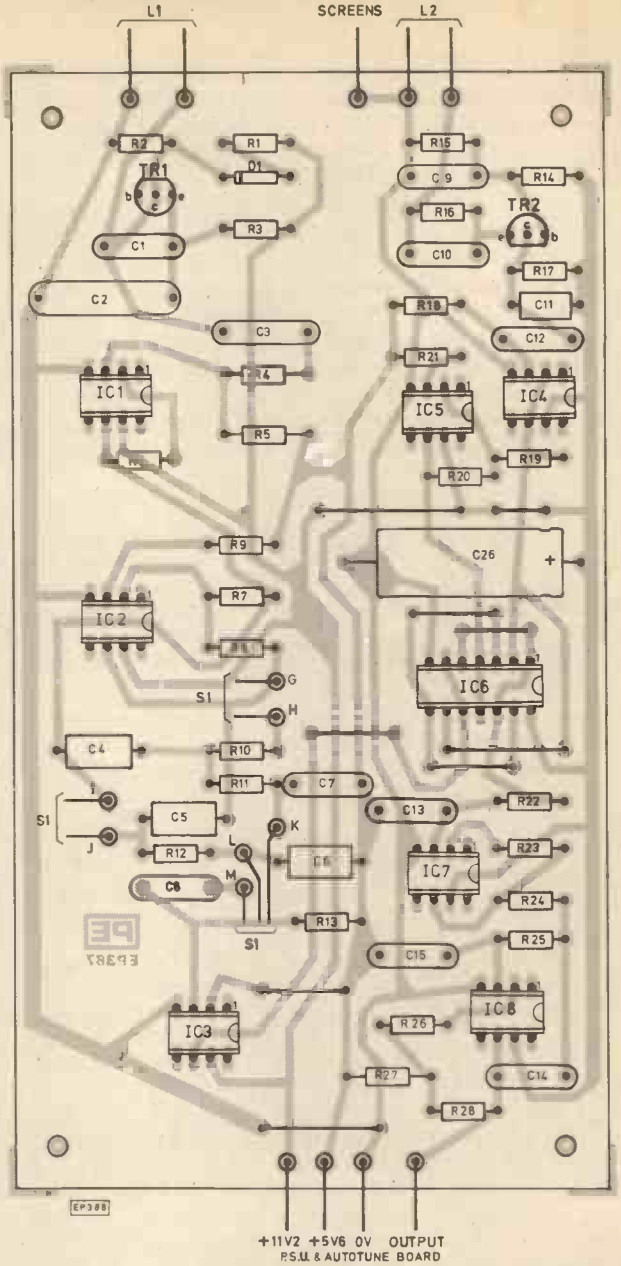


PE MAGNUM METAL LOCATOR

PART 2 . . . ANDY FLIND



FRONT-END BOARD



rearranged to provide a third 'Beach' position, in which VR2 is effectively switched into the discriminate circuit instead of the ground one. Thus VR2 can then be used to reject false signals from wet beaches in the same way as from ground, whilst VR1 can once again be used to check finds as intended.

Continue the construction by fitting R14 to 21, C9 to 12 and TR2. Connect the pickup coil temporarily, apply power and check that the emitter voltage of TR2 is approximately 0·6 volts above the negative rail. Fit IC4, apply power and check IC4's output voltage (pin 6) is 5·6V. Fit IC5, apply power and check that the output of IC5 is also V/2.

Fit R22 to 28 and C13 to 15. Fit IC6, observing the usual CMOS handling precautions for this chip. Place the pickup coil in approximate position over the transmitting coil, apply power and monitor the top end of R22 with a meter. The voltage present should be somewhere between 2 and 8 volts and should alter if VR1 or VR2 (whichever is selected by shorting M to K or L) is moved. Adjust the pickup coil position to obtain 5·6V at the top end of R22. Note that the Faraday shields of the coils shouldn't touch even though they are both connected to the lead screens: if they touch on both sides they can form a 'shorted turn' in the middle of the assembly. Small pieces of card should be placed between them to prevent this from happening.

Fit IC7, check it's output is the same as that at the top of R22, i.e. 5·6V. Fit IC8. Check 5·6V is still present at IC7 pin 6—if not adjust coil position. Then check that 5·6V is also present at the output of IC8. This completes the construction of the front-end p.c.b.

HARDWARE ASSEMBLY

The rest of the hardware can be constructed next. This is made mainly from $\frac{3}{4}$in diameter plastic plumbing pipe and fittings, assembled as shown in Fig. 8. It's simply glued and pushed together, making a very presentable handle and stem in a surprisingly short time. Wood dowelling is inserted at strategic points of the stem to prevent it from flattening when bolts are passed through it and tightened. The search coil is fixed by a length of studding passing through the two brackets and the end of the stem, with a wingnut at each end, so that it's tilt may be easily adjusted by the user. The control box base is secured to the shaft with two bolts, and the tuning button is fitted into the end of a bicycle handlebar grip which is then pushed onto the plastic pipe, threading the wires through the pipe to emerge through a small hole close to the control box.

CONTROL BOX ASSEMBLY

The electronics now have to be assembled into the control box. The top should be cut to accept meter, pots and switch in the layout shown in Fig. 9. Note that the top only fits the base one way round before starting this! A pattern of holes can be cut in one of the aluminium side panels to act as a speaker fret, the speaker being glued into place. A clip to hold the three PP3 batteries is fashioned from sheet aluminium and wood and bolted to the same panel, and to the ends of the bolts a piece of Veroboard is attached to act as a connecting block for the leads from the batteries and tuning button. Four 4BA bolts passing up through the base of the box act as stand-off pillars on which the two p.c. boards are mounted one above the other, the front-end board being uppermost.

The best way to make all the connections to the boards is with ribbon cable, soldering this to them before fitting them into the case and noting the poit to which each coloured wire goes. A headphone socket is optional: if required it may be connected as shown in Fig. 5. 'R' will have to be selected for the phones to be used, in the prototype a value of 100 ohms was found to be suitable. A 5-pin DIN plug and socket was used for the coil lead, whilst not strictly necessary this does allow for experimenting with different coils at a later date.

The box specified is supplied with feet which were discarded, the securing bolts being shortened a little to compensate.

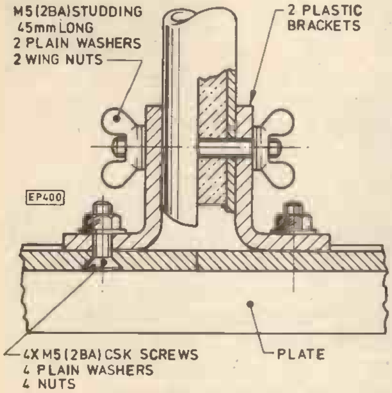


Fig. 6 (left). Search plate mounting assembly

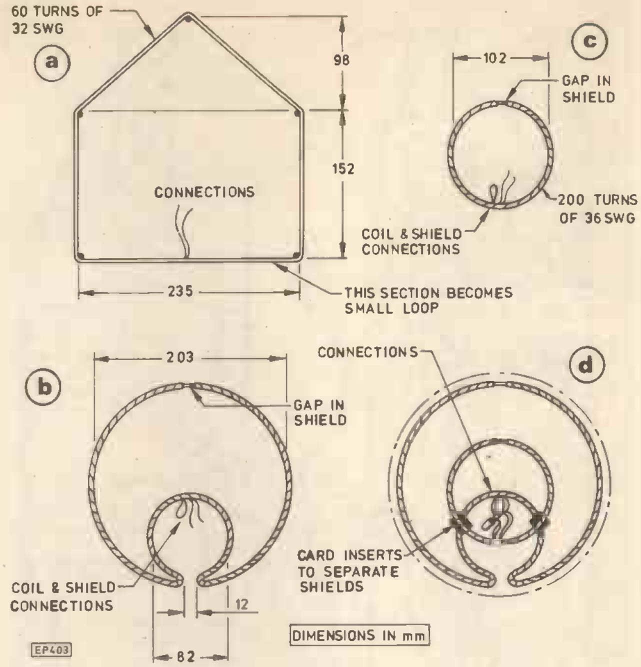
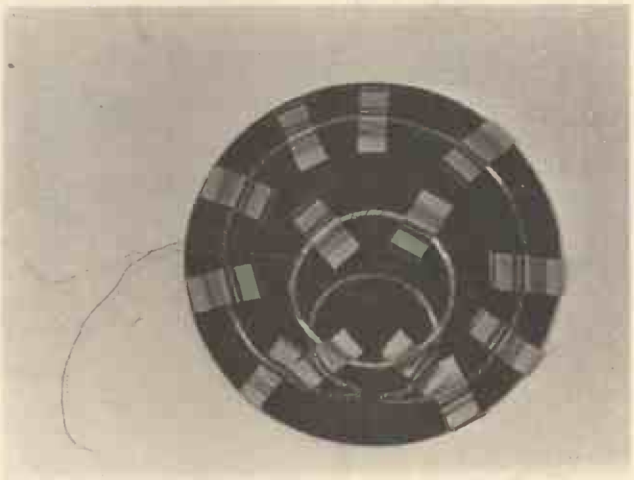
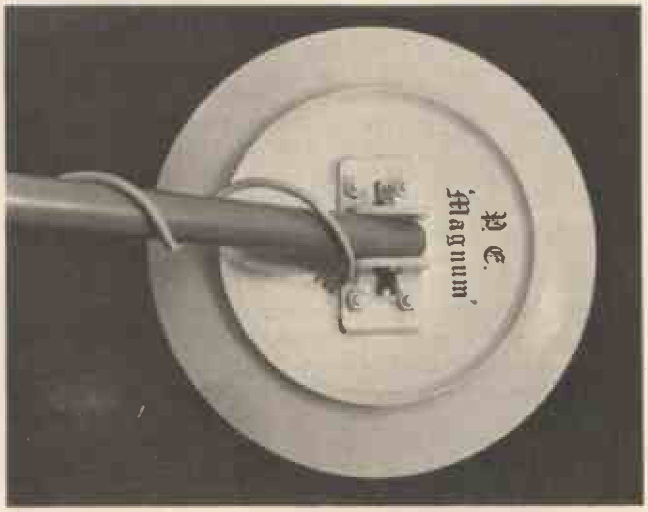


Fig. 7 (right). (a) Winding the transmitting coil; (b) Transmitting coil bent to shape; (c) Pick-up coil; (d) Positioning the coils





SETTING UP THE SEARCH COILS

When all the components have been wired up the final tricky part has been reached; the setting up of the search coils. This must be done with metal parts such as the securing bolt and wing nuts in place, though there is no need to have the coil assembled to the stem. There should be no large metal objects close to the coil during this stage. This might also be a good time to mention that the machine can be affected by line timebase radiation from 625-line TV sets, so if you get a 'mushy' sound or a pulsed audio effect from it, check this first. Coil adjustment is actually not as critical as it is for a normal IB machine, but there is a best point and for a GEB machine it is the position where absolute minimum residual amplitude output (and maximum phase shift effect) is obtained from the pickup coil. (Conventional IBs usually work best with a slight 'offset' from absolute null.) This cannot be monitored with the phase sensitive detector in the machine itself, so the circuit of Fig. 10. should be lashed up and connected to IC4 output (top end of R19) and used with

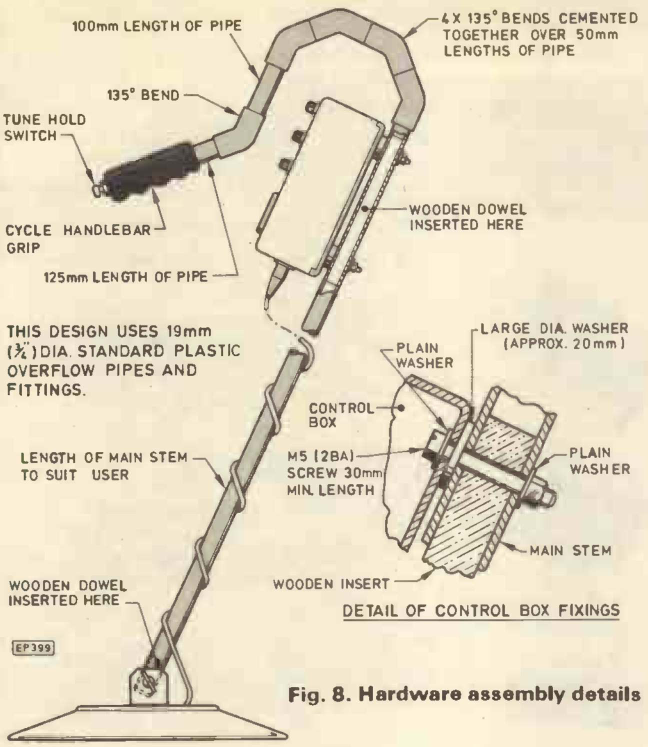
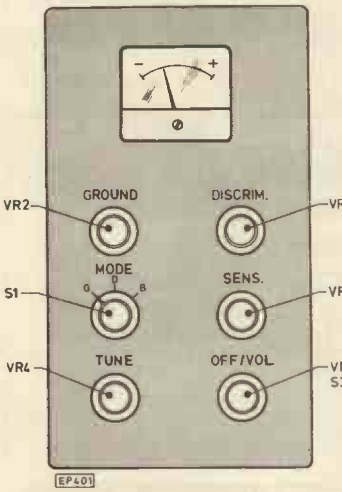


Fig. 8. Hardware assembly details



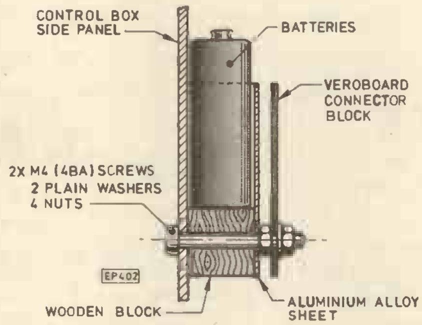


Fig. 9 (left). Control fascia; (above) Detail of battery mounting

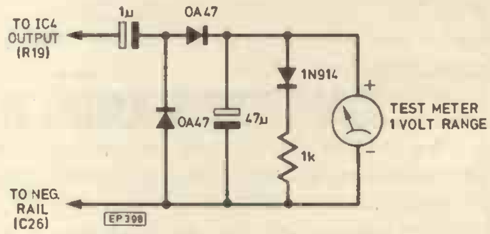


Fig. 10. Circuit for setting up search coils

the 1 volt range of a testmeter to facilitate setting up minimum amplitude.

