Hobby Electronics

OCTOBER '82

ISSN 0142-6192

70p

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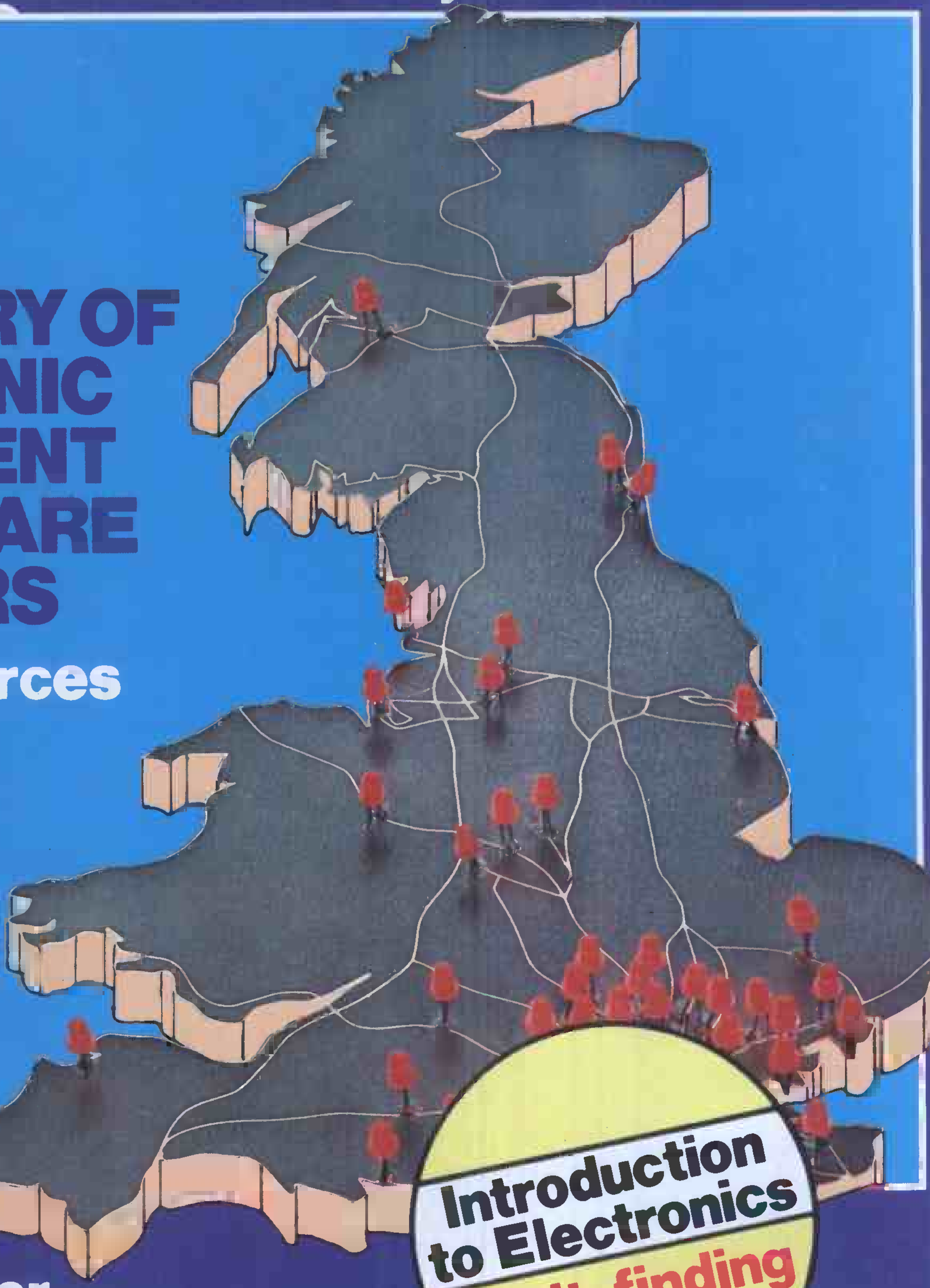

Introduction to Electronics

Fault-finding made easy

Look inside for....

PROJECTS•FEATURES

VIEWS•NEWS•REVIEWS

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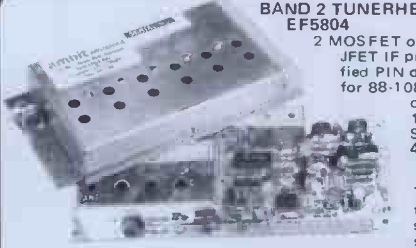
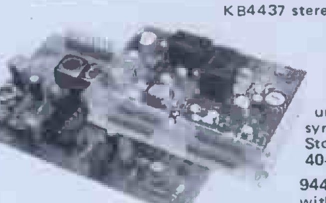
THE MOST COMPREHENSIVE RANGE OF COMPONENTS, KITS AND MODULES IN THE WORLD & THERE'S ONLY ROOM FOR A FRACTION HERE, GET THE CATALOGUE AND FIND THE REST.



BAND 2 TUNERHEADS (Varicap Tuning)
EF5804
2 MOSFET of stages MOSFET mixer, JFET IF preamp, with internally amplified PIN diode AGC. Tuning voltage for 88-108MHz is 2-8V. Buffered LO output. AGC input 145 x 70 x 24mm.

Stock No.		1-24	25+
40-05804	Blt	24.95	19.65



7255 The latest complete FM tunerhead from RF input to stereo output. MOSFET RF stages, HA11225 IF and KB4437 stereo decoder. 7255 special offer price: **£30.00 plus VAT**

911225A The 911225A is the 7230 'edited' and shrunk into a screened metal case, 97 x 56 x 24mm. The unit is ideally suited to use with synthesised tuner systems.

Stock No		1-24	25+
40-91225	Built	20.82	16.25

944378 'Hyperfi' series decoder module with the TOKO KB4437 pilot cancel PLL IC birdy filter and the KB4438 muting stereo audio preamp with 26/38kHz pilot tone filtering.

Stock No.		1-24	25+
40-04378	Built	19.95	18.05

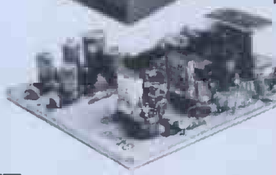
DFCM500 Wide range digital frequency/capacitance meter. Frequency ranges; 0-1MHz, 1-50MHz and 80-500MHz. 8 digit LED display, mains or Ni-Cad battery operation

Stock No.		1-24	25+
40-01500	Kit	95.95	86.50

AUTOBRIDGE
An Automatic power tracking VSWR and self-ranging power meter. Complete Kit: All PCBs, board mounted components, meters, case (undrilled), transformer etc.
Stock No: 40-40400 £52.86 + £1.50 P&P

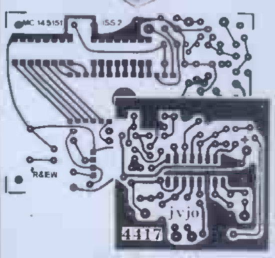
FET DIP OSCILLATOR
An essential piece of test equipment for the RF constructor. GDO or WM function covering 1.6-215MHz in five ranges. Audio and meter indication. Kit includes; fibre glass PCB, all components, all hardware, punch, painted and screen printed case, wire etc. for coils and printed scale.

Stock No:		1-24	25+
40-16215	Kit	17.90	16.20



10.MHz SSB GENERATOR
PCB, All components, eight-pole crystal filter.

Stock No.	Price
40-10700	£29.65



R&EW PROJECT AND DATABRIEF PCBs
High quality glass fibre printed circuit boards for projects and Databriefs published in Radio & Electronics World.

27MHz Deviation Meter	£1.98
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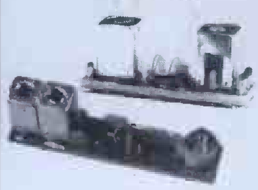
0-30V PSU	£3.92
2m PA Mk II	£5.14
ULN3859 (Undrilled)	£0.84
SSB Exciter	£3.37
HA12017	£2.16
Up Converter	£4.75

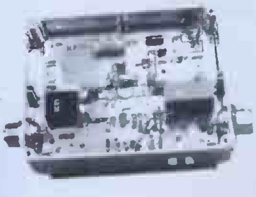


2m PRE-AMP
Very compact low-noise MOSFET 2m pre-amp. Gain 22dB. Noise figure; less than 1.5dB, i/p and o/p impedance; 50 ohm size; 34 x 9 x 15mm. From April '82 R&EW.

Stock No.		1-24	25+
40-14400	Kit	2.55	2.30

70cm PRE-AMP
Compact low-noise pre-amp. Gain at 433MHz; 13dB. I/P and O/P impedance 50ohms. Size 50 x 10 x 17mm. From March '82 R&EW

Stock No.		1-24	25+
40-07000	Kit	3.90	3.60



2m POWER AMP
20 watt 144MHz linear power amplifier. 10dB gain, 2W input — 20W output. Automatic switched relay. By-passes power amp in receiver mode. Developed from original class C version in Dec 81 R&EW. High power output relay. Pre-drilled heatsink, optional RX pre-amp. Kit only.

Stock No.	1-24	25+
40-14421 Less Preamp	28.50	25.65
40-14422 With Preamp	30.40	27.36

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4010	0.30	4520	0.60	74LS13	0.20	74LS151	0.30
4011	0.11	4521	1.30	74LS14	0.30	74LS153	0.27
4012	0.14	4522	0.89	74LS20	0.12	74LS154	0.99
4013	0.25	4526	0.60	74LS21	0.12	74LS155	0.35
4016	0.22	4527	0.80	74LS22	0.12	74LS156	0.37
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4019	0.38	4529	0.70	74LS27	0.12	74LS158	0.30
4020	0.55	4531	0.65	74LS28	0.15	74LS160	0.37
4021	0.55	4532	0.80	74LS30	0.12	74LS161	0.37
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4023	0.15	4536	2.50	74LS33	0.15	74LS163	0.37
4024	0.33	4538	0.85	74LS38	0.14	74LS164	0.40
4025	0.15	4539	0.80	74LS40	0.13	74LS165	0.60
4027	0.26	4543	0.80	74LS42	0.30	74LS168	0.70
4030	0.35	4549	3.50	74LS47	0.35	74LS169	0.85
4043	0.50	4553	2.70	74LS48	0.45	74LS170	0.90
4044	0.60	4554	1.20	74LS49	0.55	74LS173	0.60
4046	0.60	4555	0.35	74LS51	0.13	74LS174	0.40
4049UB	0.24	4556	0.40	74LS54	0.14	74LS175	0.40
4050	0.24	4557	2.30	74LS55	0.14	74LS181	1.05
4051	0.55	4558	0.80	74LS73	0.21	74LS190	0.60
4060	0.75	4559	3.50	74LS74	0.16	74LS191	0.60
4066	0.30	4560	2.50	74LS75	0.22	74LS192	0.45
4068	0.16	4561	1.00	74LS76	0.20	74LS193	0.42
4069UB	0.14	4562	2.50	74LS78	0.19	74LS194	0.35
4070	0.16	4566	1.20	74LS83	0.40	74LS195	0.35
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4081	0.12	4583	0.80	74LS107	0.25	74LS245	0.80
4093	0.30	4584	0.27	74LS109	0.20	74LS257	0.40
4175	0.80	4585	0.45	74LS112	0.20	74LS258	0.37
4502	0.60	40174	1.05	74LS113	0.20	74LS260	0.50
4503	0.50	40195	1.08	74LS114	0.19	74LS266	0.22
4506	0.70	74LS00	0.10	74LS122	0.35	74LS273	0.70
4507	0.37	74LS01	0.10	74LS124	1.80	74LS279	0.35
4508	1.50	74LS02	0.11	74LS123	0.35	74LS365	0.32
4510	0.55	74LS03	0.11	74LS125	0.24	74LS366	0.34
4511	0.45	74LS04	0.12	74LS126	0.24	74LS367	0.32
4512	0.55	74LS05	0.13	74LS132	0.42	74LS368	0.35
4514	1.25	74LS08	0.12	74LS133	0.24	74LS373	0.70

Memory Micros Linears:

LM10CN	3.88	SL1611	1.60	KB4433	1.52	U265	3.16
L149	1.86	SL1612	1.60	KB4413	1.95	U266	2.43
U237B	1.28	SL1613	2.06	KB4436	2.53	LC7137	7.50
U247B	1.28	SL1620	2.17	KB4437	1.75	ICM7216B	19.50
U257B	1.28	SL1621	2.17	KB4445	1.29	ICM7216C	19.95
U267B	1.28	SL1623	2.44	KB4446	2.75	ICM7217A	9.50
LM324	0.45	SL1625	2.17	NE5044	2.26	SP8647	6.00
LM339N	0.66	SL1630	1.62	MC5229	9.60	95H90	7.80
LF347	1.60	SL1640	1.89	SL6270	2.03	HD10551	2.45
LM348	0.90	SL1641	1.89	SL6310	2.03	HA12009	6.00
LF351	0.49	TDA2002	1.25	SL6440	3.38	HD44015	4.45
LF353	0.76	ULN2242	3.05	SL6600	3.75	HD44752	8.00
LM380N	1.00	ULN2283	1.00	SAS6610	1.48	MC145151P	6.00
ZN419CE	1.98	CA3089	1.84	SL6640	2.75	Z80A	3.75
ZN427E/8	6.28	CA3130E	0.80	SL6690	3.20	Z80A P10	3.50
NE544	1.80	CA3130T	0.90	SL6700	2.35	Z80A CTC	4.00
NE555N	0.20	CA3140E	0.46	SAS6710	1.48	Z80A DMA	9.95
SL560C	1.98	CA3189E	2.20	LS7225	3.65	Z80A DART	7.50
NE564	4.29	CA3240E	1.27	ICM7555	0.94	Z80A S10/1	11.00
NE567	1.30	MC3357	2.85	ICL8038CC	4.50	Z80A S10/2	11.00
uA741CN	0.20	ULN3859	2.95	TK10170	1.87	Z80A S10/9	9.95
TBA820M	0.78	LM3900	0.60	TK10321	2.75	Z8001	65.00
ZNA1034	2.10	LM3909N	0.68	HA11223	2.15	8255	2.58
LM1035	4.50	LM3914N	2.80	HA11225	1.45	6800P	2.90
TDA1062	1.95	KB4412	1.95	HA12002	1.22	6809	8.75
TDA1083	1.95	KB4417	1.80	HA12402	1.95	6802	3.50
TDA1090	3.05	KB4420B	1.09	HA12411	1.20	68A00P	4.25
HA1197	1.00	KB4423	2.30	HA12412	1.55	68B00P	4.65
MC1350	1.20	KB4424	1.65	LF13741	0.33	2114-L2	1.49
HA1370	1.90	KB4430	2.30	MK50375	3.85	4116-2	1.59
HA1388	2.75	KB4431	1.95	MM53200	3.90	2732	4.00
SL1610	1.60	KB4432	1.95	U264	2.27	2716	3.00

Coils, Filters: Toko, Murata, NTK, Cathodeon.

SFE6.0MA	0.80	CDA10.7MA	0.70	10M15D	14.50
CFSE10.7	0.80	SFE27MA	0.94	LFB4	1.95
SFE10.7MA	0.45	SAF10.7MC-Z	3.75	LFB6/CFU455H	1.95
CFSB10.7	0.50	MF45510AZ121	18.55	LFB8	1.95
SFE10.7MJ	0.50	MFL45501L	11.95	LFB10	1.95
SFA10.7MF	0.75	10M15A	1.99	LFB12/CFU455F	1.95
SFE10.7ML	0.70	21M15A	3.45	LFH6S/ CFW455HT	2.45
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CFSH10.7M1	0.50	10M22D	17.20	LFH8S	2.45
CFSH10.7M2	0.50	10M8D	15.50	LFH12S/ CFW455FT	2.45
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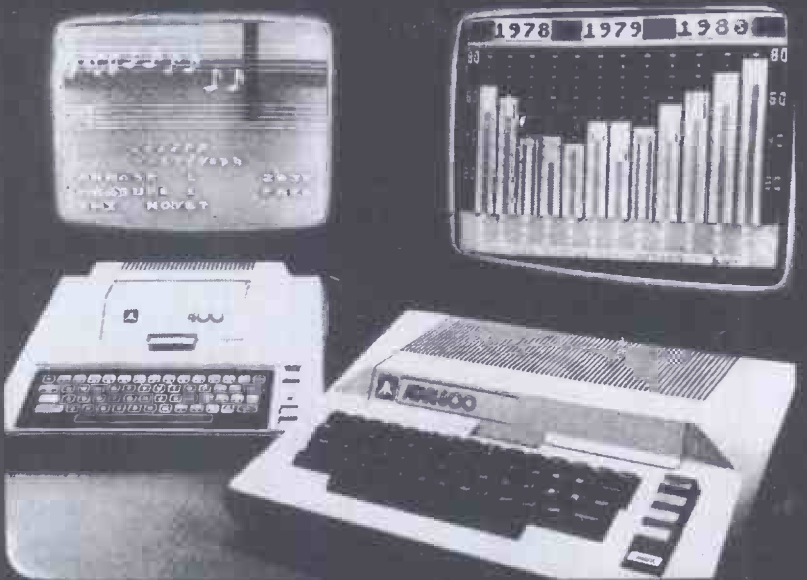

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ALL DEVICES BRAND NEW, FULL SPEC. AND FULLY GUARANTEED. ORDERS DESPATCHED BY RETURN OF POST. TERMS OF BUSINESS: CASH/CHEQUE/P.Os OR BANKERS DRAFT WITH ORDER. GOVERNMENT AND EDUCATIONAL INSTITUTIONS' OFFICIAL ORDERS ACCEPTED. TRADE AND EXPORT ENQUIRY WELCOME. P&P ADD 50p TO ALL CASH ORDERS. OVERSEAS ORDERS POSTAGE AT COST. AIR/SURFACE. ACCESS ORDERS WELCOME.

VAT

All prices exclusive of VAT. Please add 15% VAT to the total cost incl. P&P

We stock thousands more iems. It pays to visit us. We are situated behind Watford Footbal Ground. Nearest underground/BR Station: Watford High Street. Open Monday to Saturday: 9am to 6pm

POLYESTER CAPACITORS: Axial Lead Type
400V: 1nF, 1n5, 2n2, 3n3, 4n7, 6n8 11p; 10n, 15n, 18n, 22n 12p; 33n, 47n, 68n 16p; 100n, 150n 20p; 220n 30p;
330n 42p; 470n 52p; 680n 60p; 1µF 68p; 2µ2 82p; 4µ7 85p.
160V: 10nF, 12n, 100n 11p; 150n, 220n 17p; 330n, 470n 30p; 680n, 38p; 1µF 42p; 1µ5 45p; 2µ2 48p.
1000V: 1nF 17p; 10nF 30p; 15n 40p; 22n 36p; 33n 42p; 47n 48p; 100n 50p; 470n 99p.

POLYESTER RADIAL LEAD CAPACITORS: 250V:
10nF, 15n, 22n, 27n 6p; 33n, 47n, 68n, 100n 7p; 150n, 220n 10p.
330n, 470n 13p; 680n 19p; 1µF 23p; 1µ5 40p; 2µ2 46p; 4µ7 60p.

ULTRASONIC TRANSDUCERS
40kHz 395p/pr

ELECTROLYTIC CAPACITORS: (Values are in µF) 500V: 10 52p; 47 78p; 250V: 100 65p; 63V: 0.47, 1.0, 1.5, 2.2, 2.5, 3.3 8p; 4.7 9p; 6.8, 10 10; 15, 22, 12p; 33 15p; 47 12p; 100, 19p; 100, 19p; 1000 7p. 50V: 47 12p;
68
20p; 220 24p; 470 32p; 2200 90p. 40V: 4.7, 15, 22 9p; 3300, 90p; 4700, 120p; 25V: 1.5, 6.8, 10, 22 8p; 33 9p; 47 8p; 100 11p; 150 12p; 220, 15p; 330 22p; 470 25p; 680, 1000, 34p; 2200, 50p; 3300, 76p; 4700 92p; 16V: 40,
47, 100 9p; 125, 12p; 220 13p; 470, 20p; 680 34p; 1000 27p; 1500, 31p; 2200 36p; 3300 74p; 4700 79p.
TAG-END CAPACITORS: 64V: 2200 139p; 3300 198p; 4700 245p; 50V: 2200 110p; 3300 154p; 40V: 4700 190p; 25V: 2200 90p; 3300, 4000, 4700 98p; 10,000 320p; 15,000 345p; 16V: 22,000 350p.

TANTALUM BEAD CAPACITORS
35V: 0.1µF, 0.22, 0.33 15p; 0.47, 0.68, 1.0µF, 1.5 16p; 2.2, 3.3 18p; 4.7, 6.8 22p;
10µF 28p; 16V: 2.2, 3.3 16p; 4.7µF, 6.8, 10 18p; 15, 36p; 22 30p; 33, 47 40p; 100 75p; 220 88p; 10V: 15, 22, 26p; 33, 47 35p; 100 55p; 6V: 100 42p.

POTENTIOMETERS: Rotary, Carbon, Track. 0.25W Log & 0.5W Lin.
500Ω, 1KΩ & 2KΩ (Linear only) Single Gang 30p
5KΩ-2MΩ Single Gang 30p
5KΩ-2MΩ Single Gang D/P Switch 78p
5KΩ-2MΩ Double Gang 88p

SLIDER POTENTIOMETERS
0-25W log and linear values 60mm
5KΩ-500KΩ single gang 70p
10KΩ-500KΩ dual gang 110p
Self Stick Graduated Bezel 40p

MYLAR FILM CAPACITORS
100V: 1nF, 2, 4, 4n7, 10 6p; 15nF, 22n, 30n, 40, 47 7p; 56, 100n, 200 9p; 470n/50V: 12p.

MINIATURE TYPE TRIMMERS
2-6pF, 2-10pF, 2-25pF, 5-56pF 30p.

COMPRESSION TRIMMERS
3-40pF; 10-80pF 20p; 20-250pF 28p; 100-580pF 39p; 400-1250pF 48p.

PRESET POTENTIOMETERS
Vertical & Horizontal
0.1W 50 M-5 MΩ Miniature 7p
0.25W 100 M-3.3 MΩ horiz. 10p
0.25W 200 M-4.7 MΩ vert 10p

OPTO ELECTRONICS
LEDs with Clips

TIL209 Red	11
TIL211 Grn.	14
TIL212 Yel.	14
.2" Red	12
.2" Yell or Grn	
Square LEDs	14
Bi-Colour R/G	65
Bi-Colour G/Y	75
Tri-colour R/G/Y	85
OCP71	120
ORP12	78
2N5777	45
LD271	46
SFH205	91
TIL32	52
TIL78	55
TIL38	65
TIL100	90
7 Segment Displays	
TIL321 .5 CA	115
TIL322 .5 CC	115
DL704 .3 CCth	99
DL707 .3 CA	99
.3 Green CA	120
DL747 .6 CA	180
FND357	120
FND500	90
MAN3640	175
10 Seg Bargraph	225
LCD 3½ Digits	525
Isolators	
IL74	45
ILD74	99

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

RESISTORS — Carbon Film High Stability. Low Noise. Miniature Tolerance 5%.

	RANGE	VAL	1-99	100+
¼W	2Ω2-4M7	E24	2p	1p
½W	2Ω2-4M7	E12	2p	1p
1W	2Ω2-10M	E12	5p	4p
2% Metal Film 10Ω-1M			6p	4p
1% Metal Film 51Ω-1M			8p	6p

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

CERAMIC CAPACITORS 50V: 0-5pF to 10nF 4p; 22n to 47n 5p. 100n 7p.

GAS & SMOKE DETECTORS
TGS812 or TGS813 575p

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BBC MICRO
Upgrade kit now available
16-K RAM (8 × 4816 AP)
£18.00

VOLTAGE REGULATORS

		+ ve		− ve	
1A	TO3				
5V	7805	145p		7905	220p
12V	7812	145p		7912	220p
15V	7815	145p		—	
18V	7818	145p		—	
1A	TO220 Plastic Casing				
5V	7805	40p		7095	45p
12V	7812	40p		7912	45p
15V	7815	40p		7915	45p
18V	7818	40p		7918	45p
24V	7824	40p		7924	45p
100mA	TO92 Plastic Casing				
5V	78L05	30p		79L05	60p
6V	78L62	30p			
8V	78L82	30p			
12V	78L12	30p		79L12	60p
15V	78L15	30p		79L15	60p

CA3085	95p	LM317P	99p	TBA625B	75p
LM300H	170p	LM323K	500p	TDA1412	150p
LM305H	140p	LM337	175p	78H05	550p
LM309K	135p	LM723	35p	78H12	580p
LM317K	135p	TAA550	50p	78HG5	550p
				79HG	785p

SWITCHES

TOGGLE: 2A/250V
SPST Standard 33
DPDT Standard 44
SUB-MIN TOGGLE
SPST On/off 54
SPDT (c/over) 60
DPDT 6 tags 75
DPDT c/off 80
DPDT Biased 145

SLIDE: 240V
½A SPST 13
½A DPDT 13
1A DPDT 14
1A DP c/off 15

PUSH BUTTON
Push-Make 15
Push-Break 18

ROCKER: SPST on/off 10A/250V 28
ROCKER: DPDT 10A/250V 70
ROCKER: DPST ILLUMINATED 85
ROTARY: (Adjustable Stop) 1 pole/2 to 12 way; 2 pole/2 to 6 way; 3 pole/2 to 4 way; 4 pole/2 to 3 way 45

ZX81
16K RAM Pack, Fully built & tested.
Plugs straight on to your ZX81.
Only £17.35

We stock a wide selection of Computer ICs, Printers, Floppy Disc Drives, BBC Micro upgrade Kits, Micro peripherals, Books etc. at very competitive prices.

DIL SOCKETS

	Low Prof.	Wire wrap
8 way	8p	25p
14 pin	9p	35p
16 pin	10p	42p
18 pin	16p	52p
20 pin	22p	60p
22 pin	25p	70p
24 pin	27p	70p
28 pin	28p	80p
40 pin	30p	99p

PROTO DEC

Euroboard	520
S Dec	450
Bimboard I	500
Veroblock	375

Adventures with Electronics by Tom Duncan Complete Kit: £15

DENCO COILS
'DP' VALVE TYPE
Range 1 to 5 BL., RD, TI Wht. 122p
6-7 B-Y-R 110p
1,5 Green 150p
'T' type 1 to 5, Bl, Rd, Wht. Yl 150p
B9A Valve Holder 42p
RDT2 145p

RFC5 chokes 140p
RFC7 (19mH) 160p
13; 14; 15; 16; 17 120p
18/1.6 135p
18/465 152p
TOC 1 124p
MW5FR 122p
MW/LW SFR 154p

VEROBOARD

0.1" Pitch	clad	plain
2½ × 3¾"	73p	62p
2½ × 5"	83p	—
3¾ × 3¾"	83p	—
3¾ × 5"	95p	79p
3¾ × 17"	326p	211p
4¾ × 17"	426p	—
Pkt of 100 pins	50p	
Spot face cutter	118p	
Pin insertion tool	162p	

COPPER CLAD BOARDS
Fibre glass
6 × 6" 90p
6 × 12" 150p
S.R.B.P.
9 × 8 95p
Ferric Chloride 1lb Anhydr. 195p

DIODES

BY126	12
BY127	12
CR033	250
OA9	40
OA47	12
OA70	12
OA79	15
OA85	15
OA90	8
OA91	8
OA95	8
OA200	8
OA202	8
IN914	4
IN916	8
IN4001/2	5
IN4003	6
IN4004/5	6
IN4006/7	7
IN4148	4
IN5401	15
IN5404	16
IN5406	18
IN5408	19
IS44	9
IS921	9
6A/100V	40
6A/400V	50
6A/800V	65

We stock a wide selection of Electronic Books and Magazines.