Set VR1, VR2 and VR3 to mid-point. Switch to 'Discriminate' and switch on. The meter monitoring amplitude will probably indicate full scale. Carefully adjust the pickup coil position until the reading falls—this may take some patience as it's easy to push the coil right past the null position without noticing it if you're too hasty. Remember to keep those Faraday shields apart! Once you have the coils somewhere near the null, try presenting metal objects to the coil whilst watching the centre-zero meter. A non-ferrous object such as a copper coin should cause it to rise, whilst a ferrous object such as a nail should cause a fall. If the opposite happens the phase of the pickup coil must be reversed, either by turning it over or by reversing its lead connections.

Once correct coil phase has been established setting up consists of adjusting the pickup coil position for absolute minimum output from the amplitude monitoring test circuit, use resin to stick it down in stages, rechecking the adjustment at each stage. Final fine trimming can be done with only a small section of the pickup coil still moveable.

After the positioning of the coils has been completed the coils can be given a coat of resin, followed by a layer of chopped strand glassfibre mat and more resin, which produces a search head assembly that is neat, tough and totally waterproof. One word of caution; don't use more resin than you have to or the finished head may be heavier than necessary.

FINAL ASSEMBLY AND TESTS

All the test components can now be removed and the machine finally assembled and tested. If you've never used a GEB machine before, you're in for some pleasant surprises.

On switching on, the meter should self-zero within a couple of seconds and the tuning control should then be set just below the threshold of the audio tone. The sensitivity of this machine is quite incredible; on most inland sites you'll probably need to keep the sensitivity control set to around mid-point. With the switch in 'Ground' position, a point can be found on the 'Ground' control where moving the head to and from the ground has no effect whatever—on one side of this point there will be positive ground effect, on the other negative, so it's not difficult to find. Adjusting this control for wet beaches is the same, except that the switch should be set to 'Beach'.

Once an object has been located, the machine should be switched to 'Discriminate' and the nature of the object determined. A certain amount of ground effect will be apparent in this mode, depending upon the actual terrain being searched. Ferrous objects produce a negative response at all settings of the discrimate control, but as this control is advanced so the machine will begin to reject small pieces of silver paper, then larger pieces, thick foil, and finally pull rings. It should be noted that in the pull-ring reject setting, however, it will also reject silver coins up to about 10p size. All discriminators suffer from this problem; but the ability to reject scrap iron and foil without difficulty is an absolute boon. Some practice with assorted objects—coins, nails and scraps of foil etc., is recommended before setting forth with this machine.

The tuning 'Hold' button will be found necessary for discriminating and for pinpointing the exact position of finds.

So, Good Hunting! Don't forget you need a licence for your detector; application forms for this can be obtained from: The Home Office, Radio Regulatory Dept., Waterloo Bridge House, London SE1.

★

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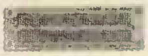
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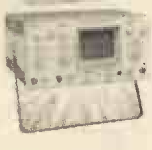

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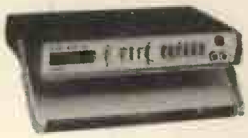

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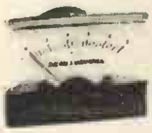

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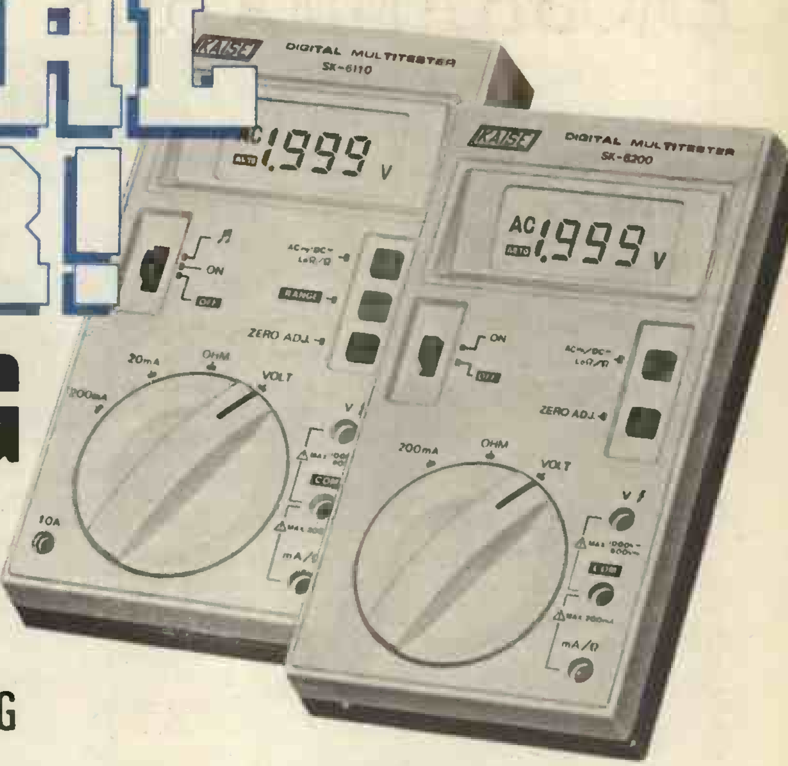

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Class 'A' Amplifier

K.Garwell

THIS type of amplifier which was designed whilst looking for a suitable unit to use in a theatre has been developed with two particular requirements in mind: reliability and short circuit protection of the output.

DESIGN CONSIDERATIONS

Class A was attractive for two reasons, which can be illustrated by reference to the conventional R.C. coupled stage shown in Fig. 1. The circuit is asymmetrical, there being only one transistor, which gives a low component count. Also the quiescent current through the stage is defined by the resistors and hence is not temperature sensitive. There is a bonus also from this type of circuit, as the output transistor is never turned off, there is no crossover distortion.

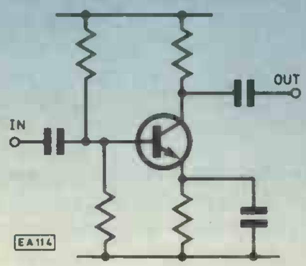


Fig. 1. Conventional R.C. coupled stage

There is, of course, one serious drawback with Class A, it's poor electrical efficiency. Sometimes referred to as conversion efficiency; the ratio between actual power into the load and power supplied from the d.c. supply. The best that can be achieved is about 17 per cent and that ignores the emitter resistor. Which would mean that a 50 watt amplifier consumed at least 294 watts and getting rid of 244 watts of heat (294-50) can be something of a problem.

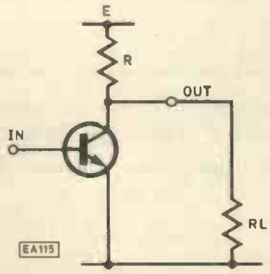


Fig. 2. Simple Class A circuit

If we look at a simplified Class A circuit without the complications of biassing and coupling as in Fig. 2 and consider the two limiting conditions. Firstly with TR1 just about cut off, i.e. the maximum positive excursion of the output. The current through the load R_L is $E/R + R_L$, but this current also flows through the collector resistor R; hence if W watts appears in the load, then WR/R_L watts appear in this resistor, which is wasted power. If R could be made very small this wasted power would also be small.

The other limiting condition appears when TR1 is just about saturated (ignoring the small collector-emitter voltage), the current through R_L is zero and hence the power is zero whilst the current through the collector resistor R is E/R and the power E^2/R, all the power is wasted. If R could be made large then this wasted power would be reduced.

This shows the two conditions have conflicting requirements. When the output is positive going R must be small, when the output is negative going R must be large.

An emitter follower, Fig. 3, has the property of impedance

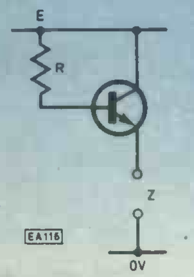


Fig. 3. Emitter follower circuit

reduction. The impedance Z measured between emitter and 0V (ground or signal earth) will be considerably less than the value of the base resistor R. Very roughly, it will be reduced in proportion to the current gain of the transistor, e.g. if the current gain is A then

$$Z = \frac{R}{A} \text{ approx.}$$

Returning to Fig. 2. If an arrangement having the characteristics of an emitter follower could be associated with R the collector resistor; and in addition, if this arrangement could be switched on whilst the output signal was positive going (made low resistance) and inhibited (high resistance) whilst the signal was negative going, then this would solve the conflicting requirements.

The requirement is to reduce the value of R whilst the output is positive going, i.e. supplying current (conventional flow) not during positive half cycles, the two are quite different. The same point must be made about the converse situation. The value of R must be increased whilst the output is negative going, i.e. demanding current, not the same thing as during negative half cycles.

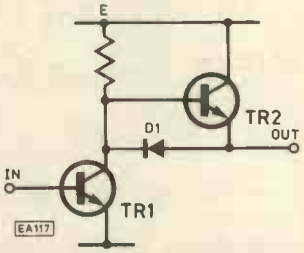


Fig. 4. Basic Class A stage with an emitter follower

Fig. 4 shows a basic combination of a Class A stage (Fig. 2) and emitter follower (Fig. 3). This combination is called Composite Collector Load Class A. The emitter follower being switched in or out of use by the diode D1.

Considering first the positive going situation where current is being supplied to the output. The collector potential of TR1 will rise in an attempt to supply current to the output or load. This situation will reverse bias diode D1 and forward bias the base emitter junction of TR2 which then behaves as an emitter follower supplying current to the load. The current through R will be only a small proportion of the load current, or looking at it another way the combined effect will be that of a collector resistor considerably smaller than R actually is.

Now consider the opposite situation when TR1 collector is negative going attempting to draw current from the output. The diode D1 will be forward biased and the base emitter junction of TR2 reverse biased. TR2 is thus out of action and the effective collector resistance is R only. TR1 thus absorbs the current from the load plus a small current via the resistor R.

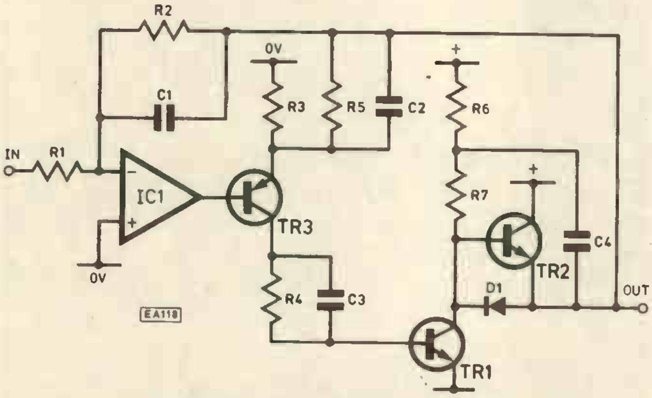


Fig. 5. Improved Class A circuit

CIRCUIT DESCRIPTION

The basic circuit shown in Fig. 4 illustrates the principle involved. To convert this to a practical design requires the addition of components to provide d.c. bias, the necessary a.c. drive to the base of TR1 and negative feedback to improve the performance. As shown in Fig. 5.

Resistors R1 and R2 establish the overall gain between input and output, which is equal to R2/R1. R2 also establishes the quiescent output voltage as equal to 0V as the other input of the op-amp IC1 is referenced to 0V.

Resistors R3 and R5 provide local negative feedback over the discrete components TR1, TR2 and TR3. This provides for a much more stable amplifier and greatly improves the distortion figures.

Resistor R4 serves two purposes. It reduces the power dissipated in TR3 enabling a TO5 assembly to be used and it also prevents any avalanche condition in the event of failure. For example, if TR2 failed in the short circuit mode the output would be driven fully positive. The negative feedback via R2 would cause TR3 to be turned hard on in an attempt to restore the output voltage and, of course, TR3 would break down. However, the presence of R4 will limit the current through TR3 to a safe value under these fault conditions.

The split collector resistor R6 and R7, together with C4, provides for bootstrapping to ensure that the base of TR2 never runs out of current, even as the output approaches the positive rail voltage. As the output voltage becomes more positive C4 causes the junction of R6 and R7 to also become more positive. This maintains a substantially constant current through R7 and hence the current handling capability of the output is reasonably constant also.

Capacitor C1 provides phase correction to the feedback loop. This may or may not be necessary and depends on component types used. The action of the switching diode D1 generates small transients and these are suppressed by C2 and C3.

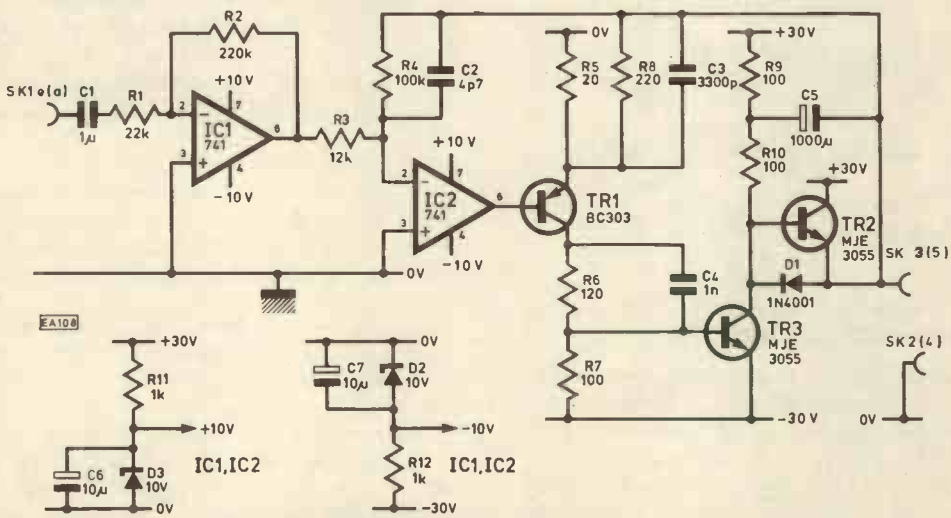


Fig. 6. Circuit diagram of one channel of the Class A amplifier. (Connections for R.H. channel shown in brackets.)

Having discussed the theory behind the Class A design we can now look at a practical implementation of the idea.

PRACTICAL AMPLIFIER

The construction of a practical amplifier, as opposed to the discussion of a theoretical one, inevitably involves compromise, and the most important compromise is between power output and readily available components.

The complete circuit diagram of the amplifier is shown in Fig. 6 (the left channel). This design is quite capable of delivering 30W into an 8 ohm load. Full drive (30 watts) is obtained with 350mV peak input. However, it was felt that it would be desirable to have a higher transient capability, hence the power supply design shown in Fig. 7 provides for ±30 volts as the quiescent supply voltages giving a transient capability approaching 60 watts. (The amplifier couldn't sustain this level for long as such a load rapidly reduces the supply voltages.)

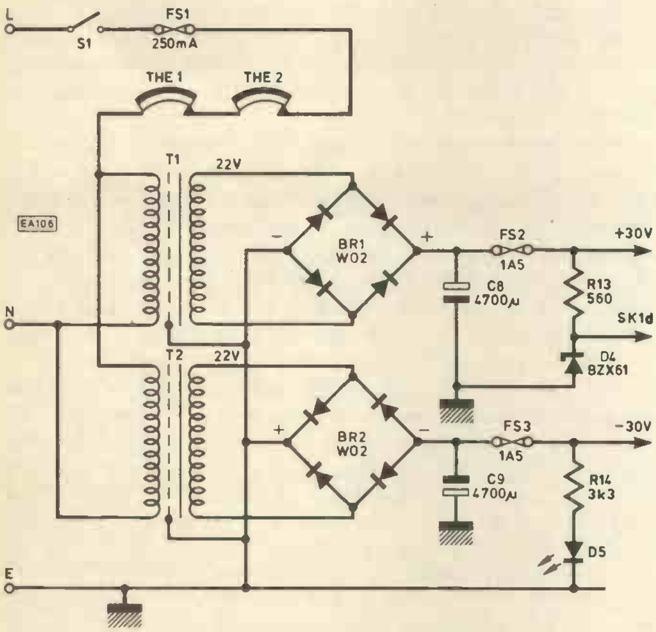
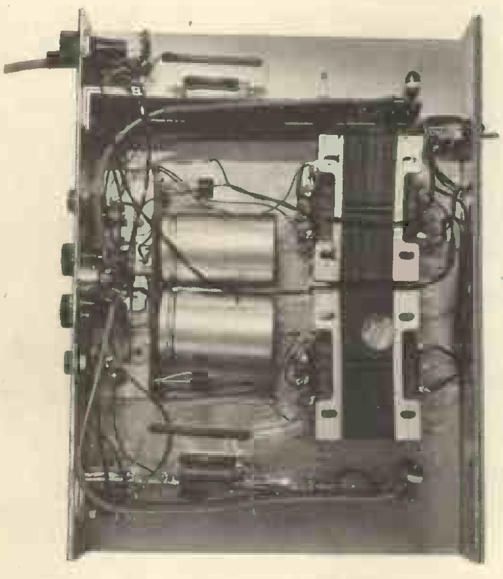


Fig. 7. Power supply circuit



Internal view of amplifier

COMPONENTS . . .

Resistors

*R1	22k
*R2	220k
*R3	12k
*R4	100k
*R5	20
*R6	120 1W
*R7	100
*R8	220 1W
*R9	100 7W
*R10	100 3W
*R11, R12	1k ½W (2 off)
R13	560
R14	3k3

All resistors ¼ or ⅓W except where otherwise stated

Capacitors

*C1	1μ polyester
*C2	4p7
*C3	3300p
*C4	1n
*C5	1000μ 25V
*C6, C7	10μ 25V (2 off)
C8, C9	4700μ 40V (2 off)

Semiconductors

*D1	1N4001
*D2, D3	10V Zener BZY88 (2 off)
D4	20V Zener BZX61
D5	LD57A
TR1	BC303
TR2, TR3	MJE 3055 (2 off)
BR1, BR2	Bridge rectifier WO2 (2 off)
IC1, IC2	741 (2 off)

Miscellaneous

THE1, THE2 thermal safety switch 70°C (RS 339-308) (2 off)
Fuse holders (3 off)
250mA fuse (slow blow)
1·5A fuse (2 off) (quick blow)
*P.c.b.
Banana sockets (4 off)
6-way DIN socket
Mains toggle switch
Suitable case
Veroboard
Transformer Douglas MT 79 FT (2 off)

* Two required for stereo design

CONSTRUCTION

The p.c.b. design for one channel of the amplifier is shown in Fig. 8 with the component layout in Fig. 9. All the components except TR2 and TR3 can be mounted on the board. The two resistors R9 and R10 should be set at least 10mm from the p.c.b.

The mounting details of the p.c.b.s, thermal switches and output transistors are shown in Fig. 10. The transistors TR2 and TR3 should be mounted onto the heatsink using mica washers.

The Veroboard layout for the power supply unit is shown in Fig. 11. The prototype was fitted into a case 250 x 180 x 60mm. The wiring diagram for the rear panel is shown in Fig. 12. The mains switch and the l.e.d. should be mounted onto the front panel.

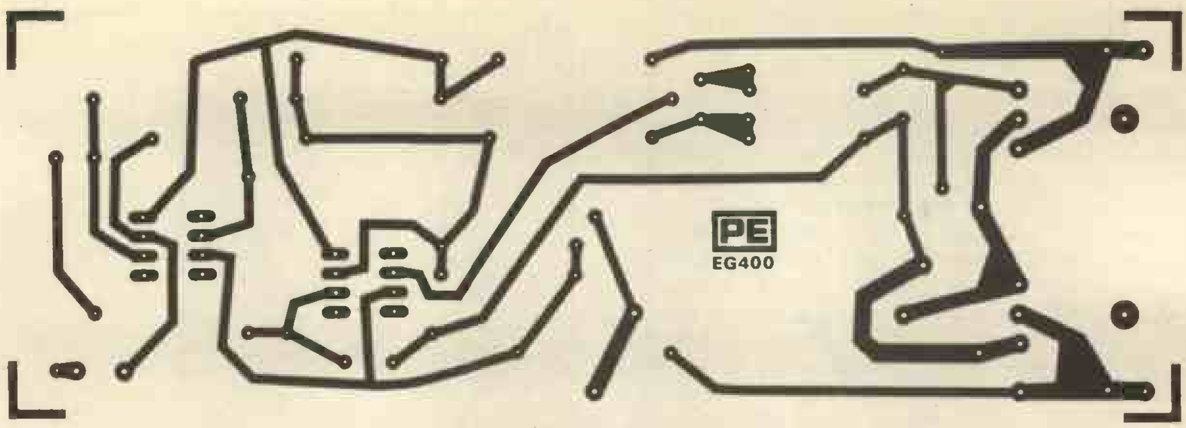


Fig. 8. P.c.b. design for one channel of the amplifier.

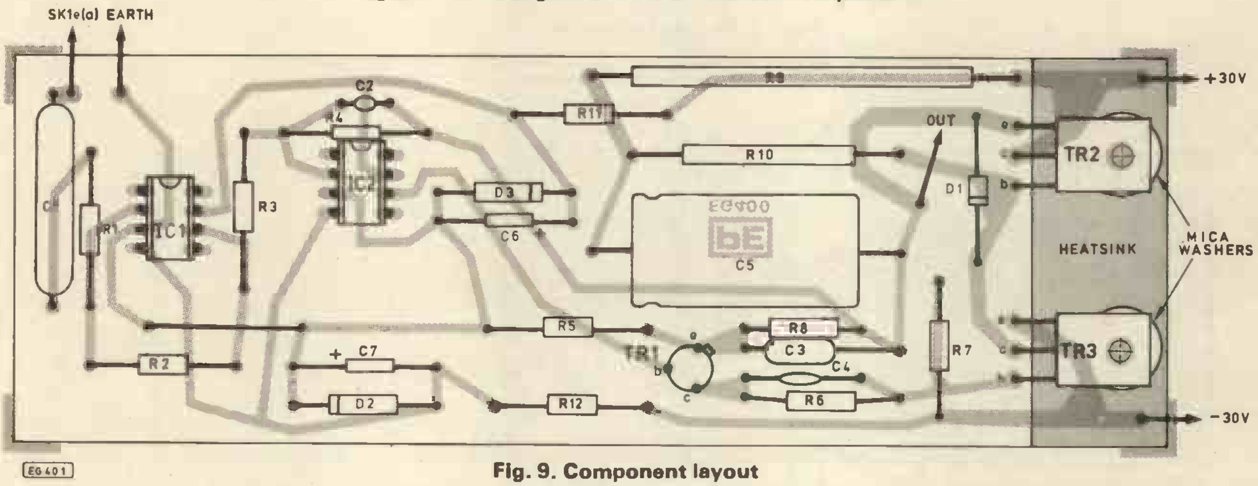


Fig. 9. Component layout

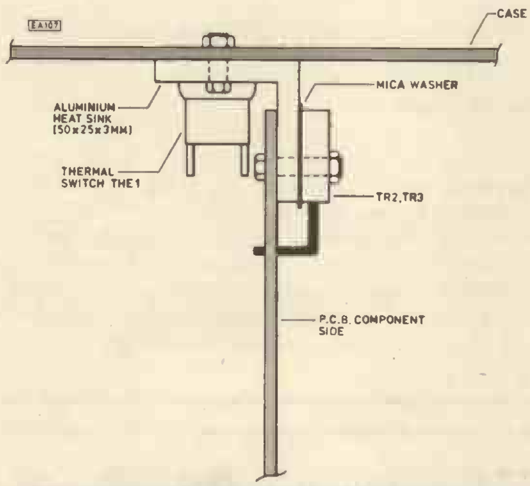


Fig. 10. Mounting details for the heatsink

TEST PROCEDURE

a. With the mains input fuse FS1 fitted and FS2 and FS3 removed, connect a 6k ohm 10 watt resistor in series with mains live and apply power. The power rails should run up to approximately their correct voltage (± 30V). Switch off and discharge the rails using a convenient resistor.

b. Fit FS2 and FS3 and with no speakers connected apply power again via the 6k resistor. A small voltage should appear at each rail, about half a volt or so.

c. If the two previous checks are good. Switch off, remove the 6k resistor and apply full power. Check across each pair of speaker sockets in turn that there is no more than a few millivolts of d.c. present.

d. If check c fails, check first the voltages supplying IC1 and IC2. ±10V.

e. Check there is no a.c. voltage at the speaker terminals.