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

NOISE
Diode 195p

BRIDGE RECTIFIERS

1A/50V	18
1A/100V	20
1A/400V	25
1A/600V	34
2A/50V	35
2A/200V	40
2A/400V	45
2A/600V	65
6A/100V	83
6A/400V	95
6A/600V	125
10A/200V	215
10A/600V	298
25A/200V	240
25A/600V	395
BY164	56
VM18	50

DIAC
ST2 25

SCRs Thyristors

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

TRIACS

3A 100V	48
3A 200V	54
3A 400V	56
8A 100V	60
8A 400V	69
8A 800V	115
12A 100V	78
12A 400V	82
12A 800V	135
16A 100V	103
16A 500V	115
25A 800V	220
25A 1000V	480
T28000D	120

TTL74

7400	11	74147	90	LS124	90	4053	50
7401	11	74150	50	LS125	24	4054	85
7402	11	74151	40	LS126	36	4055	85
7403	12	74153	40	LS132	40	4056	85
7404	13	74154	55	LS133	30	4057	1915
7405	15	74156	40	LS136	26	4059	435
7406	20	74157	30	LS138	28	4060	45
7407	20	74159	80	LS139	28	4061	1195
7408	14	74160	60	LS145	70	4062	995
7409	14	74161	48	LS147	150	4063	85
7410	14	74162	48	LS148	85	4066	24
7411	16	74163	48	LS151	40	4067	245
7412	18	74164	48	LS153	40	4068	14
7413	18	74165	48	LS155	30	4069	13
7414	20	74166	48	LS157	30	4070	13
7416	20	74167	150	LS158	30	4071	13
7417	20	74170	125	LS160	37	4072	13
7420	15	74172	275	LS161	37	4073	13
7421	20	74173	54	LS162	37	4075	13
7422	20	174174	54	LS163	37	4076	50
7425	24	74175	50	LS164	43	4077	13
7426	28	74176	40	LS165	60	4078	15
7427	22	74177	45	LS166	52	4081	13
7428	25	74178	80	LS170	70	4082	13
7430	14	74180	40	LS173	55	4085	50
7432	22	74181	115	LS174	50	4086	60
7433	22	74182	60	LS175	40	4089	125
7437	25	74184	90	LS181	95	4093	20
7438	25	74185	95	LS190	36	4094	70
7440	15	74186	470	LS191	36	4095	75
7441	68	74188	250	LS192	36	4096	70
7442	32	74190	48	LS193	37	4095	290
7443	90	74191	46	LS194	33	4097	190
7444	90	74192	46	LS195	33	4098	75
7445	55	74193	45	LS196	38	4099	190
7446	60	74194	45	LS197	48	4160	75
7447	35	74195	46	LS221	55	4161	99
7448	40	74196	46	LS240	55	4162	99
7450	16	74197	46	LS241	55	4163	99
7451	16	74198	84	LS242	55	4175	105
7453	16	74199	84	LS243	55	4194	105
7454	16	74221	54			4408	790

7460	16	**74LS**		**CMOS**		4409	790
7470	30	LS00	11	4000	10	4410	725
7472	24	LS01	11	4001	10	4411	690
7473	24	LS02	11	4002	12	4412	790
7474	20	LS03	12	4006	50	4415	480
7475	32	LS04	12	4007	14	4419	280
7476	30	LS05	13	4008	32	4422	770
7480	40	LS08	12	4009	24	4433	770
7481	120	LS09	12	4010	24	4435	850
7482	65	LS10	13	4011	10	4440	999
7483	38	LS11	13	4012	16	4450	350
7484	70	LS12	13	4013	24	4451	350
7485	60	LS13	20	4014	46	4490	350
7486	20	LS14	30	4015	40	4500	675
7489	205	LS20	13	4016	20	4501	28
7490	20	LS21	13	4017	32	4502	60
7491	35	LS22	13	4018	45	4503	35
7492	25	LS26	13	4019	25	4504	75
7493	25	LS27	12	4020	42	4506	35
7493	35	LS28	14	4021	40	4507	35
7495	35	LS30	12	4022	40	4508	130
7496	40	LS32	13	4023	13	**ICs**	
7497	90	LS33	14	4024	32	2114L-2	70
74100	80	LS37	14	4025	13	2708	225
74104	50	LS38	16	4026	80	2716	215
74105	55	LS40	13	4027	20	4116	70
74107	20	LS42	28	4028	39	4816 (BBC)	225
74109	25	LS47	35	4029	45	6116	390
74110	35	LS48	46	4030	15	6502	325
74111	55	LS55	14	4031	125	6522	320
74112	170	LS63	120	4032	80	6800	275
74116	50	LS73	18	4033	125	709C 8 pin	35
74118	60	LS74	18	4034	140	733	100
74119	80	LS75	20	4035	45	741 8 pin	74
74120	60	LS76	18	4036	275	747C	65
74121	25	LS83	36	4037	115	748C	36
74122	40	LS85	48	4038	110	753	185
74123	35	LS86	16	4039	290	810	159
74126	35	LS90	24	4040	40	81LS95	85
74128	35	LS92	32	4041	40	81LS96	85
74132	28	LS93	23	4042	40	81LS97	85
74135	40	LS95	40	4043	40	9400CJ	350
74136	28	LS96	40	4044	40	AY-1-1320	225
74141	55	LS107	40	4045	105	AY-1-5050	99
74142	175	LS109	23	4046	45	AY-1-5051	160
74143	210	LS112	22	4047	40	AY-3-8910	438
74145	50	LS113	16	4048	40	AY-5-1230	450
		LS114	22	4049	25	AY-5-1350	388
		LS122	36	4050	25	CA3011	130
		LS123	36	4051	45	CA3018	86
				4052	60		

CA3020	210	MC[illegible]	[illegible]
CA3023	210	MC1709G	90
CA3028	96	MC1710	79
CA3035	255	MC3302	150
CA3045	365	MC3340P	120
CA3046	70	MC3360P	120
CA3048	220	MC3401	65
CA3059	285	MC3403	75
CA3075	213	MC3403	110
CA3080E	70	MFC6040	75
CA3081	190	MK50398	636
CA3085	95	ML924	250
CA3089E	200	MM5303	636
CA3090AQ	375	MM5307	1275
CA3123E	150	MM5387	47
CA3130	90	NE529	225
CA3140	40	NE531	14
CA3160	96	NE543	225
CA3161	160	NE544	210
CA3189	295	NE555	16
HA1336W	240	NE556	45
ICL7106E	750	NE560	325
ICL7107	975	NE561	398
ICL8038CC	300	NE562	410
ICM7204	550	NE564	420
ICM7205	1150	NE565	120
ICM7216A	1950	NE566	155
ICM7217A	790	NE567	140
ICM7224	785	NE570	410
ICM7555	80	NE571	400
ICM7556	150	NE5534	225
LA3350	250	RC4136	89
LA4031	340	S566B	225
LA4032	295	SAB3209	425
LA4400	440	SAB3210	325
LC7120	300	SAB3271	486
LC7130	340	SAB4209	596
LC7137	395	SN76013	360
LF347	150	SN76023	360
LF351	48	SN76477	450
LF353	50	SN76488	480
LF356	85	SN76660	120
LF356	90	SL490	360
LF357	110	SP8629	299
LF398	475	TAA621	295
LM301A	24	TA7120	150
LM308	95	TA7130	150
LM311	70	TA7204	200
LM318	150	TA7205A	90
LM319	215	TA7222	150
LM324	30	TAD100	159
LM339	47	TBA120	70
LM348	64	TBA641	290
LM349	115	TBA800	80
LM358	60	TBA810	95
LM377	175	TBA820	80
LM379	480	TCA965	120
LM380	75	TDA1004	290
LM381	145	TDA1008	310
LM382	115	TDA1022	499
LM384	140	TDA1024	105
LM386	90	TDA1490	325
LM387	120	TDA2004	495
LM389	95	TDA2020	320
LM393	100	TLO61	40
LM394	290	TLO63	80
LM733	100	TLO71CP	24
LM1458	40	TLO72	45
LM2917	195	TLO74	100
LM3900	50	TLO81	24
LM3302	90	TLO82	45
LM3900	50	TLO83	75
LM3909	85	TLO84	90
LM3911	125	UAA170	170
LM3914	210	UAA180	170
LM3915	220	UA2240	120
LM3916	220	XR2206	300
LS7220	280	XR2211	575
M252	625	Z80CPU	299
M253A	1150	Z80A CPU	350
MC1303	88	Z80A CTC	290
MC1304P	260	Z80 CTC	290
MC1310	150	Z80PIO	280
MC1455	150	Z80APIO	275
MC1458	56	ZN414	80
MC1488	55	ZN424E	130
MC1458	40	ZN425E	345
MC1469	300	ZN426E	300
MC1488	40	ZN427	590
MC1489	55	ZN428	410
MC1495	350	ZN429	210
MC1496	70	ZN1034E	200
MC1596	225	ZN1040E	675

TRANSISTORS

AC125	35	BC307B	14	BFY52	23	TIP35A	110	2N1306/7	65	2N5305	24
AC126/7	35	BC328	95	BRY39	40	TIP35C	128	2N1671B	120	2N5457/8	30
AC128	30	BC338	15	BSX20	20	TIP36A	130	2N2160	350	2N5459	30
AC141/2	30	BC441	34	BSY65	36	TIP36C	140	2N2219A	28	2N5485	30
AC176/87	30	BC461	34	BSY95A	25	TIP41A	50	2N2220A	23	2N5777	45
AC188	30	BC477	40	BU105	170	TIP41B	52	2N2222	25	2N6027	32
ACY17/18	70	BC516/7	40	BU205	190	TIP42A	55	2N2369A	18	2SA636	250
ACY20/1	75	BC547/8	12	BU208	200	TIP42B	58	2N2476	50	2SA671	250
ACY22	60	BC549	14	E113	45	TIP120	70	2N2483	27	2SA715	60
AD140	120	BC556/7	15	E176	50	TIP121/2	73	2N2497	63	2SC495	70
AD149	79	BC558/9	15	E421	250	TIP141	105	2N2646	45	2SC496	70
AD161/2	42	BCY70	16	MJ2955	70	TIP142	105	2N2894	30	2SC1061	250
AF115	60	BCY71	18	MJE340	54	TIP147	120	2N2904	28	2SC1096	85
AF139	40	BCY72	20	MJE370	100	TIP2955	60	2N2905A	28	2SC1173	125
AF178	75	BD131/2	48	MJE371	100	TIP3055	60	2N2906/7	26	2SC1306	100
AF180/6	70	BD133	60	MJE520/1	95	TIS43	32	2N2926G	10	2SC1307	150
AF239	55	BD135	45	MJE2955	70	TIS44	45	2N3053	26	2SC1449	85
BC107/8	10	BD136/7	40	MJE3055	70	TIS88A	50	2N3054	58	2SC1923	50
BC108B	12	BD138/9	40	MPF102	40	TIS90	30	2N3055	48	2SC1945	225
BC108C	12	BD140	40	MPF103	30	TIS91	32	2N3121	30	2SC1953	90
BC109	10	BD695A	99	MPF104	30	VK1010	80	2N3133	45	2SC1957	90
BC109B	12	BD696A	99	MPF105	30	VN10K	55	2N3135	30	2SC1969	140
BC109C	12	BDY17	195	MPF106	40	VN46AF	78	2N3252	46	2SC2028	85
BC117/8	20	BDY60	160	MPSA05/6	25	VN66AF	80	2N3442	140	2SC2029	210
BC118	38	BDY61	160	MPSA12	30	VN88AF	94	2N3568	25	2SC2078	170
BC137	40	BF115	35	MPSA55	30	ZTX107/8	11	2N3663	15	2SC2091	85
BC140/3	30	BF167	29	MPSA56	30	ZTX109	12	2N3702/3	10	2SC2314	85
BC147/8	9	BF173	27	MPSU06	55	ZTX300	13	2N3704/5	10	2SC2166	165
BC149	9	BF177	25	MRSU56	60	ZTX301/2	16	2N3706/7	10	2SC1679	190
BC153/4	27	BF178	30	OC35	125	ZTX303	25	2N3708/9	10	3N128	112
BC157/8	10	BF179	35	OC36	120	ZTX304	17	2N3710/11	10	3N140	112
BC159	11	BF180	38	OC41/2	75	ZTX314	25	2N3713	140	40311	60
BC160	45	BF194/5	12	OC44	75	ZTX326	30	2N3771	179	40313	130
BC167A	10	BF196/7	12	OC45/70	40	ZTX341	30	2N3772	195	40316	95
BC168C	10	BF198	18	OC71/2	40	ZTX500	14	2N3773	210	40317	80
BC169C	10	BF200	30	OC76	50	ZTX501/2	15	2N3819	22	40324	100
BC170	15	BF224A	25	OC81/2	50	ZTX503	18	2N3820	38	40326	60
BC171/2	11	BF244	28	OC83/4	40	ZTX504	25	2N3822/3	45	40327	70
BC177/8	16	BF256	35	OC170/1	50	ZTX531	25	2N3866	90	40347	90
BC179	20	BF257/8	32	TIP29A	32	ZTX550	25	2N3903/4	15	40348	120
BC182/2L	10	BF259	35	TIP29C	38	2N526	58	2N3905/6	15	40360	80
BC813/L	10	BF594/5	40	TIP30	48	2N696	30	2N4037	46	40361/2	70
BC184	10	BFR39/40	23	TIP30A	36	2N697	23	2N4058	10	40407	60
BC184L	10	BFR41/79	23	TIP30C	37	2N698	40	2N4061/2	10	40408	70
BC186/7	26	BFR80/81	25	TIP31A	38	2N699	48	2N4069	45	40411	285
BC212	10	BFX29	28	TIP31C	37	2N706	19	2N4859	78	40412	90
BC212L	10	BFX81	45	TIP32A	38	2N918	35	2N4871	55	40467	130
BC213	10	BFX84	28	TIP32C	42	2N930	20	2N5135/6	20	40468	85
BC213L	10	BFX85/6	28	TIP33A	65	2N961	65	2N5138	18	40594	105
BC214	10	BFX87/8	28	TIP33C	78	2N1132/2	24	2N5179	45	40595	110
BC214L	10	BFY50/1	23	TIP34A	74	2N1304	65	2N5180	45	40603	110
				TIP34C	88	2N1305	60	2N5191	75	40636	175
										40673	85

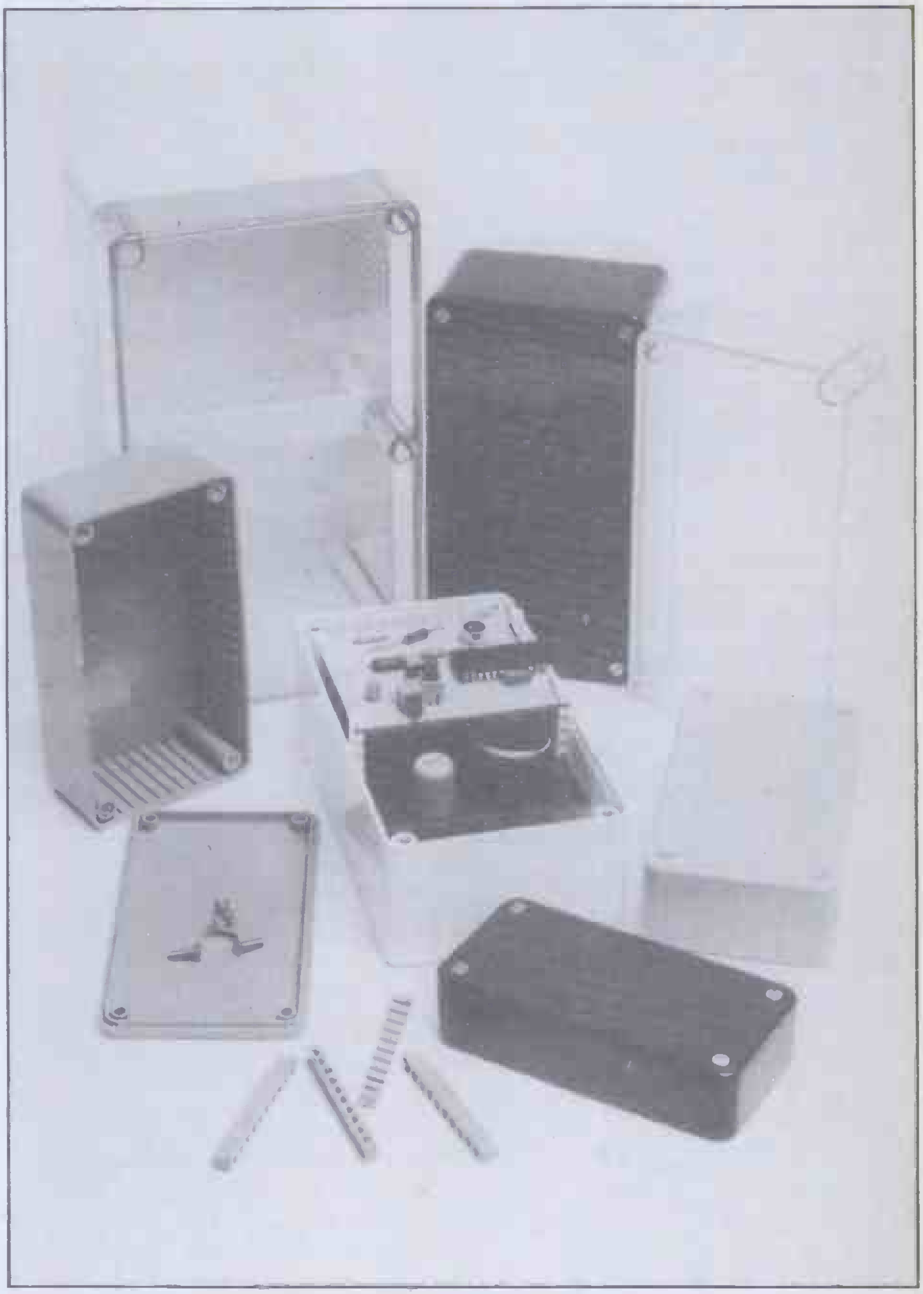
BIMDAPTORS

All 2000 Series BIMBOXES from **Boss Industrial Mouldings** now include BIMDAPTORS, which enable flat mounting of PCBs by using the vertical slots moulded into the sides of the boxes **(right)**.

The simple plastic adaptors have 1.5 mm wide horizontal slots spaced 5 mm apart, and are normally slid onto each corner of the PCB — or at closer intervals if required. Two or more PCBs can be sandwiched together and the whole assembly simply slipped into position in the box. The BIMDAPTORS are snipped off to length, just below lid-level, so that the units are firmly held down when the lid is screwed on.

Boss now offer six basic sizes within the 2000 Series, ranging from 100 x 50 x 25 mm to 190 x 110 x 60 mm. Available colours are blue, black, grey, orange or white; some have standard profile clear plastic lids and are the ideal containers for devices such as controller/timers, where it is neccessary to see inside the box.

For further information, contact **Boss Industrial Mouldings Ltd**, James Carter Road, Mildenhall, Suffolk IP28 7DE; Tel. 0638 716101.



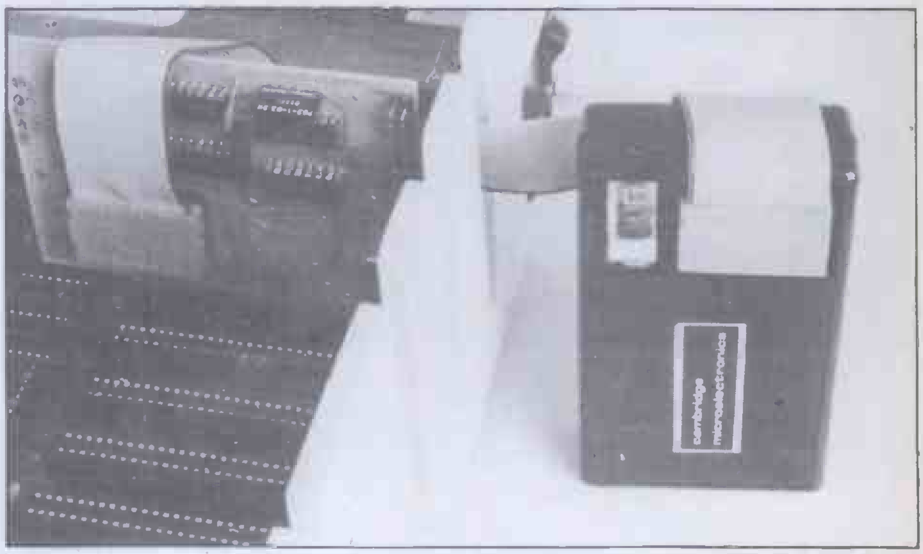
Save Your Memory

MEMIC, from **Cambridge Microelectronics**, is a family of CMOS memory units with an integral backup battery for saving up to 2K of program without the need to blow EPROMs. The units plug directly into 24-pin EPROM/ROM sockets or byte-wide RAM sockets. A flying-lead connector allows MEMIC to be used as random access memory even when plugged into a ROM socket.

The 2K bytes of fast, static memory and the lithium backup battery are built into a box measuring must 4" x 2.4" x 1"; as many units may be used as there are spare sockets. The access time is better than 200 nS; no special signals or hardware are required for use with most systems and the very low power consumption on standby gives months of memory storage.

MEMIC units **(right)** are available for an all-inclusive price of **£29.95**, fully assembled, tested, and with clear operating instructions, from **Cambridge Microelectronics Ltd**, 1, Milton Road, Cambridge CB4 1UY; Tel. 0223 314814.

We also understand that a MEMIC unit for the ZX81 (the MEMIC 81), with up to 4K of memory, will shortly be available. It is expected to be in the same price range, so watch this space for further details!



The £50 Computer

Sinclair Research have broken the £50 barrier for personal computers by reducing the price of the ZX81 from £69.95 down to £49.95. The move reflects Clive Sinclair's belief that "The personal computer is no longer the preserve of the hobbyist but (is) rapidly becoming as much a household item as the TV or hi-fi".

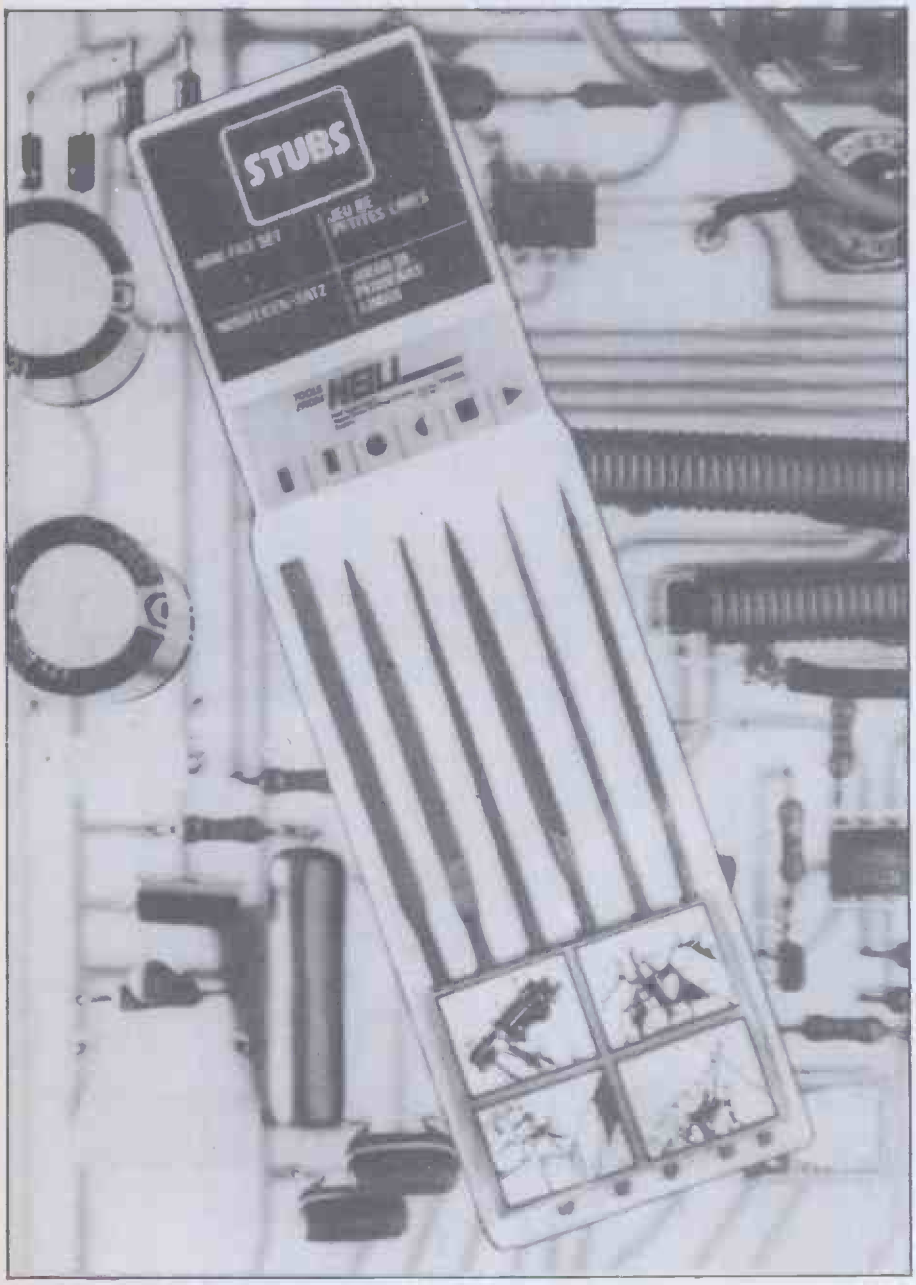
From August, the ZX81 will also be sold at selected brnaches of Boots and Greens (in Debenhams), as well as at branches of W.H. Smith.