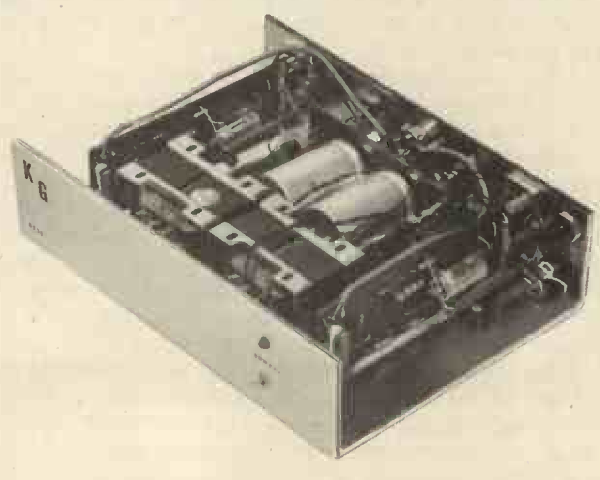
f. With speakers (8 ohm) connected but no input connection there should be a noticeable, but not loud, 100Hz buzz.

g. Check that this buzz disappears completely when the input pins are connected to 0V. Pins a and e connected to pin f on socket 1. Under these conditions there should be no sound from the speakers.

h. Check that there is +20V at pin d of socket 1.

OPERATION

The amplifier is now ready to accept a nominal input of 350mV peak output from a preamplifier. For inputs other than this the values of R1 and R2 should be changed, the



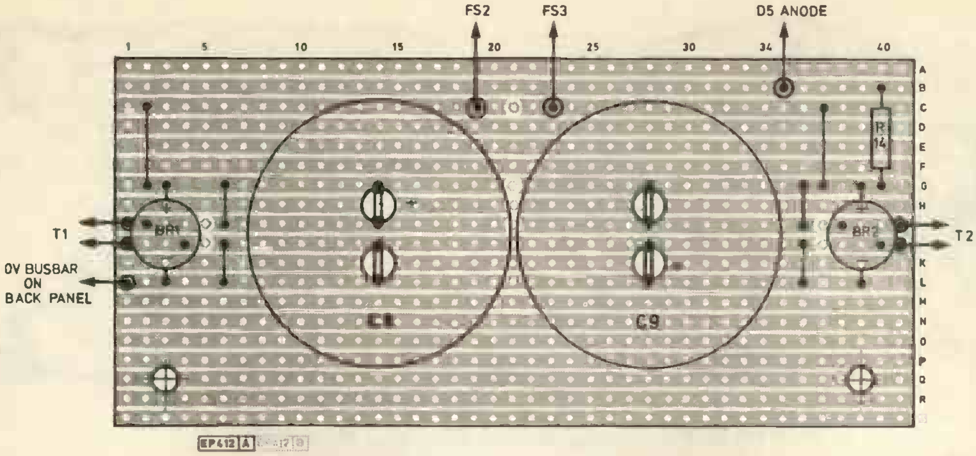


Fig. 11. Veroboard layout of the p.s u

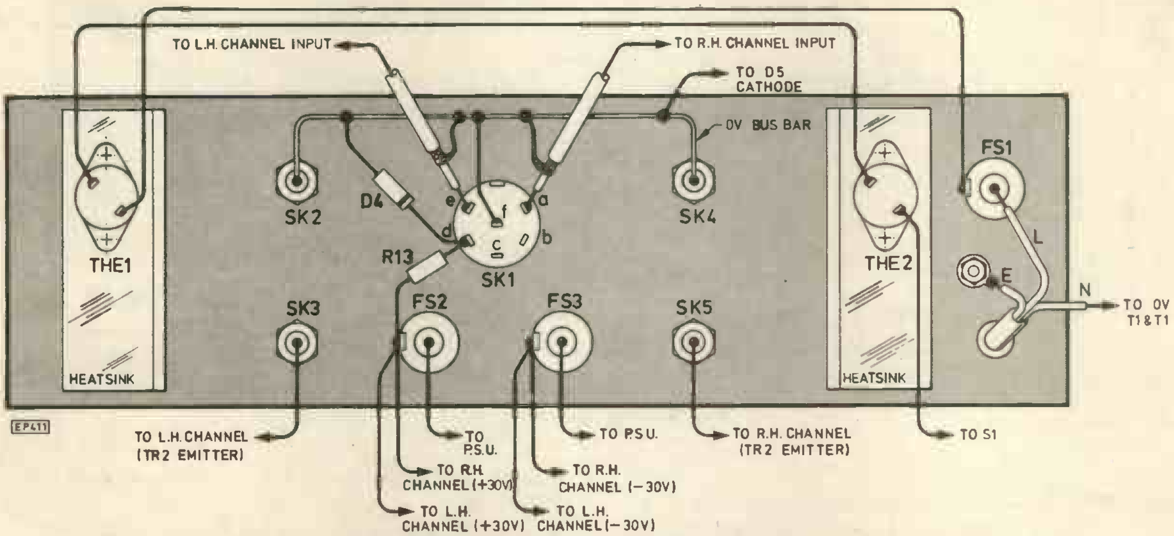


Fig. 12. Wiring diagram for the rear panel.

relationship being a direct one, i.e. for a peak input of 175mV the gain must be doubled which will be achieved by halving the value of R1. For a peak input of 700mV the gain must be halved, achieved by halving the value of R2. The limitations are that R2 should not be made larger than 220k. On the other hand, the 3dB point of C1, R1 is 18Hz, halving R1 without altering C1 will raise this to 36Hz by which point the loss of bass will be noticeable. Halving R1 and doubling C2 will maintain the status quo but values of C2 (which is not polarised) much more than 2μF start to give an uncomfortably large component.

For those who would like to experiment with the circuit rather than build a Hi-Fi system there are a number of comments which may be helpful. If higher continuous outputs are required the power supply must be uprated and the output stage fitted with cooling fins.

The circuit in Fig. 6 is deliberately bandwidth limited. It will be seen that the circuit is d.c. coupled with the exception of the input C1 and the bootstrapping C5. For d.c. coupling omit C1 and C5. The op-amp IC1 will require offset compensation and the output voltage/current capability will be limited by the current available in R9 and R10.

The high frequency capability is limited to avoid undue emphasis on system noise and to enable readily available components to be used, in particular the MJE3055 and 741 op-amp. To increase the high frequency capability these components would have to be replaced. The 741s with op-amps with a better bandwidth and the MJE3055s with a superior high frequency device. The switching time of D1 at high currents and high frequencies will start to become noticeable and it will have to be replaced with a high speed device. Experiment with the values of C2, C3 and C4 if the type of op-amp or output transistor is changed. ★

News Briefs

COMPUTING CLUB

A COMPUTING Club has been formed in the Falkirk area, to be known as the "Central Scotland Computing Club".

A Committee has been formed and it is planned to hold monthly meetings in Falkirk College of Technology, Grangemouth Road, Falkirk.

The Secretary is: James G. Lyon, 78 Slamannan Road, Falkirk, FK1 5NF, Tel: Falkirk 22430.

next month...

TRANSISTOR IDENTICHART

PE

FREE IN THE OCTOBER ISSUE TRANSISTOR IDENTICHART

Pin data on nearly 900 popular transistors including f.e.t.s and u.j.t.s, also comparable types.

CINE FRAME COUNTER

An accurate three digit frame counter which should prove a valuable aid in the production of fades and single frame sequences.

AUDIO LEAD TESTER

Many of the problems that occur in mobile PA systems are the direct result of lead failure. This unit provides a complete test sequence for the rigorous analyses of mono jack and cannon connectors to obviate this.

PRACTICAL
ELECTRONICS

OUR OCTOBER ISSUE WILL BE ON SALE FRIDAY, SEPTEMBER 12, 1980

SPACEWATCH

FRANK W. HYDE

RE-RUN FOR RUSSIA

The success of Salyut-6 will influence Russia's thinking in the immediate future. Six new unmanned spacecraft have flown since June this year. The new thinking will involve considerable changes for they see this as an opportunity to catch up in the development of world space matters. To this end the new design will see a change in the interior layout of spacecraft. For example, in the past the instruments have been placed along the sides of the vehicles. In the future it is intended that the equipment shall be placed along the central axis of the station to facilitate man-machine interface.

Recently an official said that 'a considerable duration increase of time spent in space has shown us that this is economic and that we are now able to more reasonably assess the feasibility of long manned flights, particularly manned flights to Venus and Mars.' That the thoughts of Soviet scientists are turned in this direction by saying 'in the not too distant future', seems to show that they have hopes of catching up with the United States. Certainly the launch of Salyut-6 has paved the way to such activities.

Already the Russians have plans for a station some 25 tons heavier than Skylab. The reports are that such a station will have a weight of 220,000lb and be manned on a permanent basis with a constant complement of 12 cosmonauts. This is planned for the 1980s with a new launcher capable of 10-14 million pound thrust. This is more powerful than Saturn-5. This of course can easily manage manned flights to the Moon and Mars.

The cosmonauts at present on Salyut-6 Valeriy Ryumin and Leonid Popov are, at the time of writing this page, in the eleventh week of the present mission. It is expected that they will stay for 6 months. The tasks that have currently been carried out successfully included materials processing of which one was concerned with germanium. The team also replaced an outdated module in the stabilisation system and in the medical field carried out a special examination of each other's physical condition including an electrocardiogram after performing certain prescribed exercises.

A special simultaneous experiment was carried by the cosmonauts from the space craft and another group operating a Soviet launched balloon within the Earth's upper atmosphere. This was to monitor charged particles from above and below, as it were. It is intended to fly medical doctors on future space missions as do the United States. No significant problems have arisen during the Salyut-6 manned missions. There was an occasion when cosmonaut Romanenko had bad toothache. This was dealt with by medicine from the spacecraft's medical kit with instructions from the ground medical team. Dental equipment was sent up to the space station in case the patient should become worse. Medical opinion in the Russian ranks was that appendectomy could be successful in zero gravity. This being the case there was little to be feared on long missions.

In June Russia announced more details of the Soyus-T. Both the standard Soyus and the first Soyus-T will continue to be used in service while the new Soyus-T is improved and possibly this situation will continue until the Soviet winged recovery vehicle is ready for service. Work continues on this vehicle. The Soyus-T is more efficient in the use of fuel and one way in which fuel is conserved is by separating the orbital module before the re-entry burn. This saves 10% in fuel. For the first time since the flight of the first Soyus in 1971 it was possible to fly round the Salyut and examine it visually and also with a camera.

New windows have been fitted to the Soyus because the previous design resulted in the windows becoming black during re-entry. The new design has layered windows, the blackened layer is to be jettisoned after re-entry to allow the crew full visibility There are new spacesuits also for the Soyus-T crews. These are lighter and more efficient being free and manoeuvrable.

THE SATELLITE POWER SYSTEM

In the last issue of *Spacewatch* I gave some notes which covered the general idea of the Satellite Power System and answered some questions. In this issue more details will be given about the system.

THE SATELLITE

The Satellite will be a rectangular construction 10 kilometres in one direction and 5 kilometres at right angles to it. This will support the arrays of photo voltaic cells. The cells may be of gallium arsenide or silicon. Such a structure will be of considerable weight and of the order of 36,000 metric tons. As a great deal of it will be constructed in space the weight is only involved in the initial transportation first into a low earth orbit and then raised to synchronous orbit.

The transmitting antenna with the conversion units on which are mounted the DC/RF converters will form the individual sub-assemblies of the transmitting antenna. This will have a diameter of 1 kilometre. Thus it will appear as an assembly of waveguides with a high density beam direct to the Earth. The transmitting antenna will be so arranged that the profile as presented to the ground antenna, the RECTENNA, has a highpower centre to the beam and taper off at the edges. This has been necessary because of the possible effects to the environment over a long period and short term effects due to local conditions (weather, accidental intrusion from other causes) and safety in general. To appreciate these necessities a description of the rectenna is needed.

THE RECTENNA

The Rectenna is a vast array of collecting dipoles and covers an area of 130 Km^2. It is expected to be in the form of 10 kilometres east to west and 13 kilometres north and south. By any standards this is a large area and involves the effect on the ground beneath it and the vagaries of meteorological conditions which may at one and the same time vary widely, differing from side to side or from end to end. Indeed considerations such as the number of lightning strikes, which are quite considerable in the latitude of 35° north, the position contemplated for the rectennas across America.

The centre of the microwave beam at a frequency of 2·45 GHz will at the rectenna have a power density of $23mW/cm^2$. The density will fall off towards the edges in such a way that at the site safety boundary will have reached the low level of $0{\cdot}1mW/cm^2$. At the overspill edge the beam will have a density of $1{\cdot}0mW/cm^2$. From the point of view of safety to human life the density of the beam will be way below possible ill effects. The hazards are more likely to effect other mechanical considerations and as suggested freak weather conditions.