Tooling Up

The only really essential tools of the electronics trade are a soldering iron, a pair of pliers, cutters and some screwdrivers. There are many other items, though, whose usefulness only becomes obvious if they aren't to hand when needed!

Miniature files, such as those (below) recently released by **Neill Tools**, are a good example; this new six-pack of Stubs precision needle files are ideal for construction and maintainance of electronic equipment of all kinds.

The clear plastic pack contains six 16 mm files — hand, flat, round, half round, square and three-square — and sell at a recommended retail price of **£9.45**. Details from **Neill Tools Limited**, Napier Street, Sheffield S11 8HB; Tel. 0742 71281.



Hobbyists with a sideline in DIY or craftwork will also be interested in **Universal Solder**, from **Jimi-Heat Limited**; it has the ability to join all metals to themselves or to each other. The joint is formed at a temperature of 210° using either a low-pressure gas flame or soldering iron and it will join metals such as aluminium or zinc easily and without distortion.

The solder is non-toxic and is supplied in a pack together with the flux. It is available for **£2.95**, including VAT, from branches of Woolworth and Halfords.

Gold Tested Here

The **Mitsubishi Electric Corporation** have produced an Ultrasonic Gold Ingot/Bar Tester **(below)** that can be used by "the average person" to detect the presence of cavities or foreign matter inside gold bars/ingots, detect gold plating or pinpoint the presence of substances other than gold.

We would be happy to review a sample unit for the benefit of our many gold-investing readers, but it seems unlikely that we could persuade anyone to supply the several dozen pure gold bars that would be neccessary for us to carry out a thorough test!

Double First

Murphy Electronics are currently leading the way in new developments in audio marketing techniques with the release of a twin-cassette recorder/radio. The MTC 2506 has a "double-play" facility which allows recording from one cassette deck to the other. Deck One functions in both play and record modes, while Deck Two works in playback only.

Also included in the set is a three-band stereo radio, tone and balance controls, auto-stop feature, twin condenser microphones, and sockets for headphones and extension speakers. The set operates either from mains or battery and will be available for around £99 at retail outlets. **HE**

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2.2/35V 22p
3.3/35V 22p
4.7/16V 22p
4.7/35V 24p
6.8/25V 26p
6.8/35V 26p
10/16V 26p
10/35V 28p
15/10V 22p
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15/25V 32p
22/6.3V 26p
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150nF, 220nF 11p
330nF, 470nF 18p
680nF, 1µF 28p
1.5µF, 2.2µF 44p

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BOOKS (no VAT) (Post inc. prices)
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TTL Data 3.95
Data conversion 4.50
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Special function handbook 3.95

Quality Electrolytics
By Matsushita or Siemens
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AXIALS

uFd	V	
.47	63	8p
.47	100	9p
.47	350	30p
1	63	8p
1	100	9p
1	500	40p
2.2	25	8p
2.2	63	9p
2.2	100	11p
2.2	350	30p
3.3	25	10p
3.3	40	11p
3.3	63	12p
4.7	16	8p
4.7	25	9p
4.7	40	11p
4.7	63	12p
4.7	100	14p
10	25	8p
10	40	12p
10	63	14p
10	100	16p
22	25	11p
22	40	14p
22	63	16p
22	100	21p
47	25	14p
47	40	17p
47	63	26p
47	100	28p
68	25	18p
68	63	25p
100	16	16p
100	25	16p
100	40	22p
100	63	25p
100	100	30p
220	10	16p
220	16	17p
220	25	22p
220	40	25p
220	63	30p
220	100	40p
330	16	19p
330	25	22p
330	63	38p
470	16	22p
470	25	28p
470	40	33p
470	63	43p
470	100	60p
1000	16	30p
1000	25	35p
1000	40	48p
1000	63	66p
2200	16	40p
2200	25	63p
2200	40	70p
2200	63	134p
4700	16	75p
4700	25	97p

Beautiful **Mini Radial Low Voltage**
Matsushita only

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

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178 × 240mm 95p
420 × 195mm 130p
420 × 245mm 195p

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100 × 220 2.15
203 × 114 2.21
233 × 220 4.55
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Bits C240
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2N2925 15p
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2N3053 27p
2N3054 56p
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2N3251 36p
2N3439 98p
2N3440 80p
2N3441 1.25
2N3442 1.35
2N3442MOT 2.40
2N3444 1.70
2N3445 4.80
2N3446 6.09
2N3447 5.72
2N3448 6.56
2N3468 1.00
2N3512 1.06
2N3553 2.30
2N3632 9.88
2N3638 35p
2N3638A 37p
2N3694 30p
2N3702 10p
2N3703 10p
2N3704 10p
2N3705 10p
2N3706 10p
2N3707 10p
2N3708 10p
2N3709 10p
2N3710 10p
2N3711 10p
2N3712 2.00
2N3713 1.38
2N3714 2.98
2N3715 3.31
2N3716 3.60
2N3819 21p
2N3820 38p
2N3821 1.84
2N3822 90p
2N3823 45p
2N3824 1.70
2N3860 31p
2N3866 90p
2N3877A 28p
2N3902 6.05
2N3903 16p
2N3904 16p
2N3905 15p
2N3906 15p
2N4030 66p
2N4031 55p
2N4032 66p
2N4036 58p
2N4037 43p
2N4239 1.00
2N4240 3.00
2N4347 2.26
2N4351 1.18
2N4400 15p
2N4401 27p
2N4402 30p
2N4403 30p
2N4409 36p
2N4410 42p
2N4427 79p
2N4440 12.58
2N4870 80p
2N4871 55p
2N4888 90p
2N4898 1.29
2N4901 1.69
2N4902 3.52
2N4903 3.24
2N4904 2.75
2N4905 3.25
2N4906 3.42
2N4907 3.25
2N4908 3.70
2N4909 2.90
2N4918 95p
2N4919 1.28
2N4920 1.34
2N4921 56p
2N4922 69p
2N4923 99p
2N5086 35p
2N5087 39p
2N5088 37p
2N5089 37p
2N5190 70p
2N5191 70p
2N5193 90p
2N5194 78p
2N5209 23p
2N5245 37p
2N5246 40p
2N5248 46p
2N5249 48p
2N5266 2.88
2N5293 98p
2N5294 1.28
2N5295 1.37

2N5401 35p
2N5415 1.10
2N5416 1.54
2N5447 16p
2N5448 19p
2N5449 21p
2N5450 23p
2N5451 25p
2N5457 29p
2N5458 29p
2N5459 29p
2N5460 72p
2N5543 5.00
2N5551 37p
2N6082 11.98
2N6121 54p
2N6122 56p
2N6123 59p
2N6124 56p
2N6125 59p
2N6126 71p
2N6129 79p
2N6130 93p
2N6131 98p
2N6132 83p
2N6133 1.16
2N6134 1.36
2N6253 1.45
2N6254 1.55
2SC 1306 95p
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3N138 3.60
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3N143 2.85
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3N154 2.56
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BC147A 12p
BC147B 12p
BC147C 12p
BC148 10p
BC148A 12p
BC148B 12p
BC148C 12p
BC149 10p
BC149B 12p
BC149C 12p
BC152 35p
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BC157 11p
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BC157B 13p
BC158 10p
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BC159 11p
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BC159B 13p
BC159C 14p
BC160 42p
BC161 48p
BC167 10p
BC167A 12p
BC167B 13p
BC168 10p
BC168B 12p
BC168C 12p
BC169 10p
BC169B 12p
BC169C 12p
BC177 16p
BC177A 25p
BC177B 26p
BC178 16p
BC178A 24p
BC178B 25p
BC179 20p
BC179A 25p
BC179B 25p
BC182 10p
BC182B 12p
BC182L 10p
BC182LA 13p
BC182LB 13p
BC183 10p
BC183A 11p
BC183B 12p
BC183C 13p
BC183L 10p
BC183LA 13p
BC183LB 13p
BC183LC 14p
BC184 10p
BC184B 12p
BC184C 13p
BC184L 10p
BC184LB 13p
BC184LC 14p
BC186 24p
BC187 24p

BC212 10p
BC212A 12p
BC212B 13p
BC212L 10p
BC212LA 13p
BC212LB 13p
BC213 10p
BC213A 11p
BC213B 12p
BC213C 13p
BC213L 10p
BC213LA 13p
BC213LB 13p
BC213LC 14p
BC214 10p
BC214B 12p
BC214C 13p
BC214L 10p
BC214LB 13p
BC214LC 14p
BC237 14p
BC237A 16p
BC237B 17p
BC237C 18p
BC238 14p
BC238A 15p
BC238B 16p
BC238C 17p
BC239 15p
BC239A 16p
BC239B 17p
BC239C 18p
BC300 45p
BC301 44p
BC302 43p
BC303 47p
BC327 14p
BC328 14p
BC337 15p
BC338 15p
BC440 32p
BC441 33p
BC460 39p
BC461 33p
BC516 40p
BC517 40p
BC547 13p
BC547A 14p
BC547B 14p
BC548 12p
BC548A 13p
BC548B 14p
BC548C 15p
BC549 13p
BC549B 14p
BC549C 16p
BC550 30p
BC550C 33p
BC557 15p
BC557A 16p
BC557B 16p
BC558 14p
BC558A 15p
BC558B 15p
BC558C 17p
BC559 15p
BC559B 16p
BC559C 17p
BC560 32p
BC560C 34p
BCY70 18p
BCY71 18p
BCY72 19p
BD131 44p
BD132 44p
BD135 40p
BD136 40p
BD137 42p
BD138 39p
BD139 39p
BD140 40p
BD237 98p
BD238 98p
BD239A 57p
BD239C 64p
BD240A 59p
BD240C 73p
BD241A 61p
BD241C 67p
BD242A 62p
BD242C 70p
BD243A 72p
BD243C 85p
BD244A 82p
BD244C 1.00
BD245A 1.14
BD245C 1.34
BD246A 1.31
BD246C 1.50
BD249A 2.00
BD249C 2.31
BD250A 2.11
BD250C 2.46
BD437 88p
BD438 88p
BD439 90p
BD440 91p
BD441 91p
BD442 93p
BD529 1.00
BD530 75p
BD535 75p
BD536 80p
BD537 80p
BD538 80p
BD539 80p
BD539C 1.10
BD540 85p
BD540C 1.26
BD675 72p
BD676 73p
BD677 78p
BD678 83p
BD711 1.32
BD712 1.32
BDX14 1.30
BDX18 1.59
BDX32 3.47
BUY54 1.70
BYD55 1.75
BDY56 1.80
BDY57 5.85
BDY58 6.15
BF194 12p
BF195 12p
BF196 12p
BF197 12p
BF198 15p
BF199 15p
BF200 1.49
BF225J 32p
BF240 38p
BF241 38p
BF244A 38p
BF244B 39p
BF245A 39p
BF245B 51p
BF246 52p
BF246A 53p
BF246B 53p
BF247A 54p
BF247B 56p
BF254 38p
BF255 42p
BF256A 45p
BF256B 62p
BF256C 73p
BF257 32p
BF258 32p
BF259 35p

BF457 48p
BF458 56p
BF459 62p
BF469 85p
BF470 85p
BFR39 25p
BFR40 25p
BFR41 25p
BFR79 25p
BFR80 25p
BFR81 25p
BFR90 2.11
BFS28 2.96
BFS61 1.00
BFS98 1.10
BFX29 26p
BFX30 27p
BFY50 23p
BFY51 23p
BFY52 23p
BFY53 31p
BSX19 24p
BSX20 24p
BSX21 40p
BU104 2.22
BU105 1.70
BU109 3.29
BU126 1.47
BU204 2.20
BU205 2.20
BU206 1.80
BU208 1.89
BU326S 2.35
BU406 1.45
BU407 1.45
BU408 1.35
BU500 2.95
BUV20 11.00
BUV21 10.90
BUV23 13.60
BUV24 12.10
BUV25 15.00
BUX20 17.00
BUY18S 3.95
E430 5.60
J300 48p
J310 53p
MJ802 3.90
MJ900 2.90
MJ901 3.10
MJ1000 2.50
MJ1001 3.00
MJ1800 3.60
MJ2500 2.19
MJ2501 2.25
MJ2955 1.00
MJ3000 2.19
MJ3001 2.25
MJ3701 2.55
MJ4502 3.99
MJ15003 4.86
MJ15004 5.00
MJ15015 2.45
MJ15016 3.34
MJE340 53p
MJE350 81p
MJE2955 99p
MJE3055 69p
MPSA05 23p
MPSA06 26p
MPSA10 28p
MPSA12 29p
MPSA13 48p
MPSA14 46p
MPSA16 30p
MPSA18 65p
MPSA20 48p
MPSA42 49p
MPSA43 48p
MPSA55 28p
MPSA56 30p
MPSA65 40p
MPSA66 47p
MPSA70 45p
MPSA92 39p
MPSA93 48p
MPSU01 42p
MPSL51 48p
MPSU01 84p
MPSU04 1.32
MPSU05 55p
MPSU06 56p
MPSU07 75p
MPSU51 88p
MPSU55 58p
MPSU56 59p
MPSU57 1.20
OC20 2.30
OC22 2.00
OC23 2.00
OC25 2.50
OC28 1.70
OC29 2.35
OC35 2.35
OC41 80p
OC43 82p
OC70 65p
OC71 50p
OC72 50p
OC82 50p
OC82D 70p
OC83 76p
TIP29A 32p
TIP29C 38p
TIP30A 38p
TIP30C 36p
TIP31A 39p
TIP31C 39p
TIP32A 42p
TIP32C 42p
TIP33A 76p
TIP33C 78p
TIP34A 74p
TIP34C 88p
TIP35A 1.07
TIP35C 1.29
TIP36A 1.29
TIP36C 1.39
TIP41A 49p
TIP41C 56p
TIP42A 55p
TIP42C 60p
TIP49 1.20
TIP50 1.40
TIP53 1.57
TIP54 1.59
TIP110 74p
TIP112 90p
TIP115 81p
TIP117 96p
TIP120 69p
TIP122 73p
TIP125 1.20
TIP127 1.27
TIP130 1.50
TIP132 1.60
TIP135 1.80
TIP137 1.80
TIP140 1.04
TIP142 1.04
TIP145 1.19
TIP147 1.19
TIP2955 77p
TIP3055 70p
TIS43 40p
TIS45 46p
TIS46 46p
TIS47 46p
TIS88A 82p

VN10KM 60p
VN46AF 84p
VN66AF 85p
ZTX107 10p
ZTX108 10p
ZTX109 10p
ZTX300 13p
ZTX301 15p
ZTX302 15p
ZTX303 23p
ZTX304 15p
ZTX310 35p
ZTX311 32p
ZTX312 35p
ZTX313 36p
ZTX314 24p
ZTX320 35p
ZTX330 35p
ZTX341 28p
ZTX500 14p
ZTX501 14p
ZTX502 14p
ZTX503 17p
ZTX504 24p
ZTX510 34p
ZTX530 24p
ZTX531 25p

DIODES
1N34A 30p
1N821 70p
1N823 96p
1N914 4p
1N916 10p
1N1190 1.47
1N4001 4p
1N4002 4p
1N4003 5p
1N4004 5p
1N4005 5p
1N4006 6p
1N4007 7p
1N4009 20p
1N4148 5p
1N4150 18p
1N4448 22p
1N4517 22p
1N5172 30p
1N5176 94p
1N5400 12p
1N5401 13p
1N5402 14p
1N5403 15p
1N5404 15p
1N5405 17p
1N5406 18p
1N5407 19p
1N5408 20p
1N5024 52p
1N5625 60p
1N5626 62p
1N5627 68p
1S44 10p
BA102 25p
BA115 25p
BA133 40p
BA138 30p
BA142 20p
BA144 15p
BA155 15p
BA156 38p
BA157 25p
BA158 30p
BA159 32p
BA182 40p
BA201 18p
BA202 25p
BA316 25p
BA317 25p
BA318 30p
BAV10 16p
BAV19 15p
BAV20 15p
BAV49 15p
BAX13 10p
BAX16 11p
BY126 20p
BY127 22p
BY134 52p
BY182 1.26
BY188A 65p
BY206 36p
BY207 36p
BY223 1.56
BY297 48p
BY299 55p
MZ2361 1.80
OA10 70p
OA47 20p
OA90 10p
OA91 10p
OA95 20p
OA200 20p
OA202 20p

BRIDGE RECTIFIERS (PIV shown in brackets)
1 amp type
W01 (100) 20p
W02 (200) 26p
W04 (400) 28p
W08 (800) 40p
2 amp type
Square with hole
S01 (100) 37p
S02 (200) 40p
S04 (400) 40p
S08 (800) 55p
6 amp type
Square with hole
PW01 (100) 50p
PW02 (200) 78p
PW04 (400) 85p
PW06 (600) 90p
25 amp type
Metal clad with hole
K01 (100) 2.20
K02 (200) 2.30
K04 (400) 2.80
K06 (600) 3.40
Proprietory Bridges
B40C1500 1.20
B80C3700 1.80
BY164 55p
BY179 92p

ZENER DIODES 400-500mW
E24 Series
2.4-47V 8p
1.3 Watt E24 Series 3.3-82V 15p
2.5 Watt E24 Series 7.5-75V 1.10

NEW OPTO DEVICES
New LEDs
Now in stock
R = red
G = green
Y = yellow
Large diffused 1+ 50+
R5D 9p 7p
G5D 15p 12p
Y5D 16p 12p
Small diffused
R2D 8p 6p
G2D 12p 10p
Y2D 12p 10p
Micro 0.1"
R1D 25p 22p
G1D 27p 25p
Y1D 27p 25p
Large clear
R5C 12p 10p
G5C 17p 13p
Y5C 17p 13p
Super bright Large (100 times brighter)
R5U 38p 29p
G5U 42p 34p
Y5U 42p 34p
Tri-colour flat
RGY8 83p 78p

DIACS
BR100 40p
ST2 25p

THYRISTORS
4, 8 & 12 Amps Texas TO220
Suffix: A = 100V
B = 200V
C = 300V
D = 400V
M = 600V
4A TIC106A 46p
TIC106B 47p
TIC106C 48p
TIC106D 50p
TIC106M 68p
8A TIC116A 66p
TIC116B 68p
TIC116C 71p
TIC116D 73p
TIC116M 80p
12A TIC126A 72p
TIC126B 72p
TIC126C 73p
TIC126D 77p
TIC126M 95p

TRIACS
Texas 400V
TO220 Case
TIC206D(4A) 68p
TIC225D(6A) 74p
TIC226D(8A) 88p
TIC236D(12A) 1.16
TIC246D(16A) 1.22
TIC263D(20A) 1.90
TIC283D(25A) 2.11

LM1871 4.39
LM1872 4.39
LM1886 7.44
LM1889 3.77
LM2907N 2.75
LM2907NB 2.60
LM2917N 1.89
LM2917N 1.89
NE531N 1.36
NE543N 2.60
NE544N 1.80
NE555 16p
NE556 45p
NE558 1.68
NE560 3.25
NE562 4.08
NE565 1.16
NE5661.49
NE567 1.37
NE570 3.75
NE571 3.75
NE5534A 1.25
PLL02A 4.95
PLL03A 12.75
TBA500 2.97
TBA500Q 3.11
TBA510 2.95
TBA510Q 3.05
TBA520 2.57
TBA520Q 2.75
TBA530 2.55
TBA530Q 2.76
TBA540 2.72
TBA540Q 2.74
TBA550 3.25
TBA560C 2.87
TBA570 2.37
TBA570Q 2.48
TCA910 2.17
TCA940 1.60
TDA1002 3.36
TDA1003 3.94
TDA1004 2.87
TDA1005 3.94
TDA1010A 2.25
TDA1022 4.95
TDA1024 1.19
TDA2610 3.90
TDA2611A 2.50
UAA170 1.69
UAA180 1.69
ULN2003 85p
UPC575C2 2.05
UPC1156 2.75
XR2206 2.82
ZN414 79p
ZN419 2.25
ZN1034 1.99
ZN1040 6.89
ZTK22 89p
ZTK33 89p

CPUs
1802 7.80
2650A 11.80
6502 3.24
6800 2.74
6802 2.60
6809 6.50
8035 3.48
8060 10.90
8080A 2.79
8085A 3.48
8900 57.75
9980 21.00
SCMP1 17.65
Z80A 3.48

LOGIC ICs including COMPUTER SUPPORT
ADC0800 22.50
ADC0816 14.90
ADC0817 10.00
AY5-2376 5.90
ICM7555 80p
INS1671 20.00
INS1771 20.00
RO2513LC 6.90
RO2513UC 7.50

LINEAR ICs
AN103 2.20
AY1-0212 6.60
AY3-0215 7.95
AY1-1320 2.20
AY1-5050 96p
AY1-1270 7.26
AY3-8910 5.39
AY3-8912 5.59
CA3048 2.99
CA3049 3.21
CA3059 2.80
CA3060 4.09
CA3090AQ 3.70
CA3130E 87p
CA3130T 1.80
CA3140E 38p
CA3140T 1.00
HA1366W 2.40
HA1388 2.64
LC7120 3.20
LC7130 3.20
LF351 47p
LF353 92p
LF355 80p
LF356 82p
LF357 1.09
LM348N 62p
LM349N 1.16
LM350K 4.80
LM379S 4.13
LM380N8 1.50
LM380N14 75p
LM381AN 2.26
LM381N 1.40
LM382N 1.40
LM383T 3.40
LM384N 1.40
LM386N1 88p
LM386N4 1.20
LM388N 2.43
LM391N60 1.70
LM391N80 1.93
LM723CH 1.21
LM723CN 39p
LM725CH 3.40
LM725CN 3.19
LM733 69p
LM741CH 96p
LM741CN 35p
LM741CN14 80p
LM747CN 69p
LM748CH 1.00
LM748CN 35p
LM1303N 1.20
LM1305N 2.60
LM1307N 3.10
LM1310N 2.75
LM1330N 1.45
2.25

SAA5000 3.00
SAA5010 7.10
SAA5012 7.10
SAA5020 5.50
SAA5030 9.00
SAA5040 15.00
SAA5041 15.00
SAA5050 8.50
SAA5052 8.50
TMS6011 3.65
8T26 1.35
8T28 1.35
8T95 1.35
8T97 1.35
81LS95 90p
81LS96 90p
81LS97 90p
81LS98 90p
6522 3.19
6532 6.95
8154 9.42
8156 3.50
Z80ACTC 2.85
Z80ADART 8.00
Z80ADMA 10.00
Z80APIO 2.90
Z80ASIO 3.39
ZN425EB

VOLTAGE REGULATORS
– Positive –
100mA
78L05A 30p
78L12A 30p
78L15A 30p
78L24A 30p
1 Amp T0220
7805T 39p
7812T 39p
7815T 39p
7824T 39p
– Negative –
100mA T092
79L05 58p
79L12 58p
79L15 58p
1 Amp T0220
7905T 44p
7912T 44p
7915T 44p
7924T 44p

ZERO INSERTION DIL SOCKETS
24 pin 4.80
40 pin 6.30

40 CMOS
4000 10p
4001 10p
4002 11p
4006 40p
4007 15p
4008 32p
4009 24p
4010 24p
4011 10p
4012 15p
4013 20p
4014 46p
4015 54p
4016 20p
4017 32p
4018 45p
4019 28p
4020 44p
4021 39p
4022 48p
4023 12p
4024 24p
4025 12p
4026 78p
4027 20p
4028 29p
4029 29p
4030 14p
4031 1.19
4032 80p
4033 1.20
4034 1.29
4035 56p
4036 2.40
4037 1.30
4038 50p
4039 2.60
4040 48p
4041 40p
4042 39p
4043 46p
4044 41p
4045 99p
4046 44p
4047 39p
4048 39p
4049 22p
4050 22p
4051 44p
4052 44p
4053 49p
4054 79p
4055 83p
4056 89p
4059 4.35
4060 42p
4063 79p
4066 22p
4067 2.40
4068 14p
4069 14p
4070 13p
4071 13p
4072 13p
4073 13p
4075 13p
4076 45p
4077 13p
4078 13p
4081 12p
4082 12p
4085 48p
4086 48p
4089 1.50
4093 20p
4094 80p
4095 60p
4096 90p
4097 2.88
4098 74p
4099 90p

For higher numbers in 40 Series, substitute 74C for 40 prefix. eg 40107 = 74C107

45 CMOS
4502 58p
4503 48p
4507 33p
4508 1.10
4510 35p
4511 55p
4512 38p
4514 1.17
4515 1.17
4516 48p
4518 39p
4519 29p
4520 56p
4521 99p
4526 59p
4527 59p
4528 49p
4532 65p
4534 4.29
4536 2.88
4538 80p
4539 65p
4543 65p
4553 2.20
4555 48p
4556 48p
4560 1.16
4566 1.45
4569 1.20
4584 48p
4585 99p

MEMORIES
1702A 3.60
2101 4.00
2102AL2 1.30
2111-1 3.00
2114 (200ns) 80p
2532 3.75
2708 3.00
2715 (5V) 2.75
4027 3.00
4044 7.00
4060 9.50
4116 (200ns) 75p
4118-3 3.25
4164 4.50
5204 7.00
6116 4.50
6514 3.30
6810 1.15
7489 4.20
74189 3.25
74LS289 3.25
74LS287 3.00
74LS288 2.25

TTL
7400 10p
7401 11p
7402 11p
7403 12p
7404 12p
7405 15p
7406 20p
7407 20p
7408 14p
7409 14p
7410 16p
7411 16p
7412 18p
7413 18p
7414 28p
7416 20p
7417 20p
7420 15p
7421 20p
7422 20p
7423 24p
7425 24p
7426 22p
7427 22p
7428 24p
7430 14p
7432 22p
7433 22p
7437 25p
7438 25p
7440 14p
7441 65p
7442 35p
7443 90p
7444 90p
7445 50p
7446 60p
7447 48p
7448 44p
7450 15p
7451 15p
7453 15p
7454 14p
7460 15p
7470 34p
7472 28p
7473 28p
7474 20p
7475 28p
7476 28p
7480 40p
7481 1.19
7482 68p
7483 38p
7484 69p
7485 60p
7486 20p
7489 2.20
7490 20p
7491 36p
7492 28p
7493 25p
7494 35p
7495 30p
7496 40p
7497 90p
74100 80p
74104 50p
74105 55p
74107 28p
74109 25p
74110 36p
74116 59p
74118 80p
74119 90p
74120 59p
74121 25p
74122 40p
74123 38p
74125 34p
74126 38p
74128 40p
74132 38p
74136 38p
74141 50p
74142 1.90
74143 2.48
74144 2.10
74145 60p
74147 1.00
74148 70p
74150 48p
74151 46p
74153 30p
74154 50p
74155 40p
74156 40p
74157 30p
74159 1.20
74160 50p
74161 40p
74162 50p
74163 50p
74164 50p
74165 50p
74166 50p
74167 1.20
74170 1.25
74172 2.75
74173 60p
74174 54p
74175 54p
74176 50p
74177 50p
74178 70p
74179 90p
74180 60p
74181 1.16
74182 60p
74184 1.00
74185 1.00
74186 4.69
74188 2.50
74190 48p
74191 48p
74192 46p
74193 46p
74194 46p
74195 40p
74196 40p
74197 45p
74198 80p
74199 83p
74221 53p

74H TTL
74H00 1.45
74H01 1.45
74H04 1.45
74H05 1.55
74H10 1.45
74H11 1.45
74H20 1.45
74H21 1.45
74H30 1.45
74H40 1.45
74H51 1.55
74H53 1.55
74H54 1.65

74LS TTL
74LS00 11p
74LS01 11p
74LS02 11p
74LS03 12p
74LS04 12p
74LS05 12p
74LS08 12p
74LS10 12p
74LS11 12p
74LS12 12p
74LS13 19p
74LS14 30p
74LS15 12p
74LS20 12p
74LS21 12p
74LS22 12p
74LS27 12p
74LS28 14p
74LS30 12p
74LS32 13p
74LS33 14p
74LS37 14p
74LS38 15p
74LS40 13p
74LS42 28p
74LS47 35p
74LS51 14p
74LS54 14p
74LS55 14p
74LS73 18p
74LS74 18p
74LS75 20p
74LS76 20p
74LS78 18p
74LS80 1.20
74LS83 38p
74LS85 48p
74LS86 18p
74LS90 24p
74LS92 25p
74LS93 24p
74LS95 38p
74LS96 96p
74LS107 20p
74LS109 27p
74LS112 22p
74LS113 22p
74LS114 22p
74LS122 38p
74LS123 38p
74LS124 89p
74LS125 24p
74LS126 25p
74LS132 30p
74LS136 28p
74LS138 32p
74LS139 30p
74LS145 70p
74LS147 1.57
74LS148 75p
74LS151 35p
74LS153 35p
74LS154 79p
74LS155 29p
74LS156 29p
74LS157 27p
74LS158 28p
74LS160 35p
74LS161 35p
74LS162 35p
74LS163 35p
74LS164 35p
74LS165 59p
74LS168 84p
74LS169 85p
74LS170 80p
74LS173 55p
74LS174 35p
74LS175 35p
74LS181 1.10
74LS183 1.79
74LS190 36p
74LS191 36p
74LS192 36p
74LS193 37p
74LS194 32p
74LS195 32p
74LS196 45p
74LS197 48p
74LS221 50p
74LS240 55p
74LS241 55p
74LS242 55p
74LS243 55p
74LS244 60p
74LS245 70p
74LS247 50p
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74LS257 35p
74LS258 35p
74LS259 55p
74LS261 1.35
74LS266 18p
74LS273 60p
74LS275 2.25
74LS279 30p
74LS280 1.80
74LS283 40p
74LS289 4.70
74LS290 45p
74LS293 45p
74LS295 89p
74LS298 89p
74LS299 2.60
74LS323 1.76
74LS324 1.45
74LS325 2.96
74LS326 2.30
74LS327 2.30
74LS347 95p
74LS348 1.00
74LS352 79p
74LS353 79p
74LS362 7.25
74LS365 29p
74LS366 29p
74LS367 29p
74LS368 29p
74LS373 55p
74LS374 55p
74LS378 58p
74LS386 1.14
74LS390 45p
74LS393 42p
74LS395 88p
74LS396 1.80
74LS398 2.70
74LS399 1.80
74LS445 1.10
74LS490 2.20
74LS540 1.60
74LS541 1.60
74LS640 1.60
74LS641 1.60

The Flash Point Alarm is designed to warn when the temperature of fat or oil in a chip pan or deep fryer reaches a dangerous level. It will not prevent fires — only you can do that.

WARNING
NEVER TURN YOUR BACK ON A CHIP PAN

Flash Point Alarm

Owen Bishop

FIRE Statistics for the UK clearly show that a large and increasing proportion of fires in the home begin in the kitchen. Of these, about 90 percent are fat fires. It does not seem to matter what kind of cooking fat is used; it could be vegetable oil, lard, dripping or margarine. Most people prefer chips and other fried food to be crisp rather than soggy, and for this the fat must be made really hot before the food is put into it. This is where the danger arises. Fat takes an appreciable time to warm up to a suitable cooking temperature (about 205°C). While this is happening, the cook may decide to get on with some other job (or even to pop quickly down the road to the corner store!) leaving the fat unattended.

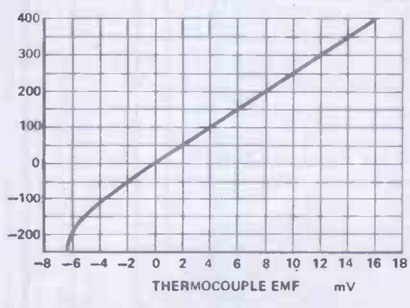
Though it may heat slowly at first, the rate increases as the cooker warms up. After cooking temperature has been reached, it does not take that much longer for the fat to reach a temperature at which it is likely to catch fire. At temperatures higher than 310°C the fat is above its flash-point and may ignite spontaneously, even though it is not in contact with a naked flame. When the cook returns from that task which was to take "only a moment", the fat may well be alight — and possibly the house as well.

This project won't prevent chip-pan fires but it will give an alarm when the temperature reaches a dangerous level. It uses a thermocouple to sense the temperature of the fat; a thermocouple was chosen because it is able to operate over the range 0°C to 400°C. The circuit is set to trigger an alarm when the temperature of the fat is more than about 200 degrees higher than room temperature. The temperature of most kitchens is between 10°C and 25°C, so the alarm sounds when the fat is at about 210°C. This allows the optimum cooking temperature of 205°C to be attained without triggering the alarm, yet provides a good margin betwen the triggering temperature and the lowest flash-point of commonly-used cooking fats.

The alarm signal takes two forms. There is an intermittent audible alarm loud enough to be heard in the next room (though it is *not* loud enough to be heard when you are down at the corner store!) and for those who are hard of hearing, there is also a visual alarm of two lamps, which flash alternately. The alarms can be external

How It Works

A THERMOCOUPLE is simply an electrical circuit formed by joining two dissimilar metals, eg copper and iron, into a loop. If the two junctions of the metals are held at different temperatures, an EMF is developed in the loop. The size of the EMF is proportional to the temperature difference between the junctions, so if one junction is held at a constant temperature, the EMF must be proportional to the temperature at the other junction.



The graph of the output of a Nickel – Chromium/Nickel – Aluminium thermocouple, similar to the type used in this project, shows the EMF developed versus the temperature difference between the thermocouple probe temperature and a reference temperature of 0°C.

The HE Flash Point Alarm uses room temperature as the reference temperature, and compares the EMF developed by the thermocouple with a reference voltage. The Alarm is triggered when the EMF rises to about 8 mV, corresponding to a temperature around 200° above room temperature. Note that the unit itself must not be placed where it can become heated above room temperature!

to the device if required; for example, you may prefer to site the audible alarm in the hall or living room, rather than in the kitchen.

The instrument is battery-powered and takes only 6mA quiescent current. In this condition, LED2 glows to indicate that the device is switched on. The amount of current required when sounding the alarm is rather greater, but the instrument should never be left for long in this state, for obvious reasons!

The Circuit

The temperature sensor used in this project is a thermocouple, made by joining together two wires of different metals or metal alloys. Usually the wires are twisted together, then welded and owing to the 'contact potential difference', an EMF appears across the junction of the dissimilar metals.

The size of the EMF increases with temperature and in the thermocouple used in this project, it increases by about 4 uV per degree Celsius. The circuit is designed to trigger at about 200 degrees above room temperature. This gives a triggering temperature of around 210°C to 225°C, which means that fat at cooking temperature (205°C) does not trigger the alarm but fat which is hot enough to catch fire spontaneously (310°C or hotter) readily triggers it.

The EMF generated by the thermocouple is detected by an operational amplifier, IC1. This has an extremely high input impedance (10^{12}ohms) so that the full EMF appears at the input pin. The op-amp is wired as a comparator and there is no feedback, so the full gain of the amplifier (about 100,000) is available. The EMF of the thermocouple is compared with a voltage reference generated by a potential divider, R1/RV1, set to give 8 mV at pin 2 of the op-amp. If the EMF of the thermocouple is less than 8 mV, the output of the comparator is −3 V; if the EMF exceeds 8 mV, even by a small amount, the output swings sharply from −3 V to +3 V, as a result of the high gain.

Because IC1 is a CMOS op-amp, the output swings fully between −3 V and +3 V, giving a clean signal to control the alarm logic. This is made up from four NAND gates in a single IC (IC2). Two of these gates, IC2a and b are wired as an astable multivibratior with a frequency of about 1 Hz. When the output of the comparator is low (−3 V), the astable is inhibited and its output (IC2a) is high. This is inverted by IC2d, the output of which (pin 11) is low. Thus no current flows to Q1 and the audible warning device is inactive. LED 1 connected to this output is not lit but the output from the other gate of the astable (IC pin 4) is low (OV); this is inverted by IC2c, causing LED 2 to light, indicating that the circuit is switched on.

When the EMF of the thermocouple exceeds 8 mV (at a temperature more than 200 degrees warmer than room temperature), the output of the comparator goes high, allowing the astable to oscillate. The LEDs flash alternately and the audible warning device is switched on intermittently, to give a bleeping alarm sound.

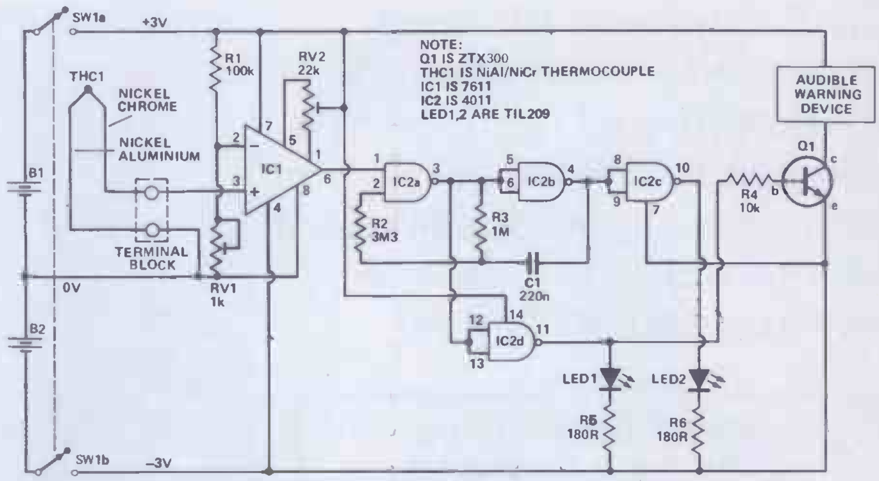


Figure 1. The circuit diagram.

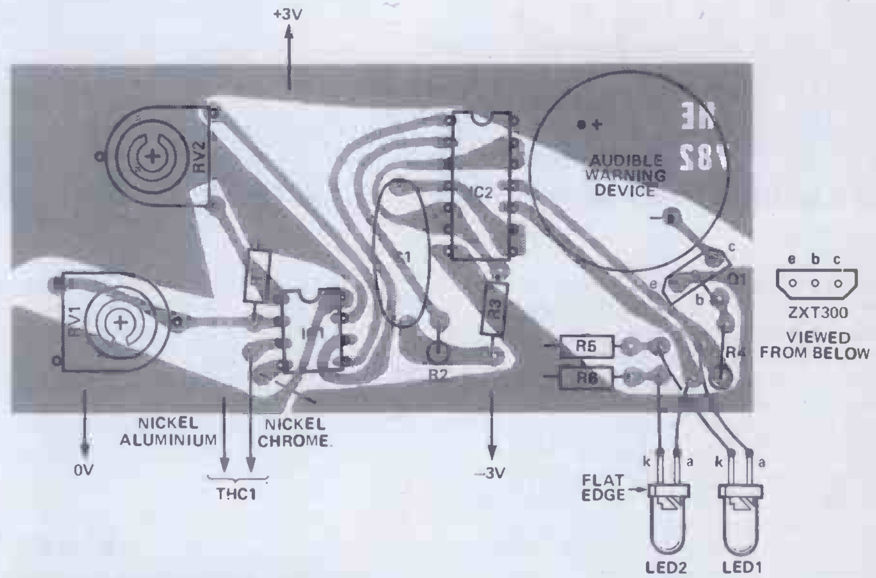


Figure 2. PCB assembly diagram. Remember not to handle the CMOS ICs!

Construction

The layout (**Figure 2**) is designed for standard size presets, not the sub-miniature types. The ICs are both CMOS, so take the usual precautions to avoid static electrical charges on your clothes or body, and use a soldering iron with an earthed bit. Mount the ICs and all other on-board components except for R4 (the omission of R4 spares you, and your family, the piercing sound of the audible alarm while you are testing and setting up the remainder of the circuit). Note that single-sided terminal pins may be used, but those which connect to the LEDs should project through the copper side of the board, not the component side — the alternative is to use double-sided pins throughout.

The LEDs used in the prototype were a special kind, ready-mounted in a chromium-plated bezel. These give a stylish appearance to the instrument, but the standard type with plastic mounts can be used instead. Mount the LEDs on the front panel and connect them by short wires to the pins on the circuit board.

The power supply is split to provide 3 lines; +3 V, 0 V and −3 V. The operational amplifier, **IC1**, was specially chosen for its ability to be able to operate from voltages as low as ±3 V. The recommended case incorporates a battery compartment with metal tags, to which power leads may be soldered as shown in **Figure 3**. The switch is a double-pole double-throw (DPDT) type, connected to the +3 V and −3 V lines and mounted on the upper half of the case. Wire up the power lines at this stage, and connect them to the circuit board.

The circuit may be tested at this stage. Since the EMF of the thermocouple is only a few millivolts, the op-amp must be balanced by using the offset null adjustment, RV2, which connects pins 1 and 5 of the IC. While the op-amp is being balanced, *both*

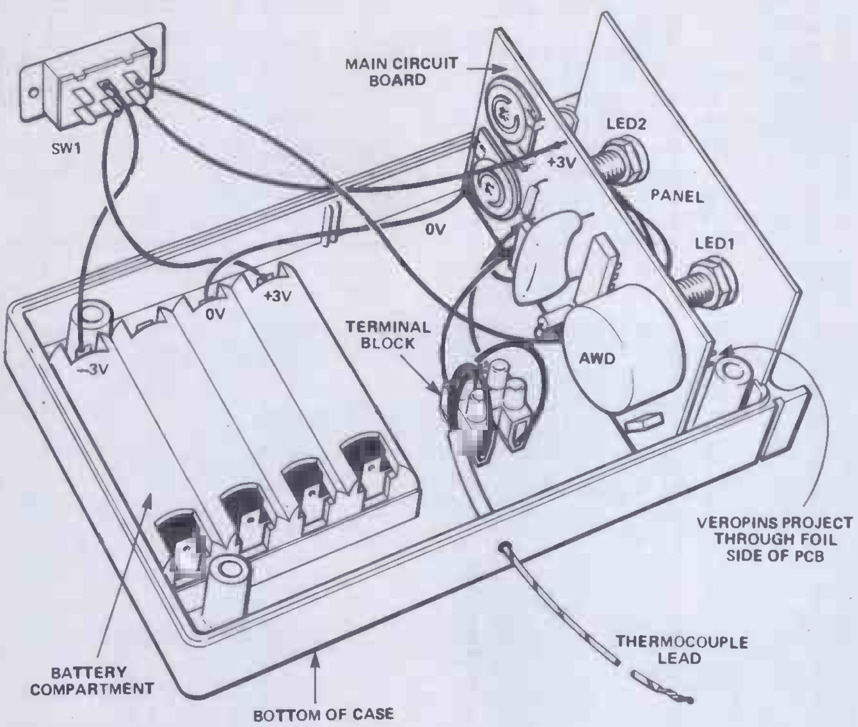


Figure 3. Fitting it all together.

Parts List

RESISTORS (All ¼ W 5% carbon)	
R1	100k
R2	3M3
R3	1M
R4	10k
R5,6	180R
POTENTIOMETERS	
RV1	1k carbon preset
RV2	22k carbon preset
CAPACITORS	
C1	220n C280 polyester
SEMICONDUCTORS	
Q1	ZTX300 silcon NPN transistor
IC1	7611 CMOS op-amp
IC2	4011B CMOS quad 2-input NAND
LED1,2	TIL209 light emitting diode
MISCELLANEOUS	
S1	DPDT slide switch
THC1	thermocouple (see Buylines)
B1,B2	2 x 'AA' cells (3 V each pair)

Audible warning device (see Buylines); case; two-way terminal block; veropins; plastic stick-on feet; connecting wire, solder etc.

BUYLINES . . . . page 30

inputs (pins 2 and 3) must be connected to the 0 V line using two test leads with crocodile clips. The easiest method is to join the two terminal pins (to which the thermocouple is to be attached later) with one lead and to connect the junction of R1/RV1 to 0 V with the other. A voltmeter or oscilloscope must be used to measure the output voltage between pin 6 of IC1 and the − 3 V line. When all the above connections are made, switch on the power. LED2 comes on to show that the circuit is active. Ideally, RV2 should be adjusted so that the output is steady at 0V (the meter would read + 3V, because you are measuring from the − 3V line), but this is difficult. If it cannot be set exactly, adjust RV2 so that the output is just on the point of swinging from − 3V to + 3V (ie, 0V to 6V on the meter).

Remove the two test leads before proceeding further. Now connect the thermocouple (temporarily) to the terminal pins on the circuit board. A thermocouple normally has red (+ve) and blue (−ve) wires. The red wire (nickel-chrome) goes to pin 3 of IC1 and the blue wire (nickel-aluminium) goes to the 0V line. For the next stage, you will need a sensitive millivoltmeter with a high-impedance input — an ordinary low-cost multimeter may draw too much current to allow the levels to be set correctly. As an alternative, use an oscilloscope, but if neither of these instruments is to hand, you'll have to construct the HE Digital Millivoltmeter (August issue).

The first step is to set the potential at pin 2 of IC1; connect the millivoltmeter between the 0V line and pin 2, and adjust RV1 until the reading is 8 mV. Now attach the meter between the 0V line and pin 3 of IC1 (the red wire of the thermocouple). It will probably show no reading at first, since the junction will be close to room temperature, so heat the junction by placing it in a hot oven (set to 230°C, 450°F or Gasmark 8).

As the temperature of the thermocouple rises, the reading on the meter should increase steadily. As the reading passes 8 mV, the circuit is triggered and the LEDs will the begin to flash alternately, at about 1Hz. If you now remove the thermocouple from the heat, the flashing stops after a second or two.

If the LEDs fail to flash, check the operation of the osciallator, IC2a,b, by testing the output from pin 4. It should rise to + 3 V and fall to − 3 V sharply and regularly, at about 1Hz. The output at pins 10 and 11 (IC2c and d) should be similar, though 180° out of phase with pin 4.

If the circuit is not triggered by a thermocouple EMF of 8 or even 9 mV, it is likely that the offset null adjustment is not properly set. Keeping the thermocouple at a steady heat, so that its EMF is close to 8mV, adjust RV2 *very slightly* so that the output of IC1, at pin 6, swings from 0 V to + 3 V and triggers the LEDs.

Assuming that all is in working order, solder R4 in position and re-test the circuit with the audible warning device (AWD) in operation. If it is to be mounted externally, solder long leads to the mounting holes on the PCB and run them through a hole cut in the side of the case. It is possible to wire two or more AWDs in parallel, all switched by Q1, should you want to make the alarm sound in several rooms at once.

Mount the two-way connector block on the lower half of the case and insert the PCB and front panel in the slots. Run wires from the connector block to the thermocouple terminal pins on the PCB. The thermocouple itself is supplied with a long lead which may be cut shorter, if desired, but take care to insert the leads in the correct sockets; if the polarity is wrong the alarm will not be triggered, even by a raging inferno. For the same reason, make certain that the screws of the terminal block are firmly tightened. Every time you renew the cells, it is best to check that the connector block screws have not been loosened.

The two halves of the case may now be bolted together and stick-on feet applied to the lower surface. The Flash-Point Alarm is now ready for use. At this point, it would be adivisable to make another test run, with the themocouple in the oven as before, to check that all is as it should be. Always remember, the only certain way to prevent, a chip-pan fire is to keep a close watch on it at all times!

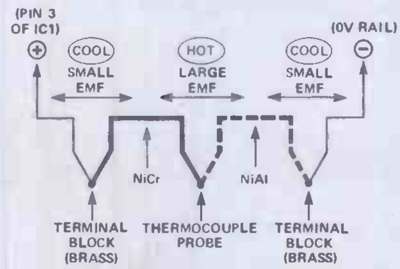


Figure 4. Three thermocouples.

Three Thermocouples

Although you have purchased only one thermocouple, the circuit really contains three (Figure 4)! The other two are made when you screw the ends of the thermocouple wires into the metal contacts of the connector block; each of these wire-connector junctions is between dissimilar metals, so an EMF is produced. However, both of these junctions are at room temperature and their EMFs are relatively small; in addition, they are opposing EMFs, and so they cancel out. This leaves only the EMF at the nickel-chrome/nickel-aluminium junction in the chip pan, which is the one used to trigger the alarm.

Using It

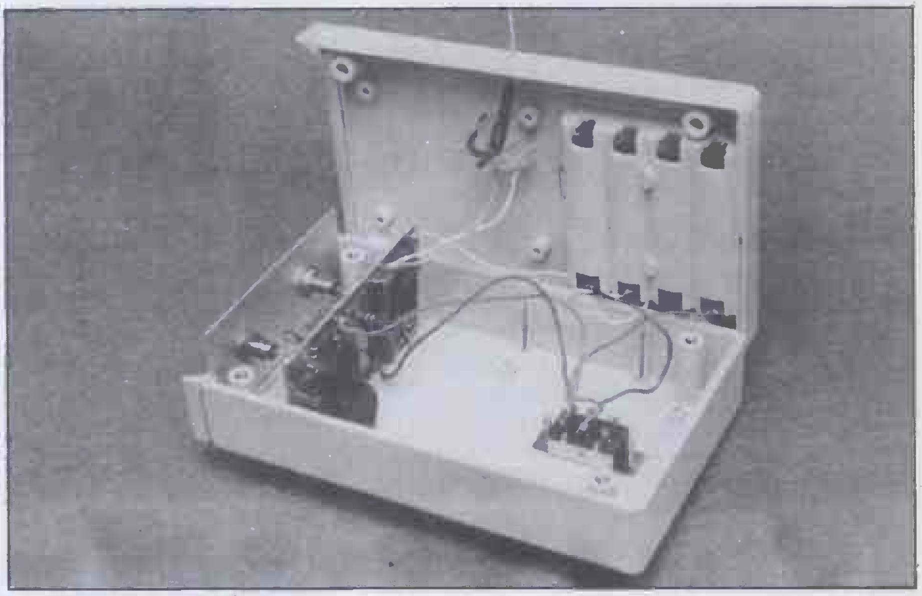
The instrument should not be placed where it can be overheated by the cooker, because this could affect the triggering temperature. The thermocouple lead must be left long enough to allow the unit to stand on a table or work-top, a few feet from the cooking area. The lead can be bent into an inverted U shape, so that it hooks neatly on to the rim of the pan, with the thermocouple immersed in the fat (the lead could be clipped to the rim of the pan, using a small bull-dog clip). Switch on the instrument *before* beginning to heat the fat and check that the indicator, LED1, is glowing. The fat reaches cooking temperature before the circuit is triggered so, in normal use, you should never hear or see the alarms in action.

If the alarms are triggered, there is immediate danger of fire, especially if the alarm has been going for several minutes with the heat still on. Switch off the heat immediately and do not leave the pan unattended until the alarm has stopped. If you attend to the pan as soon as the alarm is raised, it should not be hot enough to ignite spontaneously but, if you leave it longer, it might! Should the fat catch fire, this is how the deal with it:

1) Turn off the heat.
2) Cover the pan with a large lid or a large damp cloth, to keep air away from the fire.

Two things you should NOT do are to try to move the pan, or to throw water over it. And never panic! — but with the Flash-Point Alarm, you should never need to worry about anything except how brown you want the chips to be!

HE



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CK 1010	Complete Pre-Amplifier Kit	78.26	11.74	90.00	2.50
CK 1040	Complete 40 Watt Power Amplifier Kit	103.48	15.52	119.00	7.30
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MC 2K	Add On Moving Coil Kit	21.74	3.26	25.00	0.12
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FIRES FOULED SPARK PLUGS no other system can better the capacitive discharge system's ability to fire fouled plugs.

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PLUS

SUPER POWER SPARK — 3½ times the energy of ordinary capacitive systems — 3½ times the power of inductive systems.

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IN KIT FORM

it provides a top performance electronic ignition system at less than half the price of competing ready-built systems. The kit includes everything needed, even a length of solder and a tiny tube of heatsink compound. Detailed easy-to-follow instructions, complete with circuit diagram, are provided — all you need is a small soldering iron and a few basic tools.

AS REVIEWED IN
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and EVERYDAY ELECTRONICS December '81 Issue

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DIMENSIONS:		
	Length	12.5 cm
	Width	8.9 cm
	Height	4.3 cm
	Lead length	100.0 cm

TECHNICAL DETAILS

The basic function of a spark ignition system is often lost among claims for longer 'burn times' and other marketing fantasies. It is only necessary to consider that, even in a small engine, the burning fuel releases over 5000 times the energy of the spark, to realise that the spark is only a trigger for the combustion. Once the fuel is ignited the spark is insignificant and has no effect on the rate of combustion. The essential function of the spark is to start that combustion as quickly as possible and that requires a high power spark.

The traditional capacitive discharge system has this high power spark but, due to it's very short spark duration and consequential low spark energy, is incompatible with the weak air/fuel mixtures used in modern cars. Because of this most manufacturers have abandoned capacitive discharge in favour of the cheaper Inductive system with it's low power but very long duration spark which guarantees that sooner or later the fuel will ignite. However, a spark lasting 2000µS at 2000 rev/min. spans 24 degrees and 'later' could mean the actual fuel ignition point is retarded by this amount.

The solution is a very high power, medium duration, spark generated by the TOTAL ENERGY DISCHARGE system. This gives ignition of the weakest mixtures with the minimum of timing delay and variation for a smooth efficient engine.

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PRECISION SPARK TIMING CIRCUIT This circuit removes all unwanted signals caused by contact volt drop, contact shuffle, contact bounce, and external transients which, in many designs, can cause timing errors or damaging un-timed sparks. Only at the correct and precise contact opening is a spark produced. Contact wear is almost eliminated by reducing the contact breaker current to a low level – just sufficient to keep the contacts clean.