These considerations will all come under the scrutiny of observers and research teams. This aspect will be dealt with in later issues of *Spacewatch*.

CONVERSION OF THE MICROWAVE POWER

The Conversion of the Microwave Power is likely to take the form of sub-units of RF-LF converters arranged in such a way that around the periphery of the rectenna site feed lines will link with normal grid system in operations. It will take different forms as to the distribution voltages depending on local medium and long distance transmission networks to be fed. The order of the thinking is to insert the SPS into the existing power grid. Cost and converience will determine this for it might call for local decisions as to which is the more economical. The first of the considerations is the effect on the environment as related to the public but also the possible long term effects on the flora and fauna of America and indeed its possible effect through modification of near space in terms of communications and meteorology. Of these matters more will appear in future issues of *Spacewatch*.

CASIO WATCH OFFER

CORRECTION

Unfortunately there were some errors in our Casio Watch Offer published in the July issue. Since our offers are arranged for the benefit of readers, we would like to bring these errors to your attention.

1. We indicated that the front cover illustration was of an older watch, this is not the case.
2. The watch is stainless steel encased.
3. The watch on offer is 9·65mm thick and not "less than 9mm" as originally stated.
4. The alarm sounds for 30 seconds unless cancelled, not 60 seconds as originally stated.

These mistakes were due to our late decision to change to a watch with a constant time and date display. Since we have unintentionally misled readers on these points, we will be pleased to refund their money and postage if they so wish. We would like to make it quite clear that the guarantee will be honoured by Metac.

We have published a corrected special offer page here for those that wish to take advantage of it.

£21·95

Including V.A.T Postage and Packing

THE OFFER

For some time PE has been trying to arrange a special offer on one of the very popular range of Casio watches. Until now this has not been possible due to the control of supply by Casio. However, Metac have now been able to purchase Casio outside the UK and this offer is the result.

We do not expect readers to be able to find this Casio watch advertised at less than the Metac price.

THE WATCH
CASIO ALARM CHRONO TYPE 83 QS 41B

Stainless steel, less than 10mm thick, mineral glass, water resistant to 2 atmospheres (66 feet), Lithium battery giving approximately four years' life, four year calendar, accurate to within 15 seconds a month, full one year's guarantee.

THE FACILITIES

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★ Hour, minute, am/pm, day, date.
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★ User optional hourly chime (two bleeps).
★ Back-light.

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Please allow 21 days (maximum) for delivery (more for overseas orders)

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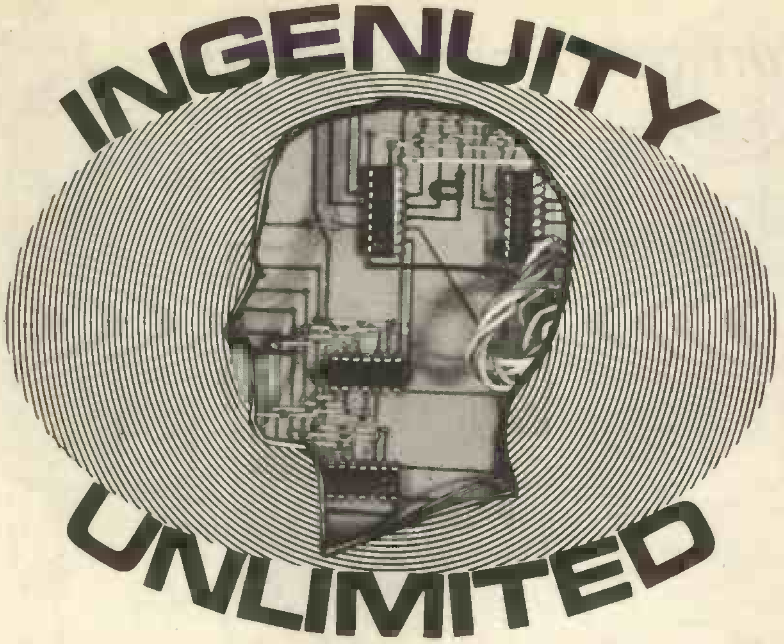


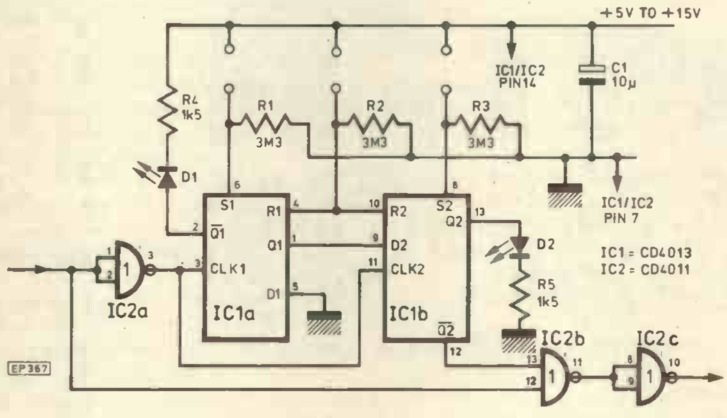
A selection of readers' original circuit ideas. It should be emphasised that these designs have not been proven by us. They will at any rate stimulate further thought.

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

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

Each idea submitted must be accompanied by a declaration to the effect that it is the original work of the undersigned, and that it has not been offered or accepted for publication elsewhere.

ALARM CLOCK WEEKEND LOCKOUT



ONE result of the pressures of modern living is the alarm clock. However, the type which must be set each night have a habit of being forgotten and the type which sound unless turned off tend to awaken their owners when they want a lie-in on Saturday morning. This circuit enables the user to selectively inhibit the alarm of his clock for either of the following two days—normally this would be operated on a Friday to stop the alarm for the weekend.

The complete circuit diagram is shown at right. The input on the left is a CMOS input which comes from the clock circuitry or mechanism. When the alarm of the clock is on, this output is high but when it is not on, or has been cancelled, it is low.

The two halves of IC1 are connected as a two stage shift register. Every time the clock input is taken high, the data in the register is shifted one place to the right. Since the input of the register is low, zeros are shifted in from the left.

The complementary output of IC1b ($\overline{Q2}$) is "ANDed" with input signal in IC2b and IC2c. Normally the shift register is full of zeros so that $\overline{Q2}$ is high. This means that the output of the unit is the same as the input.

Suppose that IC1b is in the one state. $\overline{Q2}$ would then be low and the output of the unit would remain low for the duration of any input pulse. However at the end of the pulse, the output of IC2a would go high and the shift register would be clocked. This would mean that another zero would be clocked into IC1a but the one in IC1b would be replaced by the zero in IC1a. $\overline{Q2}$ would go high and a further pulse would be passed without interruption. The action of the circuit has been to suppress one pulse applied to its input. It can be seen that the state of IC1b determines whether the next pulse will be inhibited and the state of IC1a does the same thing for the next pulse but one. Since the input is an alarm signal, the circuit will selectively inhibit this signal for the following two days.

To set the state of the flip-flops, three touch switches are used. Two of these set IC1a and IC1b respectively whilst the third resets both. Normally, the set and reset inputs are held low by R1–R3 but skin resistance across the touch contacts is much lower than these resistors so the input is pulled high, setting or resetting the desired flip-flops.

To indicate the state of the flip-flops, i.e. to tell the user which inhibits he has selected, two l.e.d.s are used. These are connected to $\overline{Q1}$ and to Q2; since these signals are of opposite logical polarity, D1 is returned via a current limiting resistor to the positive supply line whereas D2 is returned to the ground rail. This means that either l.e.d. is on when the corresponding flip-flop is in the one state.

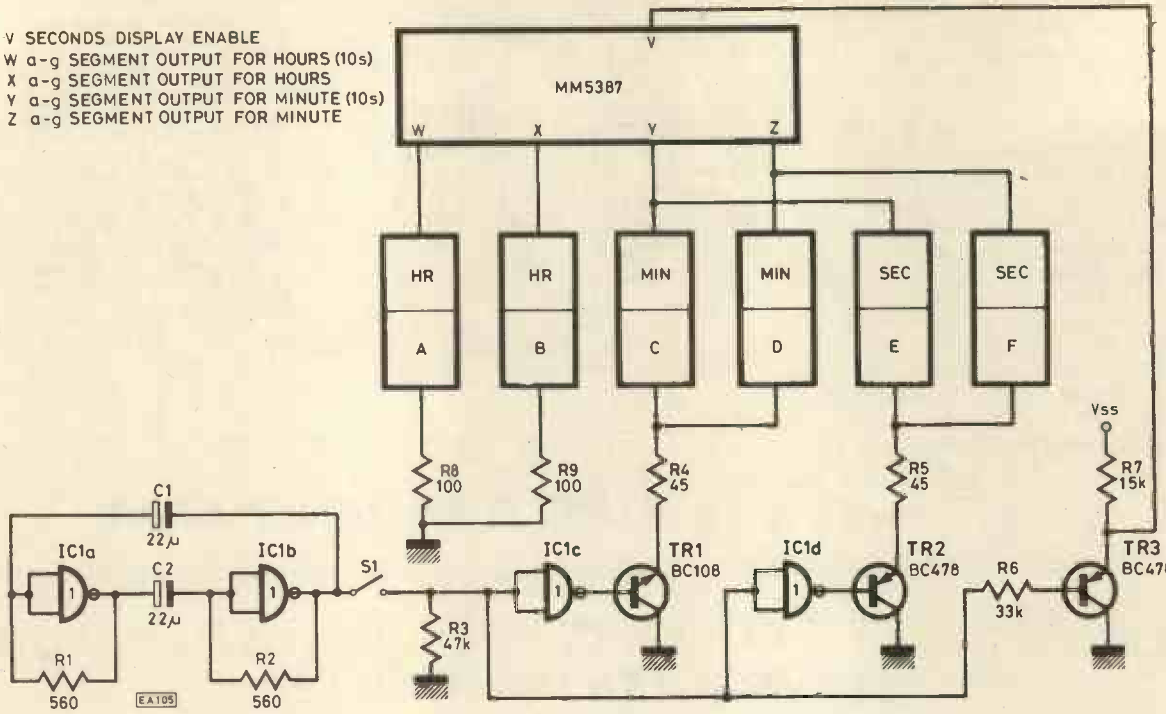
Both the input and output of the unit are at CMOS levels and it is up to the user to interface these to his clock and alarm circuitry: this should normally present no problem. The power supply can be anywhere between 5V and 15V and can often be borrowed from the clock. C1 is necessary to prevent noise on the power line from triggering the flip-flops.

The number of flip-flops could of course be made greater than two but this was thought to be the max mum needed since it corresponds nicely with a weekend.

Construction is not at all critical and can take any desired form. The touch switches and l.e.d.s can then be mounted on a convenient position on the clock.

P. M. Jessop,
Solihull,
West Midlands.

FOUR DIGIT TO SIX DIGIT CLOCKS



THERE are plenty of digital clocks in the market today. Most of them are four digit types with few of six digits available. These don't have functions like alarm, radio on and off etc. I have a design which might benefit those who own a four digit clock but would like to have a six digits displaying hours, minutes and seconds. A simple straightforward multiplexing method was used with a minimum number of components to reduce cost and complexity.

A MM5387 clock chip was used. This is the same as a MM5316 except it can drive displays directly. The circuit is for a common cathode l.e.d. display clock only.

The connections are as follows—the tens of hours and hours segment outputs from the i.c. are connected normally. The tens of seconds and seconds segments were connected parallel to tens of minutes and minutes segments respectively. Two gates of a 7400 quad NAND gate form an oscillator and switch IC1c and TR3. They also switch TR1 and TR2. These control the displaying and blanking of seconds and minutes displays. TR3 switches the seconds display option of the clock.

The oscillator provides a square wave that switches IC1c/d, TR3. TR1 is *n.p.n.* and TR2 is *p.n.p.* Therefore when one conducts the other will be cut off. When TR1 is conducting, the seconds display enable of the clock i.c. will go negative and the clock will be programmed to display hours and minutes. At the same time TR1 will also be conducting which enables displays C and D.

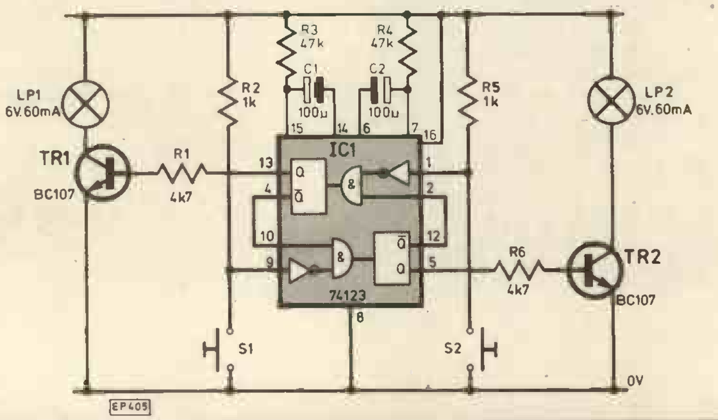
When TR2 is not conducting, the seconds displays enable of the clock i.c. will go positive. This will program the clock to display seconds. At this time TR2 will be conducting enabling displays E and F.