TYPICAL SPECIFICATION	TOTAL ENERGY DISCHARGE	ORDINARY CAPACITIVE DISCHARGE
SPARK POWER (PEAK)	140 W	90 W
SPARK ENERGY	36 mJ	10 mJ
(STORED ENERGY)	135 mJ	65 mJ
SPARK DURATION	500 µS	160 µS
OUTPUT VOLTAGE (LOAD 50pF EQUIVALENT TO CLEAN PLUGS)	38 KV	26 KV
OUTPUT VOLTAGE (LOAD 50pF + 500 KΩ EQUIVALENT TO DIRTY PLUGS)	26 KV	17 KV
VOLTAGE RISE TIME TO 20 KV (Load 50pF)	25 µS	30 µS

TOTAL ENERGY DISCHARGE should not be confused with low power inductive systems or hybrid so called reactive systems.

FAULT-FINDING FOR BEGINNERS

Fault-finding, on a newly completed project or even on commercial equipment, is easy — once you know the rules!

FAULT-FINDING on a project can be a time-consuming job. Even experienced electronics engineers will sometimes spend hours looking for a reason why a particular circuit doesn't work - so what chance has the hobbyist got, of quickly locating faults? Occasionally, a fault will be obvious, but more often than not it will remain hidden away, after many hours' of hard slog to detect and then repair it.

Prevention Is Better Than Cure

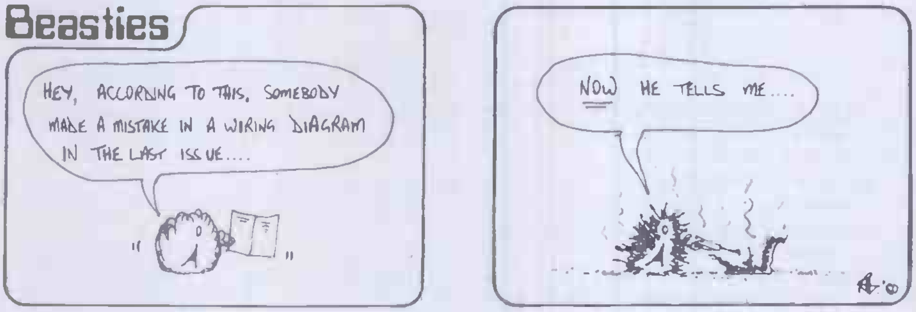
There are many categories of possible faults, but the more usual ones occur because of a mistake. For instance, it's all too easy to misread the resistor colour code and put an incorrect value into the circuit. Of course, in some cases a small change may not make any difference, but in other circuits resistances can be critical — and you may find that a project simply doesn't work at all just because you've inserted a 100k resistor instead of a 120k. The moral of the story is *to make sure you know the colour code.*

Similarly, an incorrect capacitor value may prevent a circuit from operating according to plan while polarised components ie, transistors, integrated circuits, diodes and certain capacitors, have to be inserted the right way round, for obvious reasons.

Another builder-originated source of faults is to do with soldering. A single dry-joint can affect performance and may prevent the circuit from working at all. Soldering technique improves with practice, so fewer and fewer soldering problems should arise the more projects you make. But dry-soldered joints aren't the only type of fault which can be caused by slap-happy soldering; in its hot state solder is, of course, molten, and unless care is taken it can form conducting bridges to copper tracks close by the soldering joint. Even a microscopically thin solder bridge can form a short circuit and prevent your project from working.

Occasionally, too, a circuit will malfunction due to a faulty component, but it is the exception to the rule.

Most suppliers thoroughly screen the components they sell and it is unlikely that a component will be faulty at the time of purchase. It can happen however, that a component may be damaged by mis-handling — some components are quite 'fragile'. Always take particular care with CMOS ICs, which can be easily destroyed by static discharge. Never touch the pins, and always solder the supply pins before moving onto the input/output connections.



Begin At The Beginning

OK, you've taken all the right precautions, worked carefully and finally completed the project. Now the magic moment — power on! WAIT! There's something you should do first; *check everything once more.* Many faults can actually be detected before you switch on, and that's the best time to find them. A smoking resistor may precisely pinpoint a fault — but it could also destroy many valuable components in the process. Far better to check first.

- Look at the components; are they all in the right places, according to the component overlay diagram? Are all the polarised components inserted the right way round?
- Look underneath the PCB or Veroboard, on the copper side; check carefully for solder bridges or stray bits of wire, component leads not trimmed etc. Particularly check around the power supply connections; if something is going to 'blow', it will probably be caused by an incorrect connection to the power rails. Solder bridges can be very fine and difficult to detect, so if your project is using expensive components, the time spent going over the board (with a jeweller's eyeglass, if possible) is time well spent.
- Finally, check for dry joints. All soldering connections should be clean and bright. A dull, mottled joint is probably a dud, though they aren't always that obvious.

Once these pre-switch-on observations have been completed, it's time to apply the volts. But remember, those first few seconds, just after you hit the switch, can tell you a lot about the nature of a fault. For example, if the project is an amplifier, say, you might get a high pitched whine for a very few seconds, after which the project just lies there like a stale loaf in a bakers shop ..... or it may be some other strange, unexpected results. The point is that those first few moments just may be the onlv clue you have!

Crash, Bang, Wallop

There, you've done it, now. Switched on the power, only to find ..... well, something other than what you expected. But wait a minute. What did you expect? Very few circuits will actually do anything, at first, since there are usually a series of adjustments, setting-up operations and so on to be completed before a project will 'work'. Never mind ..... just for the moment, you are simply looking to see that nothing disastrous is happening. If it's a common or garden variety mutant-blaster (originally from the planet Zorg), then why is R23 glowing red hot?

If R23 *is* glowing, then switch off immediately. It takes only fractions of a second to 'cook' an expensive component so, at the first sign of a serious fault, the sooner you switch off the better.

At this stage you should be using your eyes, ears and nose (an overheated resistor has a very distinctive smell which you will probably come to recognise!) but not your fingers, please. It's a good idea to take notes, too, because it's all too easy to forget something which may provide the vital clue to the location of the fault.

What happens next depends on the results after power-on. If the project immediately began to smoke, then something is obviously very wrong. On the other hand, perhaps it just lays there, harmlessly. A third possibility is that everything looks alright but, after performing all the adjustments and so on, it still lies there, uselessly.

The Golden Rules

Assuming, for the moment, that something is drastically wrong, it's time to follow the First Rule of Fault-Finding, which is this: "Look For The Simplest Faults First". If the circuit was overheating, check the board again, looking for incorrect resistor values, short circuits, incorrect supply connections etc. Here's where those first observations will pay off; if R23 was smoking then it's safe to assume that the fault lies in that area of the circuit.

Check the supply voltages; it's surprising how often a 'brand new battery' will turn out to be an old, overused one that should have been thrown out but somehow got mixed up with a new one! If the circuit is mains-powered, disconnect the DC supply to the circuit and check the off-load voltage. If the positive supply is fused, have you remembered to put a fuse in? (don't laugh, it could happen to you!).

After checking and re-checking all the obvious things, without finding a clue to the fault, it is time to consider the Second Law: "When In Doubt, Read The Manual" (or the Circuit Description/How It Works or whatever). Read all about it and try to understand, firstly, the result you should be getting and secondly, the result you are getting. You should assume, at this stage, that the fault is caused by an error on your part. Yes, of course you're perfect (aren't we all?) but it is nevertheless true that 99% of faults are caused by an error in construction, so don't immediately write off to the editor, or complain to the component supplier.

Even if you suspect that your problem is caused by that stray 1%, don't just give up. Study the circuit closely, comparing it with the component overlay and all the other information printed in the magazine. Errors in published projects are usually very obvious, once you know where and how to look. With stripboard construction, for example, a common problem is the ommission of one or two track breaks — cuts in the copper strips — so if you suspect this, check the component layout against the circuit, making sure that there are no components connected on the board which are not connected in the circuit. Ask yourself, for example, should the collector of that transistor *really* be connected to the OV rail? This procedure will often produce results with projects on PCB, too.

Look for circuit blocks which are repeated, eg, op-amp units, and try to 'spot the difference'. The more work you can put in at this stage, the sooner your project will be alive and well — and the more you will learn about electronics, too. Also, a single dead component is a lot easier to replace than an entire circuit board!

Blocks And Chains

Now, we're just about out of rules. The remaining one is best expressed as "Divide And Conquer". It works like this.

Most circuits consist of a number of circuit elements — amplifiers, oscillators, filters and so on — linked in chains, or connected together in some other, more complicated fashion.

The block diagram, Figure 3, shows an example of the circuit blocks of HE's Echo-Reverb project, from the May '82 issue.

The principle of the last rule is simply to isolate sections of the circuit until the

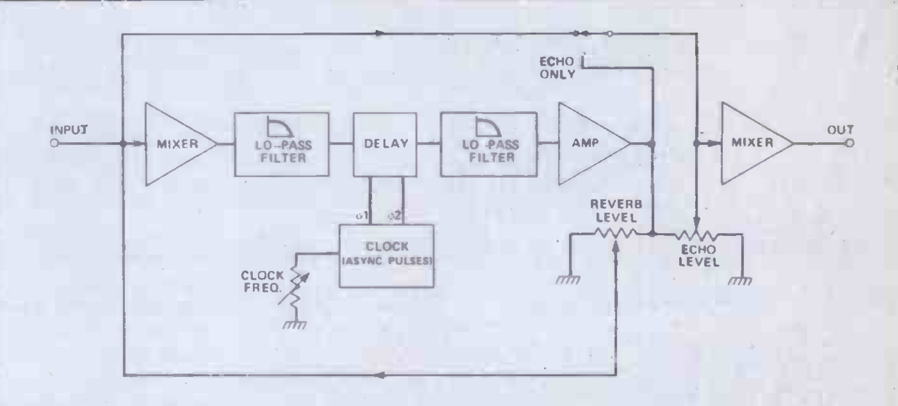


Figure 1. Block diagram of our Echo-Reverb project, from the May '82 issue.

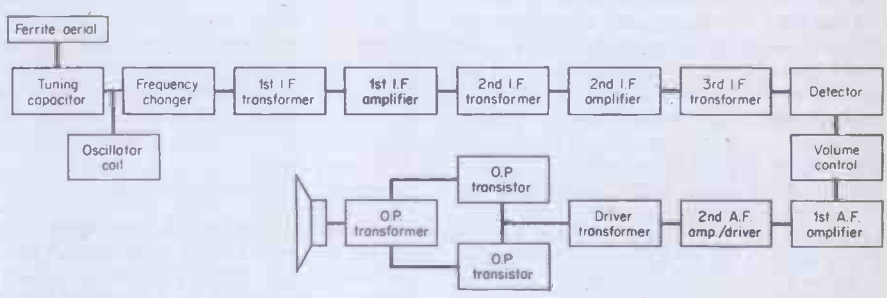


Figure 2. A typical small transistor radio.

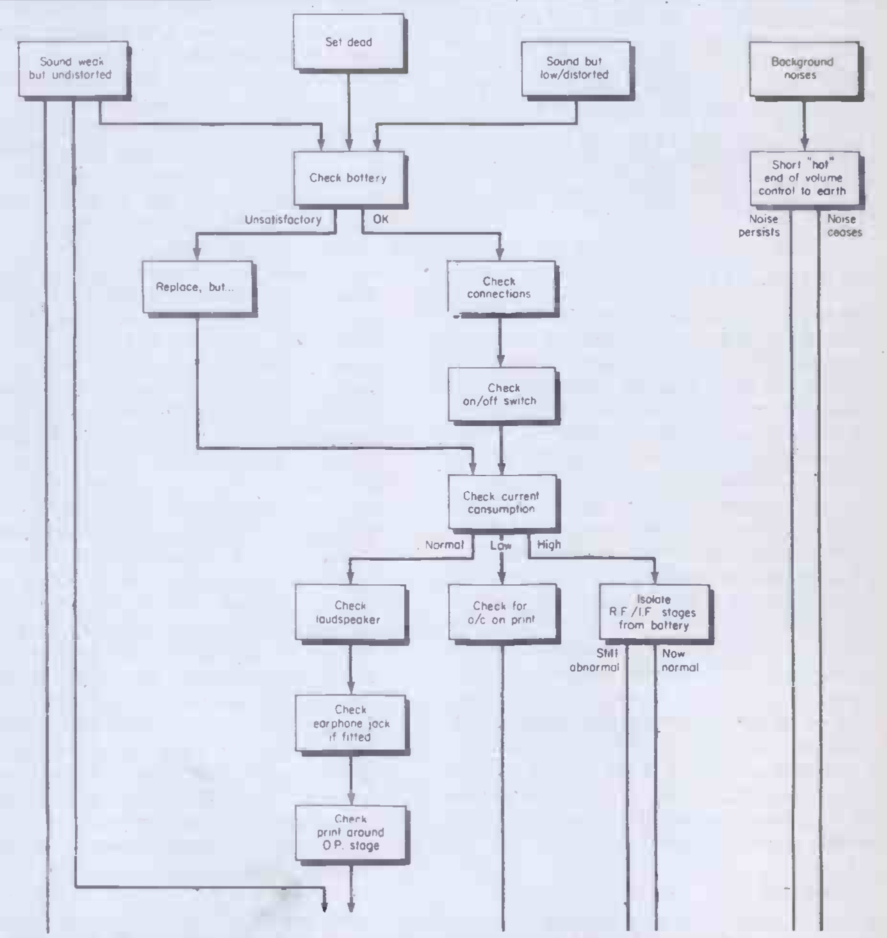
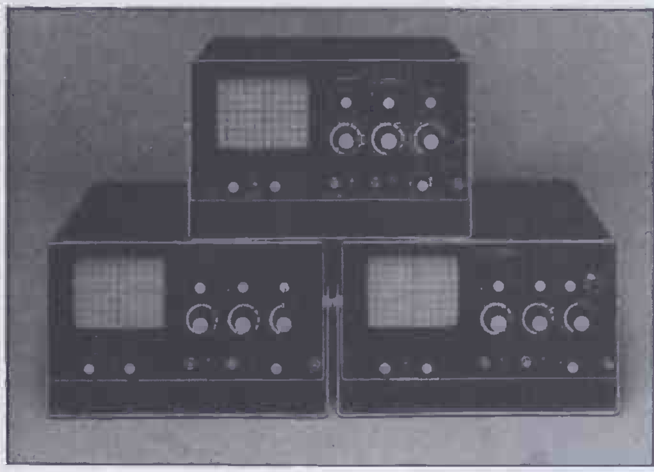


Figure 3. Flow-chart for fault-finding on a transistor radio of the type illustrated in Figure 2.



A 'scope is a technician's best friend! A small model, such as any one of the Scopex models shown, will more than repay the investment if you are working on a good number of projects, while for professional (or even semi-professional) work, a 'scope is essential.

fault has been pinned down to a single block. The exact method used depends on the type of circuit; with straight-chain circuits, such as an audio amplifier or an AM radio receiver, the recommended approach is to start in the middle. If the circuit is working correctly at that point proceed towards the output end, until you locate the stage where the signal is lost. If there is no signal present at the mid-point, then the fault obviously (well, probably) lies towards the 'input' end of the chain, so work back in that direction.

Above all, fault-finding at this level requires a calm, logical common-sense approach. If you know how the circuit works and what it is supposed to be doing, you stand a good chance of being able to figure out the block in which the fault lies. The diagrams of **Figures 2 and 3** show the block diagram of a typical, small transistor radio, together with a section of a fault-finding chart. The chart illustrates the advantages of a logical approach; simply by asking the right questions, the correct answer becomes obvious and the location of the fault can be found.

What Next?

Once you've decided in which block the fault lies, look at the circuitry of the block itself and once again apply the Golden Rules. Carefully check the PCB area and each component for physical defects. You know the fault is there, somewhere — it's just a matter of finding it! Perhaps the body of a resistor is cracked, or one of the IC's pins has been bent underneath. Try tapping components very lightly with the insulated end of a small screwdriver; this trick will often turn up a bad solder joint or duff component. If overheating seems to be the problem, use an aerosol freezing spray to cool down the suspect component; if the fault suddenly vanishes, you've at least isolated the component. Now you only have to find out why its overheating! These two 'tricks of the trade' are the most effective methods for locating intermittent faults — those which come and go!

Tools of the Trade

Fault finding without instruments is impossible. If you've come this far without even a multimeter then you're some undiscovered genius who should be writing this, rather than reading it!

A multimeter is simply the most common and most useful tool of the electronics trade. Already, a multimeter will have been used to isolate the fault to a particular circuit block, but it's when you're locating the faulty component that a meter is really essential for the following tests:

- Measure the supply voltages on all ICs; be sure to use probes with sharp points for this, to avoid bridging two adjacent pins. You should know the voltages (or range of voltages — they're rarely exactly as marked on the circuit) to expect, and where to find them. If you find an incorrect reading, track along the copper, looking for breaks, shorts etc.
- Measure the voltages around suspect transistors; although the actual readings will depend on the circuit configuration, in general the collector of an NPN transistor that is normally conducting will be positive with respect to the emitter (negative for PNP), but the voltage will be somewhat less than the positive rail. The base should be at least OV6 more positive than the emitter (OV6 negative, for PNP). If the transistor is normally cut off, the base voltage will be less than OV6 above the emitter, or even negative (for NPN), while the collector will be at the positive supply voltage, give or take a volt or so.
- Measuring in-circuit resistance, eg, when checking for a high resistance dry joint, it can be quite frustrating because the components in the circuit will obviously affect the reading; the only certain way to measure resistance in-circuit is to isolate, by lifting components or (in extreme cases only) cutting the circuit tracks. These measures may also be necessary if you suspect that a faulty component or group of components are responsible for an incorrect voltage reading (Divide And Conquer, remember?). Some meters, such as the Teston meter reviewed in last month's issue, have a special range for measuring in-circuit resistance, and this facility is very useful (as the reviewer mentioned) for taking resistance readings around transistors or diodes.

Scope For Improvement

For most hobbyists, owning test equipment other than a multimeter is something of a luxury. However, there are several other items which can be built cheaply; an audio signal generator (HE May 82 issue) is quite adequate for work on audio circuits. A simple audio amplifier with a high impedance, AC-coupled input (to isolate DC levels in the circuit under test) or even a high impedance earphone, is invaluable for tracing the signal path through an amplifier. An audio/RF signal injector/tracer (HE August 79; April 82) is slightly more versatile, as it can be used on AM radio circuits as well.

This list could go on indefinitely, because the more complicated circuitsrequire more specialised test equipment. In general, though, there is one item which, though expensive, is useful for almost all fault-finding and totally essential for work on some kinds of circuits,and that is an oscilloscope. If you are going to be 'into electronics', either as a long-term hobbyist or as a semi-professional, say, then a 'scope is a very worthwhile investment.

Extracting The Digit

A 'scope is usually necessary for fault-finding on digital circuits, where correct operation depends not on voltage levels but on the presence (or absence) of a fixed-level pulse which is too fast to register on a multimeter. The only way pulses can be observed is either on a 'scope, or by using a special logic probe. It is also important to understand the logic of the circuit, from the truth tables of simple AND, OR, NOR and NAND gates through flip flops, registers and so on, to the logical combination of the elements used in the circuits. The Model Train Lights Controller project, published last month, for instance, was a good example of a sequential logic circuit in which correct operation depends on the logic state of particular inputs *and* the state of the logic elements which resulted from the last sequence of inputs! The timing diagrams, tracing the effect on the circuit of a sequence of inputs, are an important fault-finding tool for this type of circuit!

The Final Secret

To conclude, I will now reveal the most important secret of fault-finding: experience. There is no substitute, so when your project just lies there limply, don't get frustrated and annoyed, or throw it against the wall! Roll up your sleeves and get on with it. Sooner or later the circuit will burst into life, and you will discover that you've learned a lot about electronics, in the process.

Happy Hunting!

Our thanks to Bernard Babani (publishing) Ltd. for permission to reproduce the diagrams of Figures 2 and 3 from their "Transistor Radio Fault-Finding Chart" by Chas E. Miller; publication number BP70, price 50p.

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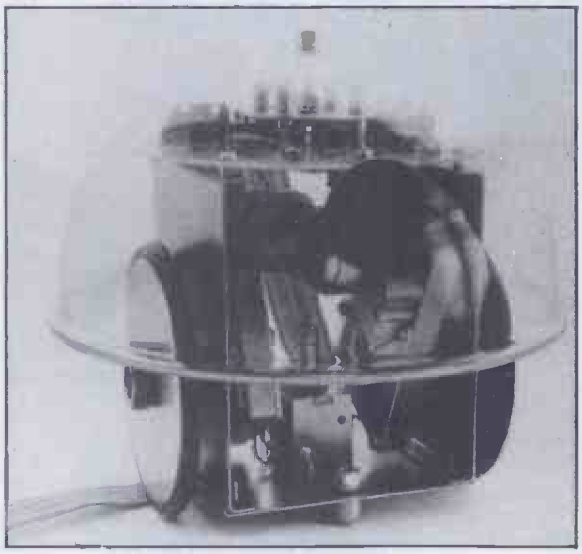

HEBOT II

HEBOT Rolls Again

Way back in November 1979 we published one of the first ever mobile robot projects, which we christened HEBOT. It proved to be enormously popular and, judging by the mail we still receive, reader's enthusiasm for simple robotics has not decreased over the years!

HEBOT has long since 'passed on' but now, in conjunction with Powertran Ltd., we are proud to present its successor.

HEBOT II is a very similar animal — er, robot — but using today's more sophisticated circuitry and operating under the control of a microcomputer. Like the original, it is a 'turtle' robot, propelled by two large, independently controlled rubber wheels which enable it to perform a wide variety of movements. Obstacle-sensors allow it to explore its environment, discovering the limits of movement or the shape of a room, or it can draw patterns or graphs using a pen, which presses down on command. Its blinking eyes and on-board beeper can be programmed to communicate with the operator, eg to indicate that it has finished a task.

The projected cost of this educational and inspirational robot is around £75, and it is initially intended to be controlled via a Sinclair ZX81 microcomputer — though future developments will open still greater possibilities. Look out for HEBOT II in the November issue of Hobby Electronics.

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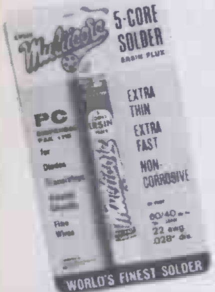

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FORTH's unique combination of speed, versatility and ease of programming has already made it a prime choice for professional applications as diverse as pub games and radio telescopes, and gained it an enthusiastic national user group. Now the Jupiter Ace can bring this addictive language into your own home.

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Leading computer Designers Richard Altwasser and Steven Vickers have a reputation for pushing technology forwards. After playing the major role in creating the ZX Spectrum they formed Jupiter Cantab to develop their latest brainchild the Jupiter Ace.

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Ian Sinclair

The inventor of the wire-recorder (the precursor of the modern tape recorder) and the first practical method of modulating radio frequencies.

If you haven't heard of him, it's certainly not because of any lack of publicity. Poulsen's invention of magnetic recording, which is still the basis of most tape and magnetic disc recording systems, has been well-documented; but some of his work, notably such achievements as modulation of radio waves, are not quite so well-known. Poulsen was born in 1869 in Copenhagen, Denmark. He doesn't seem to have distinguished himself much at school, but was fascinated by telegraphs and telephones and so progressed from school to Technical College.

When he left College, Poulsen fulfilled his ambitions by joining the Copenhagen Telephone Co as a technical assistant, and it was during his time there that he invented a device to record telephone conversations, a device which he christened the Telegraphone. This was patented in 1898 and a working model of the device aroused considerable interest at the Paris Exposition in 1900. What exactly was it ?

A Record First

The drawings are still around and there is absolutely no doubt that it was the first magnetic recorder. Since the discovery of magnetic hysteresis by Charles Steinmetz, engineers were much more aware of how to deal with magnetism, and Poulsen had thoroughly absorbed Steinmetz's work. He realised that if an AC signal were superimposed over DC in an electromagnet and if, at the same time, a magnetic material moved past the poles of the electromagnet then the material would be left permanently magnetised, but with different strengths of magnetism in different places. This remaining magnetism would surely bear some relationship to the amplitude of the AC signal at each instant.

Leading The Way

In any case, Poulsen was not just a theorist; he constructed a prototype in which the recording medium steel wire wound on a drum, with an electromagnet pressed against the wire. The poles of the electromagnet were shaped to fit closely to the wire, and the whole electromagnet (the record/replay head, as we would now call it) was raised or lowered by a lead-screw (as on a screw-cutting lathe) so that, as the drum revolved, the head was kept in contact with the wire. When the head reached the top of the drum, it was automatically lifted from the wire and returned to its starting position.

The prototype worked, and worked well enough to be a big success at the Paris Expo, but its uses were not so obvious. Home entertainment was out of the question, but Edison's Phonograph had scooped the market and, in any case, the Phonograph had the great advantage that the sound output was loud enough for everyone in a room to hear it. Poulsen's Telegraphone gave only a feeble signal from its replay head, enough for a pair of sensitive earphones, but no more. Its advantage, though, was that the recording system was electrical, using a microphone. To cut a phonograph record, on the other hand, it was necessary for the singer to perform into the wide end of the large trumpet-shaped horn, at the other end of which was a diaphragm carrying a stylus which cut the wax of the recording cylinder directly.

Despite this advantage, Poulsen could not raise any finance for his invention in Europe and, like so many before and even more since, he travelled to the US with his patents. In 1903, with some newly-acquired US associates, he formed the American Telegraphone Co, for manufacturing and selling his recorder. The production model permitted 30 minutes of recording, much longer than was possible on any Phonograph wax cylinder; it achieved this by using fine steel wire, wound on reels, as the recording medium, moving past the record/replay head at the very high speed of 84 inches per second. The market he was aiming at was the rapidly expanding one of office dictaphones which, at that time, used wax cylinders or discs, with all of their disadvantages.

Private Practices

Poulsen's dictaphone offered: more private operation, using a microphone; the possibility of remote operation and even the recording of telephone conversations; private replay, using earphones; a very much longer playing time than rival machines based on wax cylinders or discs could offer. These advantages won the machine quite a substantial share of the booming office equipment market. A few of Poulsen's machines were still in use in the 30s, but when electrical recording and replay became possible on aluminium discs, using phonograph techniques, interest in Poulsen's recorder diminished.

For Better Or Morse

Poulsen's inventive life was by no means confined to the Telegraphone, however. Like most inventers of the time, he concentrated from 1902 onwards on radio communication and, in particular, on the problem of modulation. In the dawn of radio, only telegraphy was possible, and Morse ruled. Morse ruled, in fact, for so long, and became such a millstone round the neck of amateur radio, that CB just *had* to come to prove that the 20th Century had arrived!

Poulsen also thought that Morse code was out of date by 1902—after all, teletypes using Baudot or Murray 5-bit digital codes had been in use for all of Poulsen's working life. He set out to go one step better and design a way of carrying speech by radio and, by chance, picked up a copy of a British Patent by W. Duddell for a 'singing arc'. This was a way of creating sound from an electrical discharge, similar to an arc lamp, using an electromagnet to move the discharge (which we now call a plasma) and so create the airwaves of sound.

Plasma loudspeakers, incidentally, are by no means completely dead — look our for developments! Duddell's device worked, but it needed large amounts of power and the principle, called the Ionophone, was not greatly developed at the time. Poulsen realised that it might be possible to reverse the action of this 'singing arc' and, by having the arc as part of radio frequency circuit, modulate it by the effect of sound-waves on the arc.

His Latest Flame

His first experiments looked frighteningly dangerous. An induction coil was used to generate high frequency AC, and a pair of carbon electrodes provided the arc, with one electrode connected to the earth and the other to the aerial. By speaking into the flame of the arc, Poulsen achieved amplitude modulation of the signal, and his transmissions were received ten miles away using a crude crystal detector and earphones.

This modulator was not really a practical proposition, but Poulsen went on to develop an arc between copper electrodes in gas, held in a glass tube. With the gas at lower than atmospheric pressure, a steady arc could be achieved with lower voltages and modulated by an electromagnet connected to a microphone circuit. Using this arrangement, Poulsen was able to achieve enough depth of modulation to make long-wave broadcasting of sound signals possible, and his arc-modulation system was used until high-power transmitting valves became available.

Poulsen continued his inventive career, making small and generally unnoticed contributions to radio. He tended not to advertise his successes and it is for that reason his work is not widely appreciated. As it was, his working life covered all the pioneering days of electronics, though his death in 1942 robbed him of the chance to see his first invention reach its triumphant maturity, as the tape recorder. HE

LOOK

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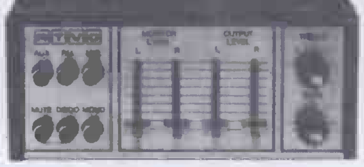

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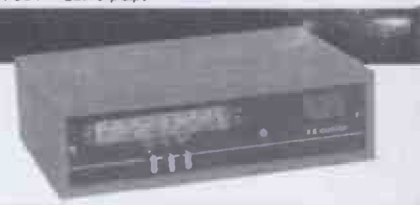
P.E. STEREO TUNER KIT



This easy to build 3 band stereo AM/FM tuner kit is designed in conjunction with Practical Electronics (July 81 issue). For ease of construction and alignment it incorporates three Mullard modules and an I.C. IF. System. FEATURES: VHF, MW, LW Bands, Interstation muting and AFC on VHF. Tuning meter. Two back printed PCB's. Ready made chassis and scale. Aerial: AM - ferrite rod, FM - 75 or 300 ohms. Stabalised power supply with 'C' core mains transformer. All components supplied are to P.E. strict specification. Front scale size: 10½" x 2½" approx. Complete with diagram and instructions.

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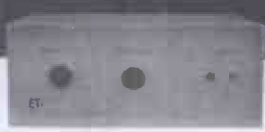

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★AC128	20	BC160	45	BCY70	18	BFX84	26	TIP30A	45	ZTX300	14	2N3442	120
AC176	25	BC168C	10	BCY71	18	BFX85	25	TIP30B	50	ZTX301	16	★2N3702	6
AC187	22	BC169C	10	BCY72	18	BFX86	28	TIP30C	60	ZTX302	15	2N3703	9
AC188	22	BC170	8	BD115	80	BFX87	25	TIP31A	45	ZTX304	17	★2N3704	6
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AD162	40	BC178	18	BD135	30	BFY52	23	TIP33A	60	ZTX502	15	2N3708	10
AF124	60	BC179	18	BD136	30	BFY53	32	TIP33C	75	ZTX503	18	2N3709	10
AF126	50	BC182	10	BD137	30	BFY55	32	TIP34A	60	ZTX504	25	2N3772	190
AF139	40	★BC182L	8	BD138	30	BFY56	32	TIP34C	85	2N697	20	2N3773	210
AF186	70	BC183	10	BD139	30	BRY39	40	TIP35A	160	2N698	40	★2N3819	18
AF239	75	BC183L	10	BD140	30	BSX20	20	TIP35C	180	2N706A	20	2N3820	40
BC107	10	BC184	10	BD204	110	BSX29	35	TIP36A	170	2N708	20	2N3823	65
BC107B	12	★BC184L	7	BD206	110	BSY95A	25	TIP36C	195	2N918	35	2N3866	90
★BC108	9	BC212	10	BD222	85	BU205	160	TIP41A	60	2N1132	22	2N3903	10
BC108B	12	BC212L	10	BF180	35	BU206	200	TIP42A	60	2N1613	30	2N3904	10
BC108C	12	BC213	10	BF182	35	BU208	170	TIP120	90	2N2218A	45	2N3905	6
★BC109	9	BC213L	10	BF184	25	MJ2955	99	TIP121	90	2N2219A	25	2N3906	10
BC109C	12	BC214	10	BF185	25	MJE340	50	TIP122	90	2N2221A	25	2N4037	45
BC114	22	★BC214L	8	BF194	12	MJE520	65	TIP141	120	2N2222A	20	2N4058	10
BC115	22	BC237	8	BF195	12	MJE521	95	TIP142	120	2N2368	25	2N4060	10
BC117	22	BC238	14	BF196	12	MJE3055	70	TIP147	120	2N2369	16	2N4061	10
BC119	35	BC308	15	BF197	12	MPF102	40	TIP2955	60	2N2484	25	2N4062	10
BC137	40	BC327	14	BF198	10	MPF104	40	TIP3055	55	★2N2646	45	2N5457	36
BC139	40	BC328	14	BF199	18	MPSA05	22	TIS43	30	2N2904	20	2N5458	36
BC140	30	BC337	14	BF200	30	MPSA06	25	TIS44	45	2N2904A	20	2N5459	30
BC141	30	BC338	14	★BF244B	22	MPSA12	30	TIS45	45	2N2905	22	2N5485	36
BC142	25	BC477	30	BF245	30	MPSA55	30	TIS90	30	2N2905A	22	2N5777	45
BC143	25	BC478	30	BF256B	45	MPSA56	30	TIS91	30	2N2906	25	2N6027	30
BC147	8	BC479	30	BF257	32	MPSU05	55	★VN10KM	45	2N2906A	25	40360	40
BC148	8	BC517	40	BF258	25	MPSU06	55	VN46AF	75	2N2907	25	40361	50
BC149	9	BC547	7	BF259	35	MPSU55	60	VN66AF	85	2N2907A	25	40362	50
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★741	14	ICL8211A	200	LM384	130	MC3340	135	★RC4558	60	★TL081	25
748	35	ICM7224	785	LM386	65	ML922	400	SL480	170	★TL082	45
9400CJ	350	ICM7555	80	LM387	120	ML924	195	SL490	250	★TL084	95
AY-3-1270	840	LF351	45	LM393	100	ML925	210	SL76018	150	TL170	50
AY-3-8910	600	LF353	85	LM709	25	ML926	140	SN76477	250	★UA2240	120
AY-3-8912	625	LF356	90	LM711	60	ML927	140	SP8629	250	ULN2003	85
CA3046	60	LM10	360	LM725	350	ML928	140	TBA120S	70	ULN2004	90
CA3080	65	LM301A	25	LM733	75	ML929	140	TBA800	80	★XR2206	300
CA3089	215	LM311	70	LM741	14	MM5387A	465	TBA810	96	ZN414	100
CA3090AQ	375	LM318	120	LM747	75	NE529	225	TBA820	80	ZN423	135
CA3130E	90	LM324	40	LM1458	40	NE531	160	TBA950	200	ZN424	135
★CA3140E	45	LM334Z	100	LM2917	200	NE544	205	TDA1008	320	ZN425E	350
CA3161E	100	LM335Z	125	LM3900	50	NE555	16	★TDA1022	525	ZN426E	330
CA3189	290	LM339	50	★LM3909	70	★NE556	45	TDA1024	125	ZN427E	650
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2-10pF 22p; 2-22pF 30p; 5.5-65pF 35p

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4000	10	★4017	38	4036	275	4055	95	4082	16	4502	60	4529	150
★4001	10	4018	45	4039	290	4059	480	4085	65	4503	40	4532	80
4002	12	4019	25	4040	60	4060	65	4086	60	4507	38	4534	485
4006	50	4020	50	4041	50	4063	85	4089	125	4508	150	4538	110
4007	15	4021	50	4042	45	★4066	30	★4093	30	4510	50	4543	100
4008	48	4022	50	4043	50	4067	295	4094	120	★4511	50	4549	360
4009	24	4023	16	4044	50	4068	16	4095	75	4512	50	4553	275
4010	24	4024	33	★4046	60	4069	16	4097	290	4514	120	4555	35
★4011	11	4025	16	4047	60	4070	15	4098	75	4515	120	4556	35
4012	15	★4026	80	4048	40	4071	15	4099	90	4516	65	4559	390
★4013	25	4027	24	★4049	25	4072	15	40106	50	★4518	40	4560	175
4014	60	4028	50	★4050	25	4073	15	40109	110	4520	70	4584	45
4015	50	4029	60	4051	45	4075	15	40163	100	4521	130	4585	60
4016	20	4030	30	4052	60	4076	60	40173	100	4526	70	4724	140
		4031	125	4053	50	4077	18	40175	100	4527	80		
		4034	140	4054	95	4081	14	40193	95	4528	70		

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An ideal opportunity for the beginner or the experienced constructor to obtain a wide range of components at greatly reduced prices.
¼W 5% Resistor kit. Contains 10 of each value from 4.7Ω to 1M (650 resistors) 480p
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25 6BA ½" bolts — 25 6BA ½" bolts
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50 6BA washers — 50 6BA washers

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

LS TTL

★LS00	11	LS21	12	LS76	18	LS125	26	LS161	37	LS221	54	LS365	30
LS01	11	LS22	12	LS78	18	LS126	25	LS162	37	LS240	69	LS366	30
LS02	11	LS26	14	LS83	40	LS132	42	LS163	37	LS241	69	LS367	30
LS03	12	LS27	12	LS85	52	LS136	26	LS164	43	LS242	75	LS368	35
LS04	12	LS30	12	LS86	19	★LS138	32	LS165	75	LS243	75	★LS373	65
LS05	13	LS32	13	★LS90	28	★LS139	32	LS166	75	★LS244	60	LS374	65
LS08	12	LS37	15	LS92	32	LS145	70	LS170	85	★LS245	70	LS375	45
LS09	12	LS38	15	★LS93	28	LS147	150	LS173	65	LS247	50	LS377	70
LS10	12	LS40	13	LS95	40	LS148	86	LS174	45	LS251	35	LS378	60
LS11	12	★LS42	32	LS96	95	LS151	38	LS175	45	LS257	35	LS390	55
LS12	12	★LS47	38	LS107	40	LS153	40	LS190	45	LS258	35	LS393	55
★LS13	22	LS48	45	LS109	21	LS154	90	LS191	45	LS259	75	LS399	175
LS14	38	LS51	14	LS112	21	LS155	35	LS192	45	LS266	22	LS541	120
LS15	12	LS55	14	LS113	21	LS156	36	LS193	45	LS273	68	LS670	150
LS20	12	LS73	18	LS114	22	★LS157	30	LS195	36	LS279	35		
		★LS74	18	LS122	38	LS158	30	LS196	50	LS283	40		
		LS75	22	LS123	38	LS160	37	LS197	60	LS353	88		

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2.3 and 4.7mm bits to suit	65p
CS 17W element	210p
Antex XS 25W Soldering iron	480p
3.3mm and 4.7mm bits to suit	65p
Solder pump desoldering tool	480p
Spare nozzle for above	70p
10 metres 22swg solder	100p

PANEL METERS

Size 60×46×35mm

0-50uA	0-500mA
0-100uA	0-1A
0-500uA	0-50V AC
0-1mA	VU
0-10mA	0-300V AC
0-50mA	0-25V DC
0-100mA	0-30V DC

All 495p each

TTL

		★7413	18	7442	32	7480	48	74107	25	74155	40	74177	45
		7414	28	7444	90	7482	65	74109	25	74156	40	74179	80
★7400	11	7416	24	7446	65	7483	60	★74121	25	74157	30	74180	40
7401	11	7417	24	7447	40	7485	60	74122	40	74160	50	74181	115
7402	11	7420	15	7448	45	7486	20	74123	40	74161	50	74182	60
7403	12	7421	20	7450	16	7489	180	74125	35	74162	50	74190	50
7404	13	7422	20	7451	16	★7490	21	74126	35	74163	50	74191	50
7405	15	7427	22	7453	16	7491	45	74132	40	74164	50	74192	50
7406	24	7428	26	7454	16	7492	25	74141	45	74165	50	74193	45
7407	25	7430	14	7460	16	★7493	25	74145	50	74167	150	74194	50
7408	14	7432	20	7472	26	7494	38	74147	90	74170	125	74195	50
7409	14	7433	25	7473	26	7495	35	74148	70	74173	60	74196	50
7410	14	7438	25	★7474	20	7496	40	74150	55	74174	66	74197	50
7411	16	7437	25	7475	26	7497	95	74153	40	74175	55	74198	90
7412	18	7440	15	7476	30	74100	80	74154	55	74176	40	74199	90

OPTO

★3mm red	8	★5mm red	8
★3mm green	12	★5mm green	12
★3mm yellow	12	★5mm yellow	12

Clips to suit 3p each

Rectangular			
★red	12	TIL32	40
green	17	TIL78	40
yellow	17	TIL111	60
TIL38	40	ORP12	85
2N5777	45	TIL100	90
		Dual color	60

Seven segment displays

Com cathode		Com anode	
DL704 0.3"	95	DL707 0.3"	95
★FND500 0.5"	100	FND507 0.5"	100
TIL313 0.3"	105	TIL312 0.3"	105
TIL322 0.5"	115	TIL321 0.5"	115

LCD: 3½ digit 580p 4 digit 620p

SWITCHES

Submin toggle
SPST 55p SPDT 60p DPDT 65p
Miniature toggle
SPDT 80p SPDT centre off 90p DPDT 90p DPDT centre off 100p
Standard toggle SPST 35p DPDT 48p
Miniature DPDT slide 12p
Push to make 12p Push to break 22p
Rotary type adjustable stop
1P12W 2P6W 3P4W all 56p each
DIL switches
4 SPST 80p 6 SPST 80p 8 SPST 100p

CONNECTORS

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

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

RESISTORS

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¼W 1% Metal film E24 series 10Ω-1M 6p each

SCRs

TIC45	28	400V 8A	70
★C106D	30	400V 12A	99

CRYSTALS

100KHz	290	6.0M	200
200KHz	370	6.144M	180
1MHz	300	7.0M	250
1.008M	370	8.0M	170
1.8432	300	10.0M	180
2.0M	270	12.0M	290
2.4576M	220	16.0M	240
3.276M	240	18.0M	240
3.579M	120	18.432	220
4.0M	150	38.667	320
4.194M	150	48.0M	220
4.43M	125	116M	300
5.0M	240		

VERO

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Size 0.1 matrix	
2.5×1	22p
2.5×3.75	75p
2.5×5	85p
3.75×5	95p
VQ board	160p
Veropins per 100	
Single sided	50p
Double sided	60p
Spot face cutter	105p
Pin insertion tool	162p
Wiring pen + spool	310p

SOCKETS

	Low profile	Wire-wrap
★8 pin	7p	25p
★14 pin	9p	35p
★16 pin	10p	42p
18 pin	15p	52p
20 pin	18p	60p
22 pin	20p	70p
24 pin	22p	70p
28 pin	26p	80p
40 pin	32p	98p
Soldercon pins		60p/100

BOXES

Aluminium		Plastic with lid + screws	
3×2×1in	70p	3×2×1in	56p
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4×3×2in	100p	7×4×2in	160p
6×4×2in	120p		
6×4×3in	150p		

BRIDGE RECTIFIERS

1A 50V	22	6A 100V	80
1A 400V	35	6A 400V	95
2A 200V	40	VM18 DIL	
2A 400V	45	0.9A 200V	50

PCB MATERIALS

Alfac transfer sheets — please state type (e.g. DIL pads etc) 45p
Dalo etch resist pen 100p
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Ferric Chloride 250ml bottle 100p

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Negative Voltage Generator

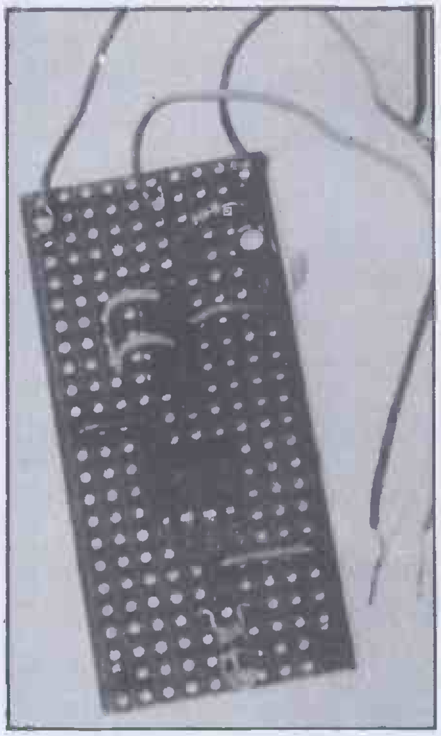
Owen Bishop

A simple circuit on a postage stamp sized PCB, but it has 1001 uses!

IT IS handy to have one or more of these devices in the electronics workshop. If you are building or designing a circuit which uses op-amps, a split power supply is nearly always required. There are other applications too; for example, this version of the circuit was built up to provide a split supply for the prototype of the Digital Millivoltmeter (HE August '82 issue). Not having enough cells to hand to make up a +4V5 battery, and being unable to get out to the shops, the only solution was to use the available batteries for the positive supply and make up this circuit for the negative supply. In the DVM project, the circuit takes up less room than the 3 cells it replaces. It also makes the power switching and wiring simpler since, instead of a double-pole switch (one pole for positive, one for negative), only a single-pole switch is required.

Construction

There is almost nothing to say about this, since it can be built up on almost any scrap of stripboard (**Figure 2**) or on



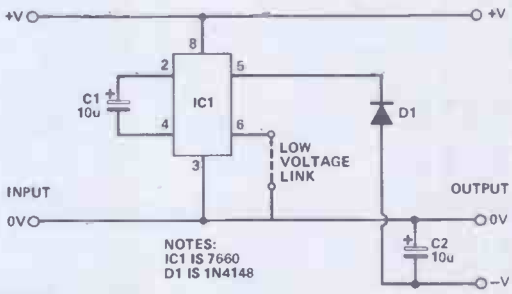


Figure 1. The circuit uses just one IC.

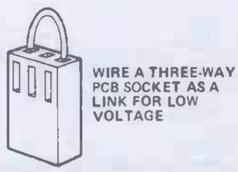


Figure 2. A three-way PCB socket can be used as the low-voltage link.

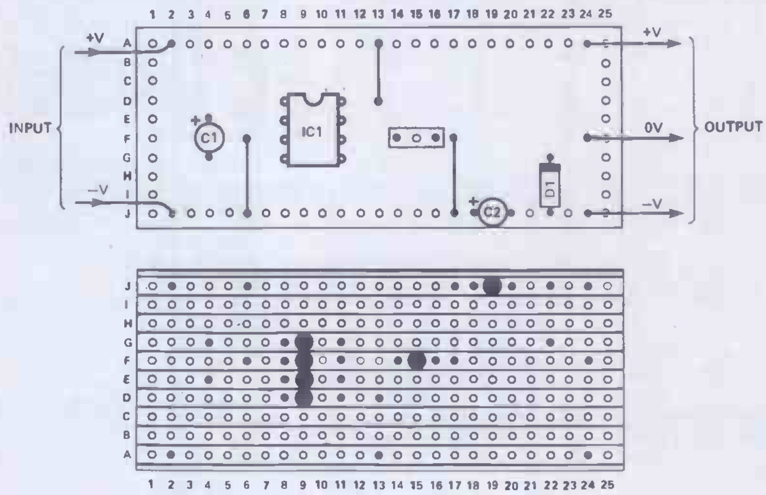


Figure 3. The Veroboard layout.

a PCB (**Figure 3**) the size of a postage stamp. Also, the circuit can be incorporated in any odd space on the main board of any other project that requires it.

It works for a wide range of supply voltages (+1V5 to +10V). Pin 6 must be joined to the 0V rail when the supply is less than +3V5 and for these low voltages, the diode may be omitted. The PCB design allows a wire link to connect pin 6 to the 0V rail for low-v-voltage operation. If the unit is to be used at various voltages, some high, some low, a switch may be wired in place of the link.

The circuit works straight away — no adjustments are needed.

The Circuit

The positive voltage comes straight through from the supply, so there is no mystery about this. The negative voltage is generated by voltage level translation. See what happens when the unit is connected to a +6V supply. There are two stages in the operation (**Figure 4**):

Parts List

CAPACITORS

C1, 2 . . . . , . . 10u 16V tantalum bead

SEMICONDUCTORS

IC1 . . . . 7660 voltage converter (see Buylines)

D1 . . . . 1N4148 signal diode

MISCELLANEOUS

Small veroboard or PCB; veropins; 3-pin PCB plug and socket, or SPST switch; wire, solder etc.

Buylines . . . . page 30

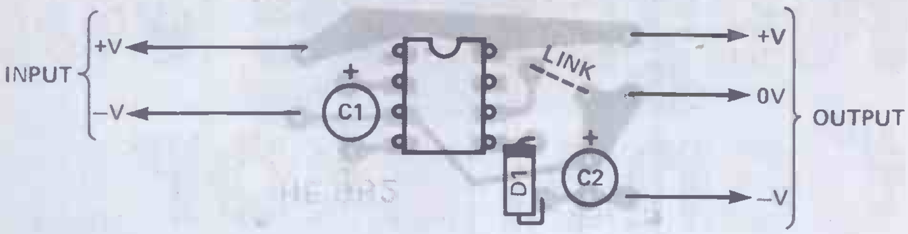


Figure 4. A full-sized PCB is reproduced on the PCB Printout page; note that the low-voltate link is hard-wired, here.

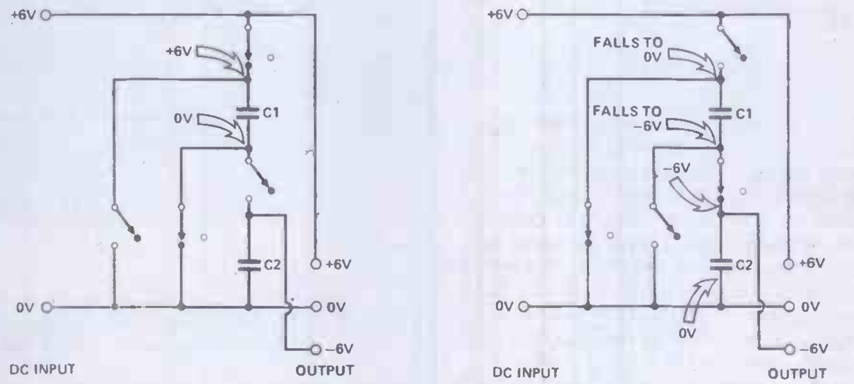


Figure 5. How the 7660 IC works: left, Stage 1; right, Stage 2.

Stage 1: C1 is charged directly from the power supply, so that its negative terminal is at 0V and its positive terminal is at +6V.

Stage 2: The switches are altered under the control of the logic circuits; the +6V plate of C1 is now connected to the 0V rail, resulting in a fall of potential of 6V. This causes a corresponding drop on its other plate, formerly at 0V but now forced down to −6V. Since this plate is now connected to C2, one side of C2 now becomes charged to −6V, the other side being at 0V.

The IC then returns to Stage 1, recharging C1 and leaving C2 charged to −6V. The states alternate very rapidly (at about 10kHz), under the control of an on-chip oscillator and various logic circuits, so that a virtually smooth DC supply is obtained. Naturally, if current is being drawn from C2 to supply the external circuit, its charge may not be renewed sufficiently rapidly from C1 and the negative voltage may fall slightly. For many applications (eg, the DVM) the negative supply is called on for relatively small currents, so usually this effect can be ignored. HE

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POINTS OF VIEW

Feel like sounding off? Then write to the Editor stating your Point Of View!

Stretching A Point

Dear Sir,
I am writing to you for help in obtaining a reel of 35 SWG and 39 SWG enamelled copper wire. I have looked in many catalogues advertised in your magazine but they only stock 34 and 40 SWG wire. If you know of any company who could supply 35 and 39 SWG could you please inform me. I would be very grateful.
B. Cook,
Tamworth,
Staffs.

We can't imagine why you need 35 and 39 rather than 34 and 40 — the difference is 0.01 and 0.02 mm, respectively! However, the Scientific Wire Company (PO Box 30, London E4) will sometimes supply custom gauges. Ask them nicely and tell them Hobby Electronics sent you!

Getting Started

I have just completed my first year studying a broad engineering course which includes a substantial amount of electronics. I have found this part slightly difficult, mainly because I cannot get practice at its application.

I very much want to begin constructing electronic circuits but, being a complete novice, I have very little idea where to start! It seems that kits are the easiest initial projects.

I have a soldering iron and some screwdrivers, but would like advice on what tools to obtain and what projects to opt for first. Yours was the first electronics magazine I have ever bought. The theory I can understand but the practical details seem very difficult without knowledge of the components.

I would be most grateful if you could spare the time to advise me.
L.M. Gair,
London.

Difficult questions to answer in a few lines, but we'll try! First, our aim in HE is to present projects for the beginner in electronics, and many of our long-running feature series are devoted to introducing both the theory and practice of electronics. The best place to start, then, is in your local library! We suggest you look closely at Ian Sinclair's "Into Electronic Components" series (August '81 — July '82) which explains in detail what the various items are, and how and why they are used. On the practical side, we'd recommend Keith Brindley's "Building Site" articles, in issues from August 1980 through to December 1981. Any article you feel should be kept for future reference can be obtained from our Backnumbers Department.

The three essential tools for the electronics constructor are a soldering iron, sidecutters and a pair of long-nosed pliers. For mechanical assembly, you'll need a selection of screwdrivers, and there are many other tools which, while not "essential" are quite handy; nut drivers, small spanners, and so on. A set of miniature files is extremely useful, and so is a "seizer" or surgical clamp; the jaws clamp firmly together to hold wires for soldering, act as a heat sink etc, and are handy for retrieving small things that drop into inaccessible places! You'll find all these items in the catalogue published by Cooper Tools. Their address is: Sedling Road, Wear, Washington, Tyne and Wear NE38 9BZ.