As the oscillator functions at about 200 hertz the displaying of hours, minutes and seconds will be displayed continuously.

The circuit works well, the only problem being that there are problems in setting time so S1 was included which will cut off the six digit function. The time should be set with this in the off position.

P. Ratnam,
Penang,
Malaysia.

QUIZ WIN INDICATOR



IF S1 is shorted, the one shot will be triggered and LP2 will light for about 3 seconds assuming that the other stage is not already in a triggered state. While lamp one is alight any closure of S2 will not cause LP1 to light as the one shot is inhibited by a logical 0 at pin 2. The same applies if the order is reversed.

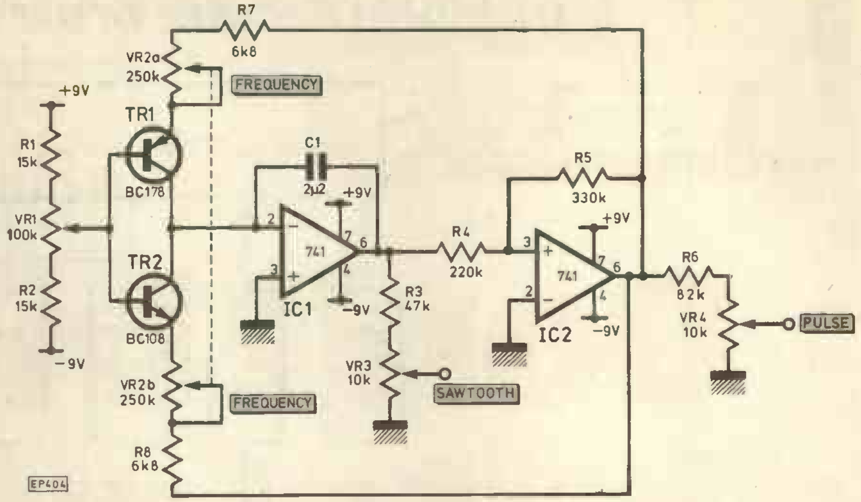
Two contestants are positioned either side of the unit with fingers on the buttons. A question is asked and the first to answer pushes his button and his lamp lights. The other lamp is inhibited and the win lamp resets itself after about 3 seconds ready for the next question.

J. Sarns,
West Mersea,
Essex.

THE circuit shown was designed to program a VCO in a synthesiser. Two waveforms are available; A sawtooth output from the wiper of VR3 and a squarewave from VR4. Both signals have a level of about 2 volts (peak to peak) about earth.

The novelty lies in the fact that the shape of both waveforms is continuously variable via VR1 which provides base bias to both transistors. This in turn alters the ratio of the currents in each. Because the current flowing out of the transistors is passed into an integrator, then the voltage at pin 6 of IC1 is a function of the control. The remaining circuitry is of the standard integrator—Schmitt trigger loop, the output of IC2 deciding which transistor is turned on by forward biasing. VR2 will vary the current available to the transistors and hence the frequency of oscillation.

M. Rodgers.
Maltby,
S. Yorkshire.



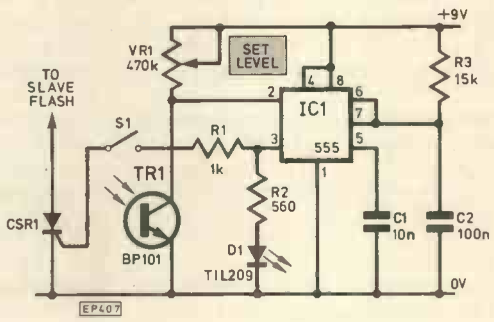
FUNCTION GENERATOR

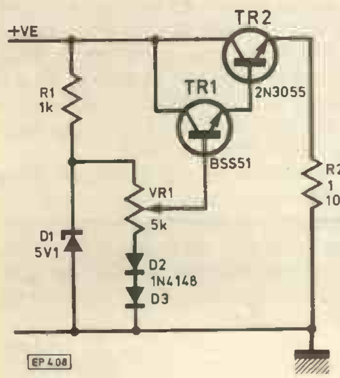
SLAVE FLASH CONTROLLER

THIS 555 circuit is used to control the operation of a slave flash unit. Here the phototransistor responds to ambient light levels. The 470k variable resistor is used to set the l.e.d. to the 'just off' condition. When the master flash unit operates the CSR conducts operating the slave unit.

S1 allows the slave unit to be set without discharging the flash.

R. C. MacKay,
Grangemouth.





WHEN carrying out battery capacity checks, it is extremely useful to have a load that does not need constant adjustment to maintain a steady current as the voltage falls.

This circuit fulfills the requirement in that once the load is set the load current remains constant throughout the discharge time of the battery. In practice the 2N3055, and the 1 ohm resistor are mounted on a suitable heatsink. The circuit was used to test 12V batteries and the load is variable between 0 and 3 amps.

D. Halliday,
Tewkesbury,
Glos.

BATTERY CHECK

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JULY 1980 60p

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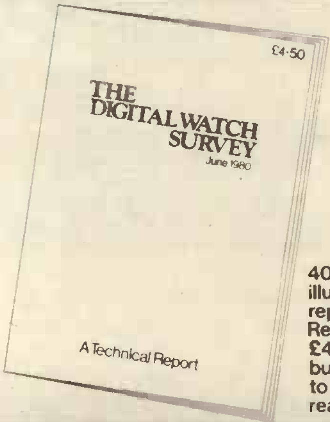

40 page illustrated report. Retail price £4·50 but just £1 to our readers.

There are so many digital watches on the market, with varying functions, that the average person is bound to feel somewhat confused.

by Trevor Raven.
C.Eng. AMBIM. MIERE

A new survey of the electronic watch industry has been produced to clarify this confusion and to give an unbiased and objective answer to the many questions that are constantly being raised.

* How accurate are electronic watches?
* Who makes Seiko's?
* What is the importance between brand names?
* Is solar power worth the extra money?
* What are the most important features in a watch?
* When will prices stop falling?

The survey answers all of these questions and tells you what to look for in a quartz watch; how they work; why the prices vary so much; what the future holds.

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Which is the best watch?

These four watches are very different in price, durability and functions. How would you choose between them?

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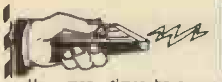
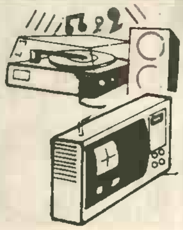
PE9



RUN YOUR HOME BY REMOTE CONTROL



How many times have you considered building a remote control project for the house but were put off by the dozens of ICs, special coils, lenses and other hard to get components, not to mention the need for a well equipped lab. to set the unit up. T. K. ELECTRONICS have changed all that. Three ICs can build a sophisticated system that requires only a capacitor and resistor to set the clock frequency (which can drift by up to 20% without affecting performance). Control radios, hi-fi (including bass, treble and volume), lighting, toys, garage doors, etc. Still not convinced? then look at the prices!

LD271	IR Emitting Diode	36p
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SL490	Keyboard Controlled Encoder/Transmitter	£2.40
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ML926	16-channel Receiver (4 Momentary binary outputs)	£1.40
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Data sheets (per device)		5p

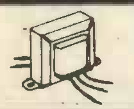
These ICs can also be used with ultrasonic and radio links, depending on range, cost and speed of operation. For more details, why not give us a ring – or send sae. We will be pleased to advise you.

NEW KIT +++ NEW KIT +++ NEW KIT +++ NEW KIT

If you do not require a sophisticated multi-channel remote control, we have developed a simple single-channel ON/OFF infra red transmitter and receiver. The transmitter unit comes complete with a hand held box and requires a PP3 (9V) battery. The receiver includes a triac capable of switching up to 500W at 240V a.c. and comprises a preamplifier, bistable latch and a mains power supply, making the unit completely self-contained. The small size of the receiver enables the unit to be "built into" all kinds of equipment from lamps to tape recorders. The minimum range is 20 feet. A suitable box for the receiver is available if required.

ONLY **£12.00**

MINI TRANSFORMERS



Standard mains primaries 240V a.c. 100mA secondaries

6-0-6V	80p
9-0-9V	85p
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8 pin	8p	18 pin	17p
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16 pin	14p	40 pin	36p

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10	Rectangular Green LED	£1.75
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5	78 L1S 12V 100mA regulator	£1.10
5	7805 5V 1A regulator	£2.25

All components brand new and to specification. Add VAT AT CURRENT RATE TO ABOVE PRICES PLUS 35p P&P Mail Order. Callers welcome by appointment

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T K ELECTRONICS (PE) 106 Studley Grange Road, London W7 2tX Tel 01 579 5794

CT4000 CLOCK/APPLIANCE TIMER KIT

The CT4000 has been designed to preset the state (on or off) of four outputs at four times per day for up to 7 days in advance, enabling the unit to control tape recorders, appliances, central heating, lights, etc. The times are set on a 0.1" high red LED display by means of a keyboard and the output states are displayed on four LEDs. Each output can switch up to 20mA at 9V. For mains loads use our Solid State Relay Kit (MK2). The kit includes a PCB, keyswitches, I.C., 4 digit LED display, transformer, plus all other components and a screen printed and drilled box which can also accommodate up to 4 Solid State Relay Kits.

£25.25

Size: 10x12x4.5 cms.
Colour: Black.

DISPLAY LIGHTING KITS

Each unit has 4 channels (rated at 1KW at 240V per channel) which switch lamps to provide sequencing effects, controlled manually or by an optional opto-isolated audio input.

DL1000K This kit features a bi-directional sequence, speed of sequence and frequency of direction change being variable by means of potentiometers. Incorporates master dimming control. **£14.60**

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

Optional Opto Input DLA1 60p

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555 Timer	21p
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MM74C926 4-digit counter with 7-seg outputs	£4.50
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S9263 Touchswitch 16-way	£4.85
TBA800 5W Audio Amp	58p
TBA810AS 7W Audio Amp	85p
TDA1024 Zero Voltage Switch	£1.00
TDA2020 20W Aduio Amp	£2.85
ZN1034E Timer	£1.80

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

MINI KITS

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

MK1 TEMPERATURE CONTROLLER/ THERMOSTAT
Uses LM3911 IC to sense temperature (80°C max), and triac to switch heater.
500W £3.20 1KW £3.50

MK2 SOLID STATE RELAY
Ideal for switching motors, lights, heaters, etc. from logic. Opto-isolated with zero voltage switching. Supplied without triac. Select the required triac from our range. £2.60

MK3 BAR/DOT DISPLAY
Displays an analogue voltage on a linear 10-element LED display as a bar or single dot. Ideal for thermometers, level indicators etc. May be stacked to obtain 20 to 100 element displays. Requires 5-20V supply. £4.75

MK4 PROPORTIONAL TEMPERATURE CONTROLLER
Based on the TDA1024 Zero voltage switch, this kit may be wired to form a "burst fire" power controller or a "proportional temperature" controller enabling the temperature of an enclosure to be maintained to within 0.5°C.
1.5KW £5.25 3KW £5.55

MK5 MAINS TIMER
Based on the ZN1034E Timer IC this kit will switch a mains load on (or off) for a preset time from 20 minutes to 35 hours. Longer or shorter periods may be realised by minor component changes. Maximum load 1KW £4.50

D.V.M. THERMOMETER KIT

Based on the ICL7106. This kit contains a PCB, resistors, presets, capacitors, diodes, IC and 0.5" liquid crystal display. Components are also included to enable the basic DVM kit to be modified to a Digital Thermometer using a single diode as the sensor. Requires a 3mA 9V supply (PP3 battery). £20.75

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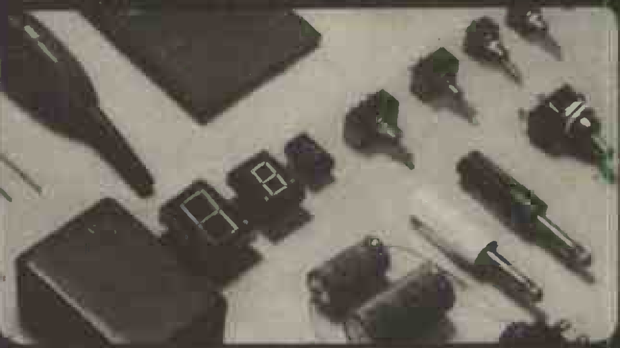

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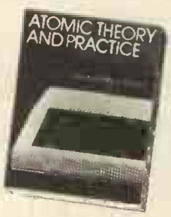
The ATOM – a definitive personal computer. Simple-to-build, simple-to-operate. But a really powerful full-facility computer. And designed on an expandable basis. You can buy a superb expanded package now – tailored to your needs. Or, you can buy just the standard Atom kit, and, as you grow in confidence and knowledge, add more chips. No need to replace your equipment. No need to worry that your investment will be overtaken by new technology. As you need more power, more facilities, you can add them!