Kit projects are probably simpler because all the components are supplied, along with the odds and ends that an inexperienced constructor would not have to hand. Kits are available for most Hobby Electronics projects, but pick an easy one to start on. Be sure to follow the instructions carefully; you'll make mistakes, of course, but there's no other way to go about it; experience is the best teacher, after all!

Speakers Without Peer

Dear Sir,
Thank you for such an excellent magazine, Hobby Electronics.

We do have a problem though; quite a lot of the projects have certain components that are either not stocked at the local electronic shops, or the man behind the counter gives you a blank look when you ask for it. That usually means he hasn't got a clue what you're talking about.

Such was the case with your stereo hi-fi, System 5080A, in the March 1980 issue. After I had completed the preamp, power amp and the power supply, I started looking around for the speakers specified. Alas, nobody knew anything about a speaker called "Peerless".

I then decided to contact one of the suppliers mentioned in Buylines. The company was Badger Sound Services Ltd. They sent me a price list as well as the order forms, which I completed and returned to them with my cheque. At this stage I thought my problems were over, when disaster struck. They sent me a letter to inform me that they were having difficulty in obtaining a set of the speakers, but that they expected them within two or three weeks.

That was six months ago, and I regret to say that my patience is running out. It seems to me that they are not eager to satisfy overseas customers because I last heard from them three months ago.

Are there other customers from foreign countries also experiencing problems in this respect, or has my luck run out? I always had my doubts about importing goods from other countries and after this I don't think I'll attempt such a thing again.

I have written to the company asking them if they can or cannot supply the goods within the next six months, because that is as long as I'll be able to wait. The project is costing me a fortune and the fact that I have to wait so long for these speakers makes it a total loss.

I sincerely hope there is someone who can help me with this problem, or to advise me on the true state of affairs.
H. Beukes,
Volksrust,
South Africa.

The speakers (or more accurately, the driver units) are still manufactured by Peerless, but the number of tweeters being produced keeps them in short supply and this is where the problem lies. We have contacted Badger Sound and they have assured us that they are doing everything possible to obtain the units for Mr. Beukes. We understand that they have written to explain the situation, and have offered alternative drivers which would suit the system.

We fully appreciate the difficulties sometimes experienced by our overseas readers, but there is very little we can do about it other than point out that it would be safer to make enquiries about the supply of unusual components before actually sending off for them.

For our South African readers, we can pass on the name of a shop recommended by an expatriate colleague; it is: A1 Radio of West Street, Durban 4001.

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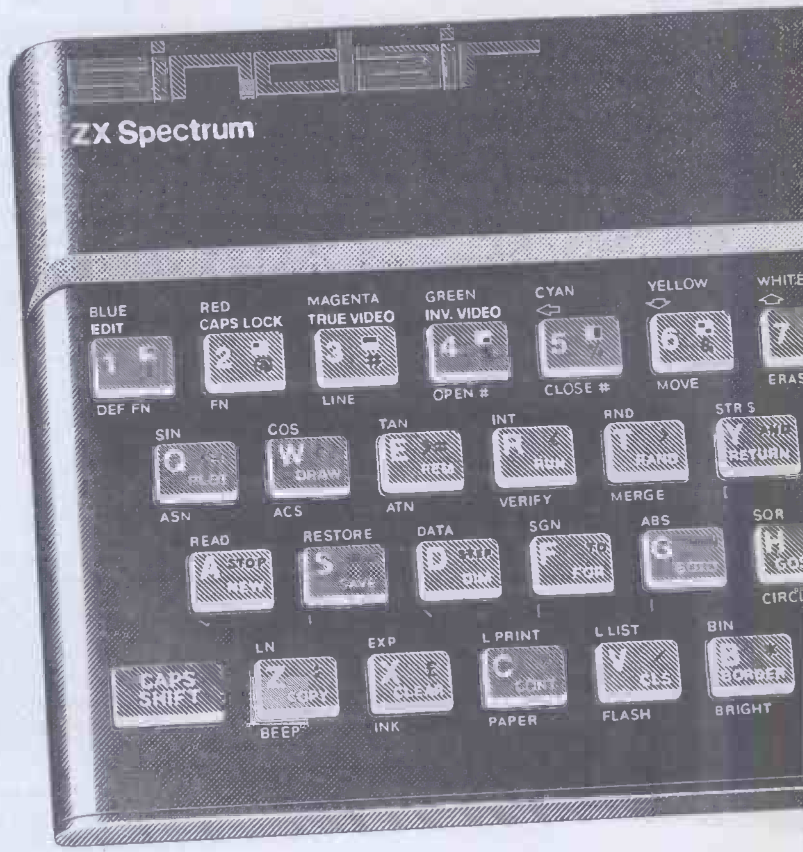

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You have access to a range of 8 colours for foreground, background and border, together with a sound generator and high-resolution graphics.

You have the facility to support separate data files.

You have a choice of storage capacities (governed by the amount of RAM). 16K of RAM (which you can uprate later to 48K of RAM) or a massive 48K of RAM.

Yet the price of the Spectrum 16K is an amazing £125! Even the popular 48K version costs only £175!

You may decide to begin with the 16K version. If so, you can still return it later for an upgrade. The cost? Around £60.

Ready to use today, easy to expand tomorrow

Your ZX Spectrum comes with a mains adaptor and all the necessary leads to connect to most cassette recorders and TVs (colour or black and white).

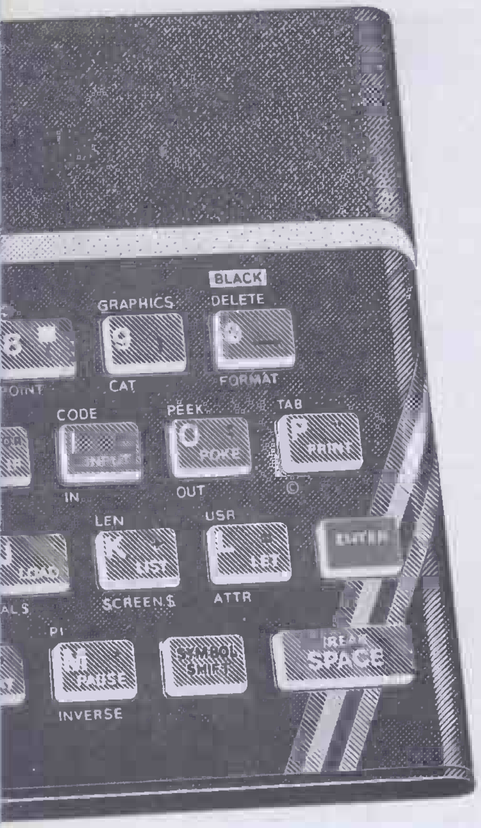
Employing Sinclair BASIC (now used in over 500,000 computers worldwide) the ZX Spectrum comes complete with two manuals which together represent a detailed course in BASIC programming. Whether you're a beginner or a competent programmer, you'll find them both of immense help. Depending on your computer experience, you'll quickly be moving into the colourful world of ZX Spectrum professional-level computing.

There's no need to stop there. The ZX Printer–available now–is fully compatible with the ZX Spectrum. And later this year there will be Microdrives for massive amounts of extra on-line storage, plus an RS232 / network interface board.

Key features of the Sinclair ZX Spectrum

- Full colour–8 colours each for foreground, background and border, plus flashing and brightness-intensity control.
- Sound–BEEP command with variable pitch and duration.
- Massive RAM–16K or 48K.
- Full-size moving-key keyboard–all keys at normal typewriter pitch, with repeat facility on each key.
- High-resolution–256 dots horizontally x 192 vertically, each individually addressable for true high-resolution graphics.
- ASCII character set–with upper- and lower-case characters.
- Teletext-compatible–user software can generate 40 characters per line or other settings.
- High speed LOAD & SAVE–16K in 100 seconds via cassette, with VERIFY & MERGE for programs and separate data files.
- Sinclair 16K extended BASIC–incorporating unique 'one-touch' keyword entry, syntax check, and report codes.

um



RS232/network interface board

This interface, available later this year, will enable you to connect your ZX Spectrum to a whole host of printers, terminals and other computers.

The potential is enormous. And the astonishingly low price of only £20 is possible only because the operating systems are already designed into the ROM.

The ZX Printer – available now

Designed exclusively for use with the Sinclair ZX range of computers, the printer offers ZX Spectrum owners the full ASCII character set – including lower-case characters and high-resolution graphics.

A special feature is COPY which prints out exactly what is on the whole TV screen without the need for further instructions. Printing speed is 50 characters per second, with 32 characters per line and 9 lines per vertical inch.

The ZX Printer connects to the rear of your ZX Spectrum. A roll of paper (65ft long and 4in wide) is supplied, along with full instructions. Further supplies of paper are available in packs of five rolls.

The ZX Microdrive – coming soon

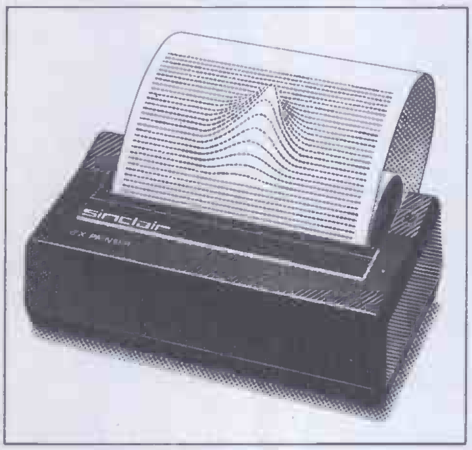
The new Microdrives, designed especially for the ZX Spectrum, are set to change the face of personal computing.

Each Microdrive is capable of holding up to 100K bytes using a single interchangeable microfloppy.

The transfer rate is 16K bytes per second, with average access time of 3.5 seconds. And you'll be able to connect up to 8 ZX Microdrives to your ZX Spectrum.

All the BASIC commands required for the Microdrives are included on the Spectrum.

A remarkable breakthrough at a remarkable price. The Microdrives are available later this year, for around £50.



How to order your ZX Spectrum

BY PHONE – Access, Barclaycard or Trustcard holders can call 01-200 0200 for personal attention 24 hours a day, every day. BY FREEPOST – use the no-stamp needed coupon below. You can pay by cheque, postal order, Access, Barclaycard or Trustcard.

EITHER WAY – please allow up to 28 days for delivery. And there's a 14-day money-back option, of course. We want you to be satisfied beyond doubt – and we have no doubt that you will be.

To: Sinclair Research, FREEPOST, Camberley, Surrey, GU15 3BR. **Order**

Qty	Item	Code	Item Price £	Total £
	Sinclair ZX Spectrum – 16K RAM version	100	125.00	
	Sinclair ZX Spectrum – 48K RAM version	101	175.00	
	Sinclair ZX Printer	27	59.95	
	Printer paper (pack of 5 rolls)	16	11.95	
	Postage and packing: orders under £100	28	2.95	
	orders over £100	29	4.95	
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BUYLINES

Flash Point Alarm

This project is the first where we've been unable to locate a mail order retailer for two of the parts. These are the thermocouple and the 7611 CMOS op-amp. We would be happy to hear from retail suppliers of either of thesel In the meantime, readers will have to contact their local electronics shop, who can order the components from the RS catalogue (codes 308-887 for the 7611 and 151-192 for the thermocouple). The AWD is also from the RS range, but **Strotron** (their London branch is at 72, Blackheath Road, Greenwich SE10 8DA) have a large selection and they *will* supply any of them mail order.

The neat battery-compartment case is from BICC-Vero. Cost of the unit, without the PCBs, is around **£12.**

Check List
RESISTORS
(All ¼ watt 5% carbon)
100k; 3M3; 1M; 10k; 2 x 180R
POTENTIOMETERS
carbon presets
1k; 22k
CAPACITORS
220n polyester C280
SEMICONDUCTORS
ZTX300 transistor; 7611, 4011B ICs; 2 x TIL209 LEDs
MISCELLANEOUS
DPDT slide switch; NiCr/NiAl thermocouple; 4 x AA cells; AWD; case; terminal block; Veropins; plastic feet.

Negative Voltage Generator

One thing to note about this project is that the board is probably the smallest we've ever printed**.**

Some of the components are not strictly necessary — and you may find cheaper alternatives. On our board we used a plug/socket combination from **RS** (codes 467-554 and 467-649), though **Maplin** do a comparable range.

The sub-miniature electrolytic capacitor can be bought from **Ambit** or **ElectroValue** and the IC was cheapest from **Watford.**

Both the Veroboard and PCB versions work out about the same price; **£4** excluding the PCB plug and socket.

Check List
CAPACITORS
2 x 10u 16V sub-miniature electrolytic
SEMICONDUCTORS
7660 IC; 1N4148 diode
MISCELLANEOUS
Veroboard, 25 holes x 10 strips; Veropins; PCB plug and socket.

Squelch unit

The miniature preset is cheapest from **Rapid**, who also do a good deal on the ceramic disc capacitor. The 3130T (metal can version) is very reasonable from **Maplin** and the case can be found in the range made by **BICC-Vero** or **Newrad.**

Cost for one unit we calculate to be about **£10.60** all inclusive.

Check List
RESISTORS
(Al ¼ watt 5% carbon)
5 x 1M5; 390R; 2 x 4k7; 100k; 470R; 3k9; 470k; 3 x 47k; 68k; 1k2; 10k; 1M; 6k8; 2M2; 270R
POTENTIOMETERS
4k7 horizontal preset
CAPACITORS
2 x 100u 10V, 2 x 1u 63V axial electrolytics; 470n; 3 x 100n; 220n polyester C280
SEMICONDUCTORS
3130T IC; BC179, 2N3819, 2 x BC109 transistors; 3 x 1N4148 diodes; TIL220 LED
MISCELLANEOUS
SPST min. toggle switch; DIN plug and socket; aluminium case; PP3 clip; LED fixing washer.

HE

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EPB-MPF board	£84.95		£2.95
PRT-MPF board	£74.75		£2.95
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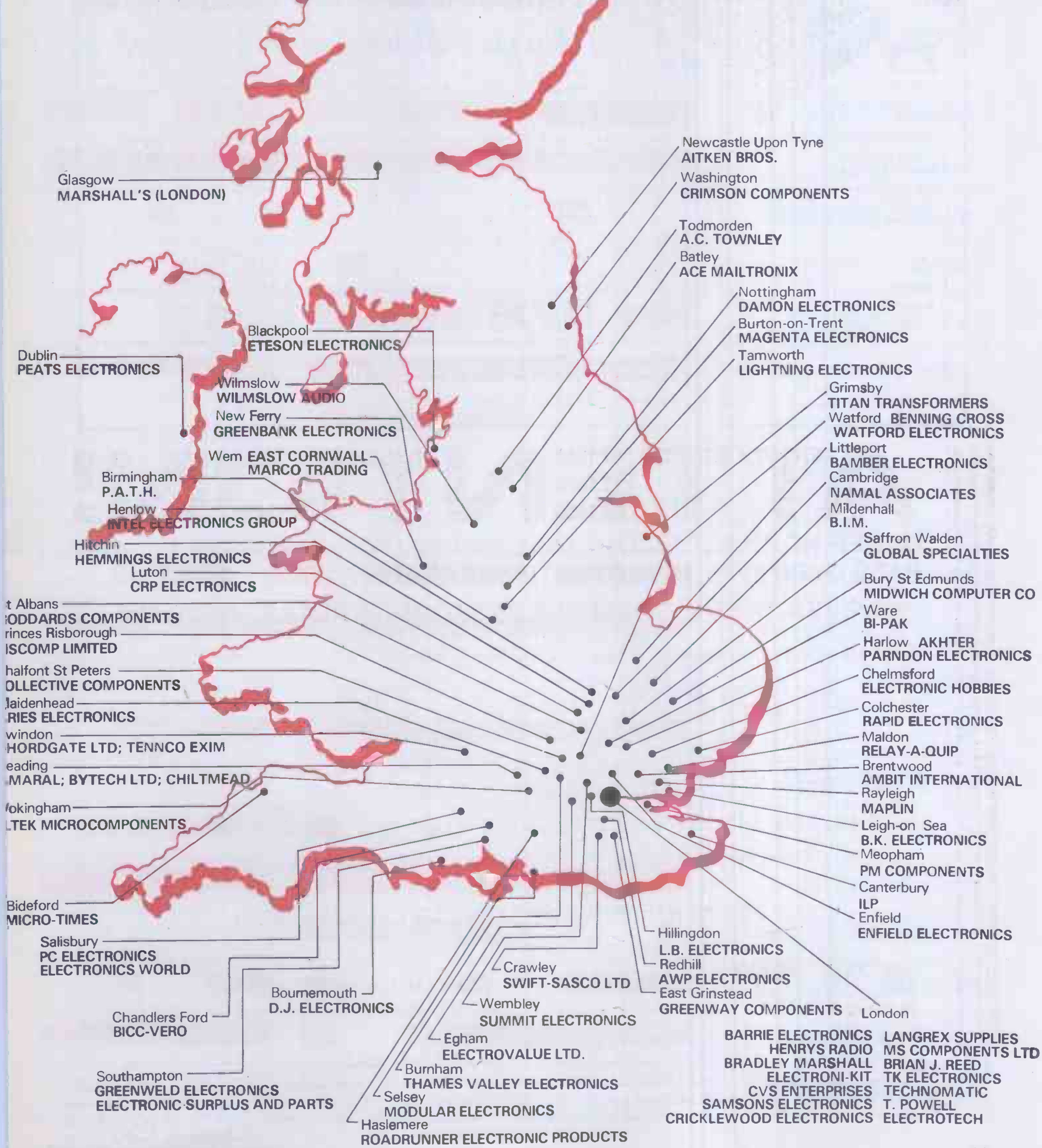
DIRECTORY OF ELECTRONICS SUPPLIES

A comprehensive guide to electronic components and hardware supplies in the United Kingdom.



NOTES:
(1) Including ferrites, RF chokes etc.
(2) Discrete devices.
(3) Other than optoelectronic.
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AITKEN BROS.	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■
AKHTER INSTRUMENTS				■													■			
ALTEK											■									
AMARAL LIMITED	■	■				■	■	■	■	■	■	■			■					
AMBIT INTERNATIONAL	■	■	■	■	■	■	■	■	■	■	■	■		■	■	■	■	■	■	■
ARIES ELECTRONICS						■	■	■	■	■	■	■	■							
AWP ELECTRONICS																				
BAMBER ELECTRONICS																				
BARRIE ELECTRONICS	■	■	■	■		■	■	■	■	■		■	■		■	■	■	■		
BENNING CROSS	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■
BICC-VERO																	■			■
BI-PAK	■	■	■	■	■	■	■	■	■	■	■	■		■	■	■	■	■		■
B.K. ELECTRONICS																				
B.I.M.												■			■					
S & R BREWSTER	■	■	■	■	■	■	■	■	■	■	■	■		■	■	■	■	■	■	■
BYTECH LTD.						■	■	■	■	■	■	■								
CHILTMEAD	■	■	■	■			■					■		■	■			■		
CHORDGATE LTD.	■	■	■	■	■	■	■	■	■			■		■	■	■	■	■	■	■
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(6) In pence unless otherwise noted. N = NIL (no charge).

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ACE MAILTRONIX	●	●	●	●	●	●	●	●		●				●	N	(5)	●		●	●
AITKEN BROS.	●	●	●	●	●	●	●	●	●	●	●	●	●	●	N	(5)	●	●	●	●
AKHTER INSTRUMENTS		●								●	●			●	N	(5)	●	●	●	●
ALTEK																(5)	●		●	●
AMARAL LIMITED														●	N	50	●	●		
AMBIT INTERNATIONAL	●	●	●	●	●	●	●	●	●	●	●	●	●	●	N	50	●	●	●	
ARIES ELECTRONICS															£5	138	●			
AWP ELECTRONICS	●				●		●			●				●	£5	(5)	●			
BAMBER ELECTRONICS											●				£5	(5)	●	●	●	●
BARRIE ELECTRONICS	●	●		●	●		●						●		£2	(5)	●			
BENNING CROSS	●	●	●	●	●	●	●	●	●	●		●	●	●	N	50	●	●	●	●
BICC-VERO	●	●	●		●	●	●	●						●	N	N		●		●
BI-PAK	●	●	●	●	●	●	●	●	●	●	●	●	●	●	N	75	●	●	●	●
B.K. ELECTRONICS								●		●				●	N	(5)	●	●	●	●
B.I.M.				●		●	●	●					●	●	N	(5)	●			●
S & R BREWSTER	●	●	●	●	●	●	●	●		●			●		N	(5)	●	●	●	●
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7432	22p
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7453	15p
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7489	170p
7490A	20p
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7495A	35p
7496	40p
7497	90p
74100	80p
74107	22p
74109	25p
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74116	60p
74118	60p
74119	80p
74120	60p
74121	25p
74122	40p
74123	48p
74125	34p
74126	34p
74128	35p
74132	45p
74136	28p
74141	55p
74142	175p
74173	210p
74144	210p
74145	50p
74147	75p
74148	70p
74150	50p

74151A	36p
74153	40p
74154	60p
74155	40p
74156	40p
74157	30p
74159	75p
74160	60p
74161	48p
74162	48p
74163	48p
74164	48p
74165	48p
74166	48p
74167	150p
74170	120p
74172	275p
74173	60p
74174	55p
74175	50p
74176	40p
74177	45p
74178	80p
74180	40p
74181	115p
74182	60p
74184A	90p
74185	90p
74186	470p
74188	250p
74190	48p
74191	45p
74192	45p
74193	45p
74194	45p
74195	45p
74196	45p
74197	48p
74198	85p
74199	85p
74221	55p
74251	65p
74273	140p
74278	100p
74279	50p
74283	50p
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74LS22	12p
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74LS27	12p
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74LS30	12p
74LS32	13p
74LS37	14p
74LS38	15p
74LS40	13p
74LS42	30p
74LS47	36p
74LS51	14p
74LS55	14p

74LS73	18p
74LS74	16p
74LS75	18p
74LS76	17p
74LS83	36p
74LS85	48p
74LS86	16p
74LS90	22p
74LS92	32p
74LS93	22p
74LS95	40p
74LS96	50p
74LS107	40p
74LS109	27p
74LS112	20p
74LS113	20p
74LS114	22p
74LS122	28p
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74LS126	25p
74LS132	34p
74LS133	25p
74LS136	25p
74LS138	27p
74LS139	27p
74LS145	70p
74LS147	120p
74LS148	75p
74LS151	70p
74LS153	40p
74LS154	80p
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74LS192	36p
74LS193	36p
74LS194	35p
74LS195	35p
74LS196	45p
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74LS251	30p
74LS253	30p
74LS257	30p
74LS258	35p
74LS259	55p
74LS260	82p
74LS261	138p
74LS266	20p
74LS273	60p
74LS279	30p
74LS283	40p
74LS298	90p
74LS323	160p
74LS324	150p
74LS348	90p
74LS352	60p
74LS353	60p
74LS363	140p
74LS364	140p
74LS365	30p
74LS367	30p
74LS368	30p
74LS373	55p
74LS374	55p
74LS375	45p

74LS377	60p
74LS378	60p
74LS390	45p
74LS393	45p
74LS399	160p
74LS467	90p
74LS540	75p
74LS541	80p
74LS670	140p

4000 SERIES	
4000	10p
4001	10p
4002	12p
4006	50p
4007	14p
4008	36p
4009	24p
4010	24p
4011	11p
4012	16p
4013	20p
4014	48p
4015	40p
4016	20p
4017	32p
4018	45p
4019	25p
4020	50p
4021	40p
4022	45p
4023	10p
4024	32p
4025	13p
4026	80p
4027	20p
4028	40p
4029	45p
4030	15p
4031	125p
4033	120p
4034	140p
4035	45p
4036	275p
4937	110p
4039	290p
4040	40p
4041	40p
4042	40p
4043	40p
4044	40p
4076	40p
4077	18p
4078	18p
4081	14p
4082	15p
4086	55p
4089	125p
4093	24p
4094	90p
4095	75p
4096	75p
4097	340p
4098	80p
4099	100p
4500	575p
4502	60p
4503	45p
4505	400p
4507	35p
4508	130p
4510	45p
4511	45p
4512	48p
4514	120p
4515	110p
4516	55p
4518	40p
4520	50p
4521	90p
4526	60p
4527	60p
4528	50p
4532	70p
4534	400p
4536	270p
4538	90p
4539	90p
4543	75p

4553	245p
4555	35p
4556	35p
4560	120p
4568	250p
4569	170p
4572	30p
4583	90p
4584	40p
4585	75p
[illegible]	90p
40097	50p
40102	180p
40103	180p
40106	40p
40109	100p
40163	60p
40174	60p
40175	75p
40193	75p
14495	400p

LINEAR ICs	
AN103	200p
AY1-0212	600p
AY1-1313	668p
AY1-1320	320p
AY1-5050	140p
AY3-1350	420p
AY3-8910	550p
AY3-8912	650p
AY5-4007D	520p
CA3028A	120p
CA3019	80p
CA3046	70p
CA3048	225p
CA3059	300p
CA3060E	350p
CA3080E	72p
CA3086	48p
CA3089	200p
CA3090AQ	375p
CA3130E	90p
CA3140E	40p
CA3140T	90p
CA3160E	100p
CA3161E	175p
CA3162E	450p
CA3189E	300p
CA3240E	120p
CA3280G	200p
D7002	480p
DAC1408-8	200p
HA1366	300p
HA1388	250p
ICL7106	850p
ICM7216B	£18
ICM7217	700p
ICM7555	80p
LC7120	400p
LC7130	400p
LF347	160p
LF351	48p
LF353	100p
LF356P	95p
LF357	120p
LM10C	350p
LM301A	27p
LM307	45p
LM308	45p
LM310	120p
LM318	150p
LM319	225p
LM324	30p
LM334Z	100p
LM335Z	140p
LM339	50p
LM348	75p
LM358P	60p
LM377	175p
LM380	75p
LM381AN	180p
LM382	120p
LM384	140p
5LM386	90p
LM387	120p
LM389	95p

LM391	150p
LM393	100p
LM394	300p
LM709	36p
LM710	50p
LM711	70p
LM723	35p
LM733	70p
LM741	18p
LM747	70p
LM748	35p
LM1014	150p
LM1801	300p
LM2917	200p
LM3302	90p
LM3900	60p
LM3909	95p
LM3911	130p
LM3914	200p
LM3915	200p
LM3916	225p
LM13600	110p
M51513L	300p
M51516L	500p
MB3712	250p
MB3730	400p
MC1310P	150p
MC1445	325p
MC1458	36p
MC1495L	350p
MC1496	70p
MC3340P	120p
MC3403	75p
MK50938	750p
ML920	800p
MM57160	620p
MN6221A	600p
NE531	150p
NE555	20p
NE556	50p
NE564	420p
NE565	130p
NE566	155p
NE567	140p
NE570	375p
NE571	375p
NE5534A	125p
PLL02A	500p
RC4136	60p
RC4151	200p
S566B	260p
SAD102A	1250p
SFF96364	800p
SL490	350p
SN76477	500p
SN76488	500p
SN76495	500p
SP8515	750p
TA7120	200p
TA7204	250p
TA7205	250p
TA7222	200p
TA7310	200p
TBA651	200p
TBA800	90p
TBA810	100p
TBA820	90p
TBA950	300p
TCA220	350p
TCA940	175p
TDA1004A	300p
TDA1008	320p
TDA1010	225p
TDA1022	520p
TDA1024	120p
TDA1034B	250p
TDA1170	300p
TDA2002V	325p
TDA2006	300p
TDA2020	320p
TL061CP	40p
TL062	60p
TL064	95p
TL071/81	25p
TL072/82	45p
TL074	100p
TL084	90p
TL094	200p
TL170	50p