*The picture shown demonstrates mixed graphics and characters in three shades of grey provided by the Standard Atom.

The standard ATOM kit includes:
● Full sized QWERTY keyboard ● Rugged polystyrene case ● Fibreglass PCB ● 2K RAM ● 8K ROM ● 23 integrated circuits ● Full assembly instructions including tests for fault-finding. (Once built, connect it to any domestic TV and power source) ● Power requirement: 8V at 800 M A. ATOM power unit available. See coupon. PLUS FREE MANUAL written in two sections – teach yourself BASIC and machine code for those with no knowledge of computers, and a reference section giving a complete description of the ATOM's facilities. All sections are fully illustrated with example programs.



The ATOM concept
Adding chips into sockets on the PCB allows you to progress in affordable steps to large-scale expansion. You can see from the specifications that the RAM can be increased to 12K allowing high resolution (256 x 192) graphics. Two further ROM chips, e.g. maths functions, can be added directly to the board giving a 16K capacity. In addition to 5 I/O lines partly used by the cassette interface, an optional VIA device can provide varied I/O and timer functions and via a buffer device allow direct printer drive. An optional module provides red, green and blue signals for colour. An in-board connector strip takes the ATOM communications loop interface. Any number of ATOMs may be linked to each other – or to a master system with mass storage/hard copy facility. Interface with other ACORN cards is simplicity itself. Any one ACORN card may be fitted internally.
So you can see there are a vast number of modular options and additions available, expanding with your ability and your budget.

The ATOM hardware includes:
● Memory from 2K to 12K RAM on board (up to 35K in case) ● 8K to 16K ROM (two 4K additions) ● 6502 processor ● Video Display allows high resolution (256 x 192) graphics and red, green and blue output ● Cassette Interface – CUTS 300 baud ● Loudspeaker allows tone generation of any frequency ● Channel 36 UHF Modulator Output ● Bus output includes internal connections for Acorn Eurocard.

The ATOM software includes:
● 32-bit arithmetic (±2,000,000,000) ● High speed execution ● 43 standard/extended BASIC commands ● Variable length strings (up to 256 characters) ● String manipulation functions ● 27 32-bit integer variables ● 27 additional arrays ● random number function ● PUT and GET byte ● WAIT command for timing ● DO-UNTIL construction ● Logical operators (AND, OR, EX-OR) ● LINK to machine-code routines ● PLOT DRAW and MOVE.

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Please send me the following items:

Quantity	Item		Item price inc. VAT+p&p	TOTALS
	ATOM KIT 8K + 2K (MIN)		@ £140.00	
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	ATOM KIT 12 + 12K (MAX)		@ £255.00	
	ATOM ASS 12 + 12K (MAX)		@ £289.50	
	1K RAM SETS		@ £11.22	
	4K FLOATING POINT ROM		@ £23.30	
	PRINTER DRIVE	6522 VIA	@ £10.35	
		Buffer (LS 244)	@ £3.17	
	MAINS POWER SUPPLY (1.5 amps)		@ £10.20	
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To: Acorn Computer Ltd., 4a Market Hill, CAMBRIDGE CB2 3NJ
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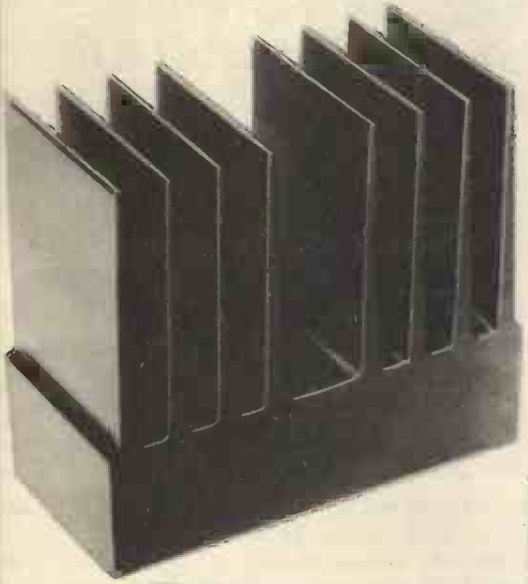
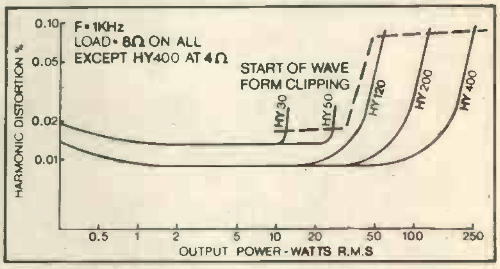


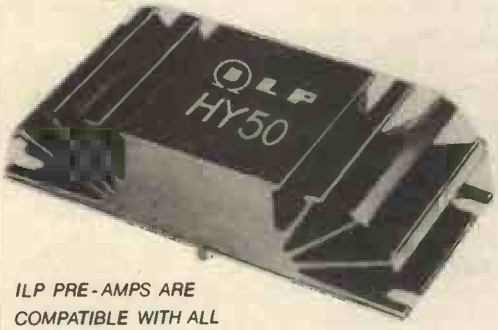
POWER AMPLIFIERS

ILP Power Amplifiers are encapsulated within heatsinks designed to meet total heat dissipation needs. They are rugged and made to last a lifetime. Advanced circuitry ensures their suitability for use with the finest loudspeakers, pick-ups, tuners, etc. using digital or analogue sound sources.



Model	Output Power R.M.S.	Distortion Typical at 1KHz	Minimum Signal/ Noise Ratio	Power Supply Voltage	Size in mm	Weight in gms	Price + V.A.T.
HY30	15 W into 8 Ω	0.02%	100 dB	-20 -0- +20	105x50x25	155	**£6.34** + 95p
HY50	30 W into 8 Ω	0.02%	100 dB	-25 -0- +25	105x50x25	155	**£7.24** + £1.09
HY120	60 W into 8 Ω	0.01%	100 dB	-35 -0- +35	114x50x85	575	**£15.20** + £2.28
HY200	120 W into 8 Ω	0.01%	100 dB	-45 -0- +45	114x50x85	575	**£18.44** + £2.77
HY400	240 W into 4 Ω	0.01%	100 dB	-45 -0- +45	114x100x85	1.15Kg	**£27.68** + £4.15

Load impedance - all models 4 Ω - ∞
Input sensitivity - all models 500 mV
Input impedance - all models 100K Ω
Frequency response - all models 10Hz – 45KHz – 3dB



ILP PRE-AMPS ARE COMPATIBLE WITH ALL ILP POWER AMPS AND PSUs

POWER SUPPLY UNITS

ILP Power Supply Units with transformers made in our own factory are designed specifically for use with ILP power amplifiers and apart from PSU 30 and 36 which are smaller PSU's – in all the other ILP manufactured PSU's, ILP toroidal transformers are used which are half the size and weight of laminated equivalents. They are also more efficient and have greatly reduced radiation.

PSU 30 ± 15V at 100mA to drive up to 12 x HY6 or 6 x HY66 **£4.50 + £0.68 VAT**

THE FOLLOWING WILL ALSO DRIVE ILP PRE-AMPS

PSU 36 for 1 or 2 HY30's **£8.10 + £1.22 VAT**

THE FOLLOWING INCLUDE TORODOIDAL TRANSFORMERS

PSU 50 for 1 or 2 HY50's **£8.10 + £1.22 VAT**
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PSU 70 for 1 or 2 HY120's **£13.61 + £2.04 VAT**
PSU 90 for 1 HY200 **£13.61 + £2.04 VAT**
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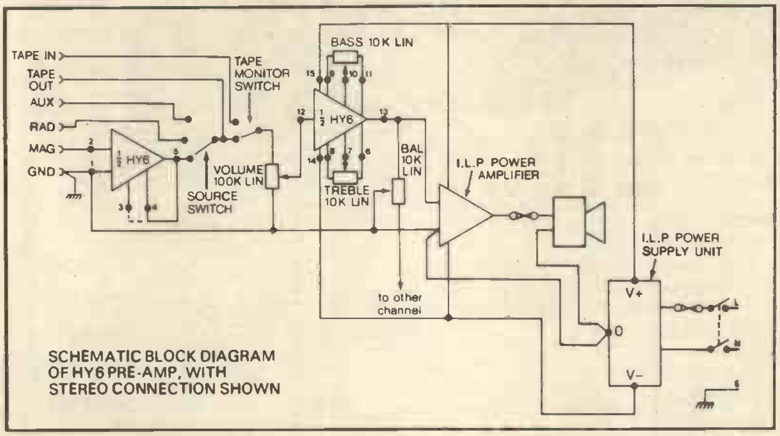
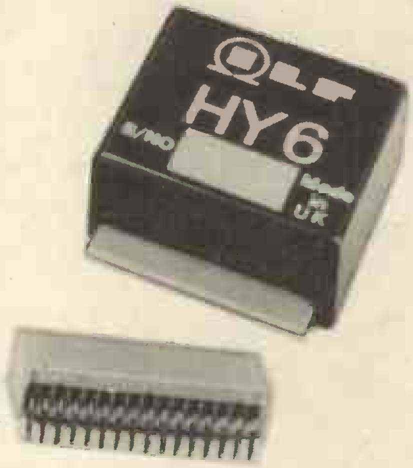
ILP

AVAILABLE ALSO FROM WATFORD ELECTRONICS, MARSHALLS AND CERTAIN OTHER SELECTED STOCKISTS.

this time with two new pre-amps





HY6 *mono* HY66 *stereo*

When ILP add a new design to their audio-module range, there have to be very special reasons for doing so. You expect even better results. We have achieved this with two new pre-amplifiers – HY6 for mono operation, HY66 for stereo. We have simplified connections, and improved performance figures all round. Our new pre-amps are short-circuit and polarity protected; mounting boards are available to simplify construction.

Sizes – **HY6** – 45 x 20 x 40 mm. **HY66** 90 x 20 x 40 mm. Active Tone Control circuits provide ± 12dB cut and boost. Inputs Sensitivity – Mag. PU. – 3mV: Mic – selectable 1-12mV: All others 100mV: Tape O/P – 100mV: Main O/P – 500mV: Frequency response – D.C. to 100KHz – 3dB.

HY6 mono
£5.60
+ VAT 84p

HY66 stereo
£10.60
+ VAT £1.59

Connectors included

B6 Mounting Board
78p + 12p VAT

B66 Mounting Board
99p + 15p VAT

- **LOW DISTORTION - Typically 0.005%**
- **S/N RATIO - Typically 90 dB (Mag. P.U. - 68 dB).**
- **HIGH OVERLOAD FACTOR - 38 dB on Mag. P.U.**
- **LATEST DESIGN HIGH QUALITY CONNECTORS.**
- **REQUIRE ONLY POTS, SWITCHES, PLUGS AND SOCKETS.**
- **COMPATIBLE WITH ALL ILP POWER AMPS AND PSUs.**
- **NEEDS ONLY UNREGULATED POWER SUPPLY ± 15V to ± 60V.**

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TRANSFORMERS + VAT 15%

30 VOLT RANGE
Pri 220/240 Voltages available 3, 4, 5, 6, 8, 9, 10, 12, 15, 18, 20, 24, 30V or 12V-0-12V or 15V-0-15V.

Ref	Amps	Price	P & P
112	0·5	2·90	0·90
79	1·0	3·93	1·10
3	2·0	6·35	1·10
20	3·0	7·39	1·31
21	4·0	8·79	1·31
51	5·0	10·86	1·52
117	6·0	12·29	1·67
88	8·0	16·46	1·89
89	10·0	18·89	1·89
90	12·0	21·09	2·24
91	15·0	24·18	2·39
92	20·0	32·40	O.A.

50 VOLT RANGE
Pri 220/240V Voltages available 5, 7, 8, 10, 13, 15, 17, 20, 33, 40 or 20V-0-20V or 25V-0-25v.

Ref	Amps	Price	P & P
102	0·5	3·75	0·90
103	1 0	4·57	1·10
104	2·0	7·88	1·31
105	3·0	9·42	1·52
106	4·0	12·82	1·73
107	6·0	16·37	1·89
118	8·0	22·29	2·39
119	10·0	27·48	O.A.
109	12·0	32·88	O.A.

MAINS ISOLATORS (SCREENED)
PM 120/240 Sec 120/240V CT

Ref	VA	Price	P & P
*07	20	4·84	0·91
149	60	7·37	1·10
150	100	8·38	1·31
151	200	12·28	1·31
152	250	14·61	1·73
153	350	18·07	2·12
154	500	22·52	2·47
155	750	32·03	O.A.
156	1000	40·92	O.A.
157	1500	56·52	O.A.
158	2000	67·99	O.A.
159	3000	95·33	O.A.

*Pri 0-220-240V Sec 115 or 240V. State sec. volts required.

CASED AUTO TRANSFORMERS
240V cable in 115V USA flat pin outlet.

VA	Price	P & P	Ref
20	6·55	1·03	56W
75	8·50	1·31	64W
150	11·00	1·31	4W
250	12·55	1·67	69W
500	20·13	1·89	67W
1000	30·67	2·65	84W
2000	54·97	O.A.	95W

CONTINUOUS RATINGS
All voltages given are at full load

60 VOLT RANGE
Pri 220/240V Voltages available 6, 8, 10, 12, 16, 18, 20, 24, 30, 36, 40, 48, 60 or 24-0-24V or 30v-0-30v.

Ref	Amps	Price	P&P
124	0·5	4·27	1·10
126	1·0	6·50	1·10
127	2·0	8·36	1·31
125	3·0	12·10	1·31
123	4·0	13·77	2·12
40	5·0	17·42	1·89
120	6·0	19·87	2·12
121	8·0	27·92	O.A.
122	10·0	32·51	O.A.
189	12·0	37·47	O.A.

12 OR 24V OR 12-0-12V
Pri 220-240 volts

Ref	12V Amps	24V Amps	Price	P&P
111	0·5	0·25	2·42	0·52
213	1·0	0·5	2·90	0·90
71	2	1	3·86	0·90
18	4	2	4·46	1·10
85	5	2 5	6·16	1·10
70	6	3	6·99	1·10
108	8	4	8·16	1·31
72	10	5	8·93	1·31
116	12	6	9·89	1·52
17	16	8	11·79	1·80
115	20	10	15·38	2·39
187	30	15	19·72	2·39
226	60	30	40·41	O.A.

AUTO TRANSFORMERS
Voltage for step up or step down

Ref	VA	(Watts)	£	P&P
113	15	0-115-210-240	2·73	0·81
34	75	0-115-210-240	4·41	1·10
4	150	0-115-200-220-240	5·70	1·10
67	500	0-115-200-220-240	12·09	1·91
84	1000	0-115-200-220-240	20·64	2 39
93	1500	0-115-200-220-240	25·61	O.A.
95	2000	0-115-200-220-240	38·31	O.A.
73	3000	0-115-200-220-240	65·13	O.A.
80S	4000	0-10-115-200-220-240	84·56	O.A.
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4·0	434	20·65	2·11
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235	330, 330	0-9, 0-9	2·19	0·44
207	500, 500	0-8-9, 0-8-9	3·05	0·85
208	1A, 1A	0-8-9, 0-8-9	3·88	0·90
236	200, 200	0-15, 0-15	2·19	0·44
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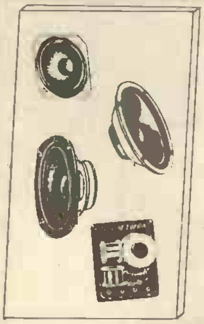

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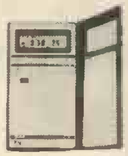

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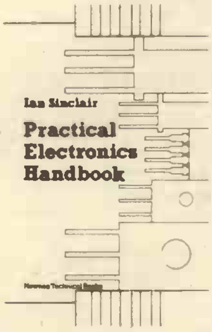

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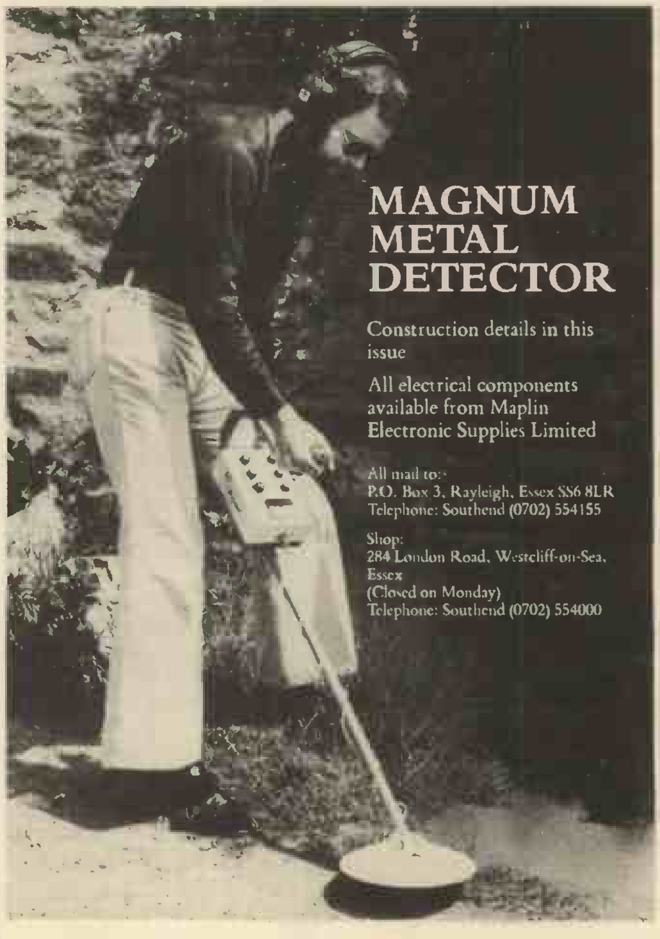

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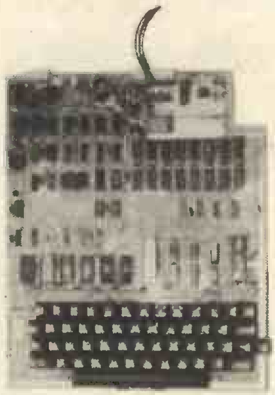

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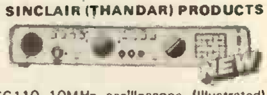

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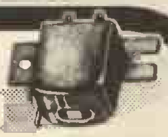

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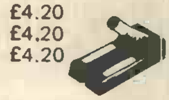

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GIANT 0.8" LED clock display, common cathode, non-multiplexed. With data **£3.95** each. **ALARM** clock module with 0.7" LED display. With data **£5.99** each. **LIQUID** crystal clock display, 0.5" digits. With data and **FREE** socket, **£5.25** each. **FLUORESCENT** reject calculators. Modern, 10 function with full memory. Most repairable but no g'tees. **£2.99** each. **TEN,** transistors I.F. transformers. All brand new. May include several types. **55p** for 10. **CLOCK CHIP** MM5316 I.C. (has alarm output). Brand new, with data **£2.35** each. **POLARIZING** filter, plastic, 0.006" thick. Any size cut from 1 sq. in. to max. size 19"x250 feet. **3p** per sq. inch. **MOMENTARY** (push to 'make') switch. Red cap. **15p** each. **SLIDE** switch, 2 pole c.o. **16p** each. **TWO** calculator keyboards (not compatible with 4204 calc. chip). **99p** the pair. **MULTIMETER CHIP.** MM5330 i.c. to build 4½ digit d.m.m. (needs additional circuitry). With data **£3.55** each. **KNOBS** Slider control knobs, fits **5** or 8mm shafts. State colour **14p** each. Rotary control knobs, black (18mm diam) with coloured cap, state colour required. **20p** each. Skirted rotary knob, same as rotary control knob above but has 'flared' skirt around base. State cap colour required. **27p** each. Colours available, black, red, green, blue, yellow, grey, white. **8 DIGIT** common cathode calculator display. 0.1", multiplexed, with data, **99p** each. **LED WRISTWATCH CHIP** with data, **95p** each. **LED WRISTWATCH DISPLAY** matches above watch chip. With data, **95p** each. **NOTE** the wristwatch chip and display are housed in 'legless flatpack' style and require some fairly fine soldering. **QUALITY** jack sockets. mono **25p** each, stereo **30p** each. **LM555** timer i.c. with applications booklet. **25p** each. **MEMORIES** 2102 static RAM. with data, **99p** each. **NORTEC** 4204, 4 function calc. chip. With data, **80p** each. **UNTESTED** 0.1" LED displays. 10 single digit displays for 95p. 'U' to test.

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74153	70p
74154	100p
74156	90p
74157	70p
74159	190p
74160	100p
74161	100p
74162	100p
74163	100p
74164	100p
74165	130p
74166	100p
74167	200p
74170	240p
74172	450p
74173	120p
74174	90p
74175	85p
74176	90p
74177	90p
74178	160p
74180	93p
74181	160p
74182	90p
74184A	150p
74185	150p
74186	500p
74190	90p
74191	90p
74192	90p
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74LS174	110p
74LS175	90p
74LS181	320p
74LS190	90p
74LS191	90p
74LS192	90p
74LS193	90p
74LS195	90p
74LS196	90p
74LS221	140p
74LS240	175p
74LS241	175p
74LS242	170p
74LS243	170p
74LS244	195p
74LS245	350p
74LS251	140p
74LS253	90p
74LS257	120p
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4022	100p
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4024	50p
4025	20p
4026	130p
4027	50p
4028	84p
4029	100p
4030	55p
4031	200p
4033	180p
4034	200p
4035	110p
4040	100p
4041	80p
4042	80p
4043	90p
4044	90p
4046	110p
4047	100p
4048	55p
4049	40p
4050	49p
4051	80p
4052	80p
4053	80p
4054	150p
4055	125p
4056	160p
4059	600p
4060	115p
4063	120p
4066	55p
4067	450p
4068	22p
4069	25p
4070	30p
4071	22p
4072	22p
4073	22p
4075	22p
4076	107p
4081	25p
4082	22p
4093	80p
4094	175p
4098	120p
4099	130p
4412	1100p
4502	120p
4503	70p
4507	55p
4510	99p
4511	150p
4514	250p
4516	110p
4518	100p
4520	100p
4521	250p
4528	120p
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*2N4871	60p
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*2N5172	27p
2N5179	90p
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2N6254	130p
2N6290	65p
2N6292	65p
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3N140	100p
3N141	110p
3N201	110p
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8253	1200p
8255	550p
8257	1100p
8259	1400p
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Z80CTC	650p
Z80A P10	800p
MC14411	1100p
MC14412	1100p

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AY-5 2376	£9

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(prim 220 240V)

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9 0 9 75mA	92p
12 0 12 100mA	95p
0 120 12500mA	280p*
0 25V (5VA)	250p
9 0 9 1A	270p*
12V 2A	350p*
0 12 15 20-24 30 1A	340p*
15 0-15 1A	265p*

(Please add 50p p&p charge to all marked* above our normal p&p charge)

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½W 10R-10M one value	5p/3pcs
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*Carbon Track Pots 5K 1M Log or Lin

*Single	30p
*Single with Switch	60p
*Dual	72p

LOW PROFILE DIL SOCKETS BY TEXAS

8 pin	10p	18 pin	22p	24 pin	30p
14 pin	11p	20 pin	25p	28 pin	40p
16 pin	12	22 pin	27p	40 pin	50p

WIRE WRAP SOCKETS BY TEXAS

8 pin	30p	18 pin	80p	24 pin	100p
14 pin	50p	20 pin	90p	28 pin	110p
16 pin	65p	22 pin	90p	40 pin	120p

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TOGGLE

SPST	55p
SPDT	58p
DPDT	60p
DPDT (Centre off)	85p
Push to make	15p
break	25p
*SLIDE DPDT	18p
*ROCKER SPST	28p

*WAFER

1P 12W	45p
3P 4W	45p
4P 3W	45p
2P 6W	45p

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CX-17W	420p
CCN 15W	420p
X25	420p

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X25	50p

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CCN	200p
IRON STAND	160p

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10.7MHz	350p
18MHz	300p
26.690M	
27.145M	425p

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2 x 18 way	120p		

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96364	£11
845	£25

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15V	7815	60p	7915	65p
18V	7818	60p	7918	65p
24V	7824	60p	7924	65p
100mA	TO-92			
5V	78L05	30p	79L05	70p
12V	78L12	30p	79L12	70p
15V	78L15	30p	79L15	70p

OTHER REGULATORS

LM309K	135p	TBA625B	120p
LM317T	200p	TL430	65p
LM323K	550p	78H05KC	625p
LM723	37p	78MGT2C	140p

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ORP12	90p	ORP60	90p
ORP61	90p	TIL78	70p

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0.125"		0.2"	
TIL32	75p	TIL220 Red	16p
TIL209 Red	13p	TIL222 Gr	18p
TIL211 Gr	20p	TIL228 Red	22p
TIL212 Ye	25p	MV5491 TS	120p
TIL216 Red	18p	Clips	3p

DISPLAYS

3015F	200p	FND500	120p
DL704	140p	FND507	120p
DL707 Red	140p	MAN3640	175p
707 Gr	140p	MAN4640A	200p
DL747 Red	225p	TIL311	600p
747 Gr	225p	TIL312/3	110p
FND357	120p	TIL321/2	130p
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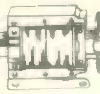

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