TL430C	70p
UA2240	150p
UAA170	170p
UDN6118	320p
UDN6184	320p
ULN2003	100p
ULN2004	75p
ULN2068	290p
ULN2802	200p
UPC575	400p
UPC592H	200p
UPC1156H	300p
XR2206	300p
XR2207	400p
XR2211	600p
XR2216	675p
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MC3446	300p
MC3480	850p
MC3486	500p
MC3487	300p
MC4024	325p
MC4044	325p
MC14412	900p
ULN2003A	100p
ULN2004A	100p
75107	90p
75110/12	160p
75114/15	160p
75121/22	140p
75150P	120p
75154	140p
75182	90p
75324	375p
75361	150p
75363	150p
75365	150p
75451/2	72p
75453/4	72p
75491/2	65p
8T26	120p
8T28	120p
8T95/96	90p
8T97/98	90p
81LS95	90p
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81LS97	90p
81LS98	90p
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BC179	18p
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BC184	11p
BC187	30p
BC212/3	11p
BC214	12p
BC237	15p
BC327	16p
BC337	16p
BC338	18p
BC461	25p
BC477/8	30p
BC516/7	40p
BC547B	16p
BC548C	9p
BC549C	18p
BC557KB	18p
BC559C	18p
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BCY71	22p
BD131/2	75p
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BD139	40p
BD140	40p
BD189	60p
BD232	95p
BD233	75p
BD235	85p
BD241	60p
BD242	60p
BD677	40p
BF244B	35p
BF256B	50p
BF257/8	32p
BF337	30p
BFR39	25p
BFR40/1	25p
BFR79	25p
BFR80/1	25p
BFR96	180p
BFX29	40p
BFX30	27p
BFX84/5	40p
BFX86/7	27p
BFX88	30p
BFX89	180p
BFY50	24p
BFY51/2	24p
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MPSA13	50p
MPSA20	60p
MPSA42	50p
MPSA43	50p
MPSA56	32p
MPSA70	50p
MPSA93	40p
MPSU06	63p
MPSU07	60p
MPSU45	90p
MPSU65	78p
TIP29A	35p
TIP29C	40p
TIP30A	35p
TIP30C	40p
TIP31A	40p
TIP31C	45p
TIP32A	40p
TIP32C	45p
TIP33A	70p
TIP33C	80p
TIP34A	90p
TIP34C	120p
TIP35A	120p
TIP35C	140p
TIP36A	140p
TIP36C	150p
TIP41A	50p
TIP41C	55p
TIP42A	60p
TIP42C	65p
TIP54	160p
TIP120	70p
TIP121	75p
TIP122	75p
TIP142	110p
TIP147	120p
TIP2955	70p
TIP4055	70p
TIS93	30p
ZTX108	12p
ZTX300	13p
ZTX452	15p
ZTX500	15p
ZTX502	16p
ZTX504	30p
ZTX552	55p
ZTX652	60p
ZTX752	60p
VN10KM	60p
VN66	80p
2N697	25p
2N698	45p
2N706A	30p
2N708	30p
2N918	45p
2N930	18p
2N1131/2	20p
2N1613	25p
2N1711	25p
2N2102	70p
2N2160	350p
2N2219A	25p
2N2222A	25p
2N2369A	25p
2N2484	30p
2N2646	45p
2N2904/5	30p
2N2906A	30p
2N2907A	30p
2N2926	9p
2N3053	30p
2N3054	65p
2N3055	45p
2N3442	140p
2N3553	240p
2N3584	250p
2N3643/4	48p

2N3702/3	12p
2N3794/5	12p
2N3796/7	14p
2N3708/9	12p
2N3773	225p
2N3819	25p
2N3820	40p
2N3823	50p
2N3866	90p
2N3902	700p
2N3903/4	18p
2N3905/6	20p
2N4037	65p
2N4123/4	27p
2N4125/6	27p
2N4401/3	27p
2N4427	90p
2N4871	60p
2N5087	27p
2N5089	27p
2N5172	27p
2N5191	90p
2N5194	90p
2N5245	40p
2N5298	65p
2N5401	60p
2N5457/8	30p
2N5459	40p
2N5460	60p
2N5485	40p
2N5875	250p
2N6027	48p
2N6052	300p
2N6059	325p
2N6107	65p
2N6247	190p
2N6254	130p
2N6290	65p
2SC1172	150p
2SC1306	150p
2SC1307	150p
2SC1957	90p
2SC1969	225p
2SC2028	120p
2SC2029	250p
2SC2078	200p
2SC2335	250p
2SC2612	250p
3N128	120p
3N140	120p
3N141	110p
3N201	110p
3N204	120p
40290	260p
40361/2	75p
40408	90p
40409	100p
40410	100p
40411	300p
40594	120p
40595	120p
40673	75p
40871/2	100p

DIODES	
BY127	12p
BYX36.300	20p
OA47	8p
OA90/91	9p
OA95	9p
OA200	9p
OA202	10p
1N914	4p
1N916	7p
1N4148	4p
1N4001/2	5p
1N4003/4	6p
1N4005	6p
1N4006/7	7p
1N5401/3	14p
1N5404/7	19p
1S920	9p

BRIDGE RECTIFIERS	
1A 50V	19p
1A 100V	20p
1A 400V	25p
1A 600V	30p
2A 50V	30p
2A 100V	35p
2A 400V	45p
3A 200V	60p
3A 600V	72p
4A 100V	95p
4A 400V	100p
6A 50V	80p
6A 100V	100p
6A 400V	120p
10A 400V	200p
25A 400V	400p

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

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

THYRISTORS	
3A 400V	45p
8A 600V	140p
12A 400V	160p
16A 100V	180p
16A 400V	225p
BT106	110p
C106D	45p
MCR101	36p
TIC44	27p
2N3525	130p
2N4444	140p
2N5060	34p
2N5064	40p

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Push to break (Black) 18p
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Square PCB Switch 65p

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ORP61	120p
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OPTO-ISOLATORS	
ILD74	130p
MCT26	100p
MCS2400	190p
ILQ74	240p
TIL111	70p
TIL112	70p
TIL113	70p
TIL116	70p

LEDS 0.125"	
TIL32	55p
TIL209 Red	9p
TIL211 Gr	12p
TIL212 Ye	14p
TIL216 Red	18p

0.2"	
TIL220 Red	10p
TIL222 Gr	12p
TIL228 Yel	14p
Rectangular LEDs (R, G, Y)	30p
NSB5881	570p
TIL311	600p
TIL312/3	110p
TIL321/2	130p
TIL330	140p
7750/60	200p

DISPLAYS	
3015F	200p
DL704	140p
DL707 Red	140p
FND357	120p
FND500	90p
FND507	90p
MAN3640	175p
MAN4640	200p

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

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

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20 pin	60p
22 pin	65p
24 pin	70p
28 pin	80p
40 pin	100p

VOLTAGE REGULATORS
FIXED PLASTIC

1A	+ve		-ve	
5V 1A	7805	45p	7905	50p
12V 1A	7812	50p	7912	55p
15V 1A	7815	50p	7915	50p
18V 1A	7818	55p	7918	60p
24V 1A	7824	55p	7924	60p
5V 100mA	78L05	30p	79L05	60p
12V 100mA	78L12	30p	79L12	60p
15V 100mA	78L15	30p	79L15	60p

OTHER REGULATORS			
LM309K 1A 5V	135p	78HGKC	600p
LM317K	325p	78HO5KC	550p
LM317T 1A Adj	140p	78MGT2C	140p
LM337T	225p	78GUIC	200p
LM323K 3A 5V	500p	79GUIC	225p
LM723 150mA Adj	37p	79HGKC	700p
TL494	400p	TL497	300p
78S40	300p	LM305AH	250p

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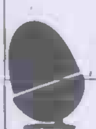

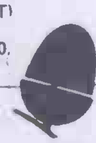

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(1) Including ferrites, RF chokes etc.
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(3) Other than optoelectronic.
(4) Access and Barclaycard, where marked.
(5) See company listing.
(6) In pence unless otherwise noted. N = NIL (no charge).

	RESISTORS	CAPACITORS	POTENTIOMETERS	TRANSFORMERS	INDUCTORS (1)	DIODES, SCRs TRIACS	TRANSISTORS (2)	LINEAR ICs	DIGITAL ICs	LINEAR MSI/LSI	DIGITAL MSI/LSI	OPTOELECTRONICS	VALVES	RELAYS	SWITCHES	FUSES AND PROTECTION	BATTERIES AND PSUs	ANALOGUE PANEL METERS	TRANSDUCERS (3)	PCB HARDWARE
COLLECTIVE COMPONENTS	■	■				■	■	■	■	■	■	■				■				
CRICKEWOOD ELECTRONIC	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■
CRIMSON COMPONENTS	■	■	■	■		■	■	■	■	■	■	■		■	■	■	■	■		
CRIMSON ELECTRIK		■	■	■			■										■			■
CRP ELECTRONICS	■	■				■	■	■	■	■	■	■		■	■		■	■		
CVS ENTERPRISES				■	■									■	■		■			
DAMON ELECTRONICS	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■
D.J. ELECTRONICS	■	■	■	■	■	■	■	■	■	■	■	■		■	■	■	■	■		■
EAST CORNWALL	■	■	■	■	■	■	■	■	■	■	■	■	■		■	■	■	■		■
ELECTRONIC HOBBIES								■	■	■	■	■								■
ELECTRONIC SURPLUS																				
ELECTRONICS WORLD	■	■	■	■	■	■	■	■	■			■		■	■	■	■	■	■	■
ELECTRONI — KIT																				
ELECTROTECH	■	■	■	■	■	■	■	■	■	■	■	■		■	■	■	■	■	■	■
ELECTROVALUE LTD.	■	■	■	■	■	■	■	■	■	■	■	■		■	■	■	■	■	■	■
ENFIELD ELECTRONICS	■	■	■	■	■	■	■	■	■			■	■	■	■	■	■	■	■	■
ETESON ELECTRONICS	■	■	■	■	■	■	■	■	■			■	■	■	■	■	■	■	■	■
GLOBAL SPECIALITIES																				
GODDARDS COMPONENTS	■	■	■	■	■	■	■	■	■			■	■	■	■	■	■	■		■
GREENBANK ELECTRONICS	■	■							■		■									■

NOTES:
(1) Including ferrites, RF chokes etc.
(2) Discrete devices.
(3) Other than optoelectronic.
(4) Access and Barclaycard, where marked.
(5) See company listing.
(6) In pence unless otherwise noted.
N = NIL (no charge).

PLUGS AND SOCKETS	ENCLOSURES, CASES	HEATSINKS	KNOBS, MISC. HARDWARE	CABLE AND WIRE	BREADBOARDS	TOOLS	PCBs and/or MATERIALS	CHEMICALS	CUSTOM KITS, MODULES	SURPLUS SUPPLIES	BARGAIN PACKS	BOOKS	CATALOGUE/PRICE LIST	MAIL ORDER MINIMUM (6)	P&P (6)	OVERSEAS ORDERS	CREDIT CARDS (4)	SHOPS	OTHER	
●													●	£5	(5)	●				COLLECTIVE COMPONENTS
●	●	●	●	●	●	●	●	●	●			●	●	N	70	●	(5)	●	●	CRICKLEWOOD ELECTRONIC
●	●	●	●	●										N	20	●	(5)			CRIMSON COMPONENTS
●	●	●	●						●				●	£3	(5)	●	●	●		CRIMSON ELECTRIK
●							●						●	N	(5)	●				CRP ELECTRONICS
		●					●		●	●				£5	●	●		●	●	CVS ENTERPRISES
●	●	●	●	●	●	●	●	●	●	●	●	●		£1	(5)		●	●	●	DAMON ELECTRONICS
●	●	●	●	●	●	●	●		●		●	●		(5)				●		D.J. ELECTRONICS
●	●	●	●	●	●	●					●		●	N	30	●		●	●	EAST CORNWALL
			●		●	●	●	●	●				●				(5)			ELECTRONIC HOBBIES
							●			●	●		●	£1	N			●		ELECTRONIC SURPLUS
●	●	●	●	●	●	●	●		●	●	●		●	N	50	●		●		ELECTRONICS WORLD
									●				●		(5)	●	●			ELECTRONI — KIT
●	●	●	●	●	●	●	●	●		●	●	●	●	£5	(5)	●	●	●		ELECTROTECH
●	●	●	●	●	●	●	●	●			●	●	●	1	(5)	●	●	●	●	ELECTROVALUE LTD.
●	●	●	●	●	●	●	●	●	●	●	●	●		50	(5)	●	●	●		ENFIELD ELECTRONICS
●	●	●	●	●	●	●	●	●				●	●	N	35			●		ETESON ELECTRONICS
	●				●								●	N	(5)	●	(5)	●	●	GLOBAL SPECIALITIES
●	●	●	●	●	●	●	●		●	●	●	●					●	●	●	GODDARDS COMPONENTS
●	●								●			●	●	2	50	●	●	●	●	GREENBANK ELECTRONICS

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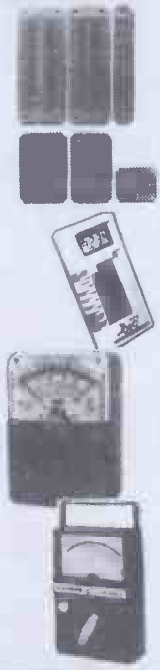

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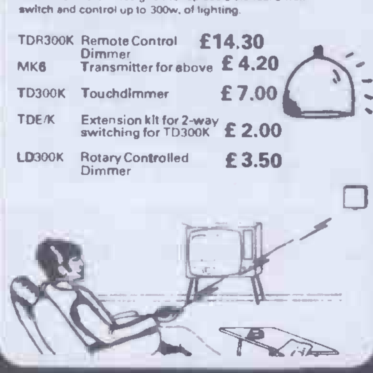

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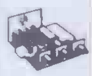

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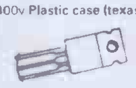

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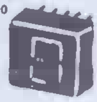

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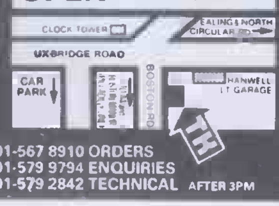

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Component pack **£29.64** less battery.

ADVENTURES WITH ELECTRONICS

by Tom Duncan

An easy to follow book suitable for all ages. Ideal for beginners. No soldering, uses an S-Dec breadboard. Gives clear instructions with lots of pictures. 16 projects—including three radios, siren, metronome, organ, intercom, timer, etc. Helps you learn about electronic components and how circuits work. Component pack includes an S-Dec breadboard and all the components for the projects.
Adventures with Electronics £2.40. Component pack **£18.98** less battery.

ADVENTURES WITH DIGITAL ELECTRONICS

New book by Tom Duncan in the popular 'Adventures' series. This book of entertaining and instructive projects is designed for hobbyists, and students. It provides a stepping stone to the microprocessor.
The first part deals with the properties of some basic ICs used in digital electronics.
The second part gives details of how to build eight devices — shooting gallery, 2 way traffic lights, electronic adder, computer space invaders game etc.
For each project there is an explanation of 'how it works' and also suggestions for 'things to try'.
No soldering — all circuits built on 2 Bimboard 1 breadboards.
Adventures with Digital Electronics book £3.25. Component pack £42.50 ref EHDC. All the components needed including 2 breadboards and hexadecimal keyboard. Available less breadboards £29.98 ref EHDF. Both less battery.

NOTES:
(1) Including ferrites, RF chokes etc.
(2) Discrete devices.
(3) Other than optoelectronic.
(4) Access and Barclaycard, where marked.
(5) See company listing.
(6) In pence unless otherwise noted. N = NIL (no charge).

	RESISTORS	CAPACITORS	POTENTIOMETERS	TRANSFORMERS	INDUCTORS (1)	DIODES, SCRs TRIACS	TRANSISTORS (2)	LINEAR ICs	DIGITAL ICs	LINEAR MSI/LSI	DIGITAL MSI/LSI	OPTOELECTRONICS	VALVES	RELAYS	SWITCHES	FUSES AND PROTECTION	BATTERIES AND PSUs	ANALOGUE PANEL METERS	TRANSDUCERS (3)	PCB HARDWARE
GREENWAY	■	■	■	■		■	■	■	■	■	■	■		■	■	■	■			■
GREENWELD	■	■	■	■	■	■	■	■	■	■	■	■		■	■	■	■	■	■	■
HART ELECTRONIC KITS	■	■	■	■	■		■	■							■	■		■		■
HEMMINGS ELECTRONICS	■	■	■	■	■	■	■	■	■	■	■	■		■	■	■		■		■
HENRYS RADIO	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■
ILP			■	■				■									■			
INTEL ELECTRONICS	■	■	■		■	■	■	■	■	■	■	■	■	■	■					
LANGREX SUPPLIES						■	■		■			■	■							
L.B. ELECTRONICS	■	■	■	■		■	■	■	■	■	■	■		■	■	■	■			
LIGHTNING ELECTRONICS	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■		■	■	■
MAGENTA ELECTRONICS	■	■	■	■	■	■	■	■	■	■	■	■		■	■	■	■	■	■	■
MAPLIN	■	■	■	■	■	■	■	■	■	■	■	■		■	■	■	■	■	■	■
MARCO TRADING	■	■	■	■	■	■	■	■	■			■	■		■	■	■	■		■
MARSHALL'S (LONDON)	■	■	■	■		■	■	■	■	■	■	■		■	■	■	■	■		■
BRADLEY MARSHALL	■	■	■	■	■	■	■	■	■	■	■	■			■	■	■	■		■
MICRO-TIMES								■												
MIDWICH COMPUTER CO								■	■	■	■									
MODULAR ELECTRONICS		■			■		■		■					■						
MS COMPONENTS LTD	■	■	■	■		■	■	■	■	■	■	■		■	■	■	■	■		■
MYERS ELECTRONICS	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■		■	■

	PLUGS AND SOCKETS	ENCLOSURES, CASES	HEATSINKS	KNOBS, MISC. HARDWARE	CABLE AND WIRE	BREADBOARDS	TOOLS	PCBs and/or MATERIALS	CHEMICALS	CUSTOM KITS, MODULES	SURPLUS SUPPLIES	BARGAIN PACKS	BOOKS	CATALOGUE/PRICE LIST	MAIL ORDER MINIMUM (6)	P&P (6)	OVERSEAS ORDERS	CREDIT CARDS (4)	SHOPS	OTHER
GREENWAY	●	●	●	●								●		●	£2	50	●			
GREENWELD	●	●	●	●	●	●	●	●	●	●	●	●	●	●	£1	50	(5)		●	●
HART ELECTRONIC KITS	●	●	●	●			●	●		●				●	N	(5)	●	●	●	●
HEMMINGS ELECTRONICS	●	●	●	●	●	●	●	●					●	●	N	(5)	●	●	●	●
HENRYS RADIO	●	●	●	●	●	●	●	●	●	●	●	●	●	●	N	(5)	●	●	●	●
ILP		●	●							●				●	90	(5)	●	●	(5)	●
INTEL ELECTRONICS	●			●	●		●							●	N	(5)	●			
LANGREX SUPPLIES													●	●	£1	50	●			
L.B. ELECTRONICS	●		●	●	●		●	●			●			●	N	(5)	●	●		
LIGHTNING ELECTRONICS	●	●	●	●	●	●	●	●	●	●	●	●	●	●	N	(5)	●	●	●	●
MAGENTA ELECTRONICS	●	●	●	●	●	●	●	●	●	●			●	●	N	45	●	(5)		
MAPLIN	●	●	●	●	●	●	●	●	●	●			●	●	(5)	(5)	●	●	●	●
MARCO TRADING	●	●	●	●	●		●				●	●		●	N	35	●		●	●
MARSHALL'S (LONDON)	●	●	●	●	●	●	●	●		●			●		N	60	●	(5)	●	●
BRADLEY MARSHALL	●	●	●	●	●	●	●	●	●	●		●	●		£1	40	●	(5)	●	●
MICRO-TIMES						●	●			●				●	N	50	●	●		
MIDWICH COMPUTER CO	●													●	N	(5)	●	●		●
MODULAR ELECTRONICS	●		●							●				●	175	50	●	●	●	●
MS COMPONENTS LTD	●	●	●	●	●	●	●	●	●					●	N	N	●	●		●
MYERS ELECTRONICS	●	●	●	●	●	●	●	●	●		●	●	●	●	£3	60	●		●	

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(1) Including ferrites, RF chokes etc.
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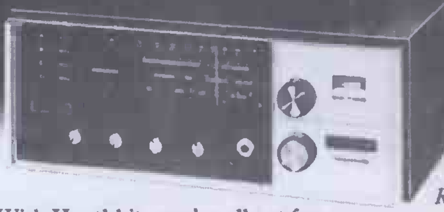
N = NIL (no charge).

Beginners' luck

30% OFF 10 selected kits for first-time builders



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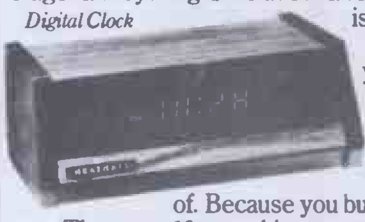

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Follow the steps and you'll end up with a hand-crafted, well-designed piece of equipment. One you'll be proud of. Because you built it yourself.

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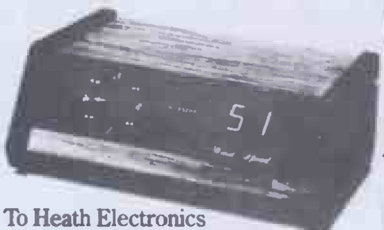
Metal Locator



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

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

RANGES
DC Voltage 0-200mV.
0-2-20-200-1000V. Acc: 0.8%
AC Voltage 0-200-1000V
Acc. 1.2% DC Current 0-200uA.
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Resistance 0-2-20-200K ohms.
0-2 Megohms. Acc. 1%
BI-PAK VERY LOWEST POSS PRICE
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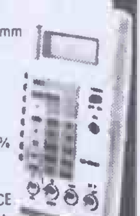

25 pieces of Audio Plugs, Sockets and Connectors to include DIN 180°-240° Inline 3-6 Pin, Speakers, Phono, Jack Stereo and Mono etc Valued at well over £3 normal Order No. SX25.
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SX30A	50 High Voltage Disc Ceramics 750v min up to 8KV Assorted useful values	£1.00
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SX42	20 small .125 Red LED's	£1
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£2.50

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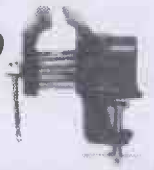
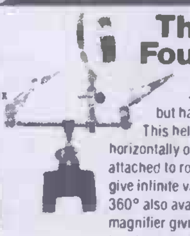


The Third and Fourth Hand...



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SX53 1 Power finned Heatsink. This heatsink gives the greatest possible heat dissipation in the smallest space owing to its unique staggered fin design, pre drilled.
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NPN like 2N3055 — but not full spec
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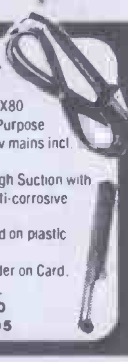

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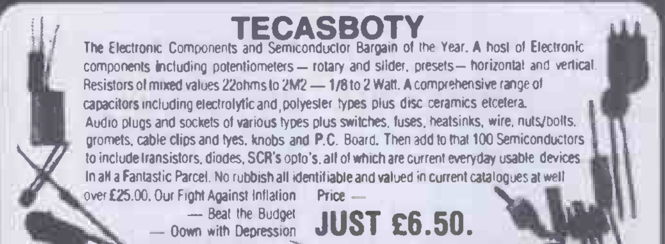

SX38	100 Silicon NPN Transistors—all perfect Coded mixed types with data and eqvt sheet. No rejects. Real value.	£3.00
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NOTES:
(1) Including ferrites, RF chokes etc.
(2) Discrete devices.
(3) Other than optoelectronic.
(4) Access and Barclaycard, where marked.
(5) See company listing.
(6) In pence unless otherwise noted. N = NIL (no charge).

	RESISTORS	CAPACITORS	POTENTIOMETERS	TRANSFORMERS	INDUCTORS (1)	DIODES, SCRs TRIACS	TRANSISTORS (2)	LINEAR ICs	DIGITAL ICs	LINEAR MSI/LSI	DIGITAL MSI/LSI	OPTOELECTRONICS	VALVES	RELAYS	SWITCHES	FUSES AND PROTECTION	BATTERIES AND PSUs	ANALOGUE PANEL METERS	TRANSDUCERS (3)	PCB HARDWARE
NAMAL ASSOCIATES										■	■									
PARNDON ELECTRONICS	■														■					
P.A.T.H.	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■		■		■
PC ELECTRONICS	■	■	■			■	■	■	■			■		■	■	■				
PEATS ELECTRONICS	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■		■
PM COMPONENTS	■						■	■				■	■			■	■			■
T. POWELL	■	■	■	■	■	■	■	■	■	■	■	■		■	■	■				
RAPID ELECTRONICS	■	■	■	■	■	■	■	■	■	■	■	■		■	■	■		■	■	■
BRIAN J. REED	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■
RELAY-A-QUIP						■								■	■					
RISCOMP LIMITED	■	■	■	■	■	■	■	■	■			■		■	■	■	■	■	■	■
ROADRUNNER PRODUCTS																				■
SAMSONS ELECTRONICS		■		■	■	■								■	■	■	■	■		
SUMMIT ELECTRONICS	■	■		■	■	■	■	■	■	■	■	■	■							
SWIFT-SASCO LTD	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■				
TECHNOMATIC				■		■	■	■	■	■	■	■		■	■					■
TENNCO EXIM														■	■					■
THAMES VALLEY	■	■				■	■	■	■	■	■	■			■	■				
TITAN TRANSFORMERS				■													■			
TK ELECTRONICS	■	■	■	■	■	■	■	■	■	■	■	■		■	■	■	■	■	■	■

NOTES:
(1) Including ferrites, RF chokes etc.
(2) Discrete devices.
(3) Other than optoelectronic.
(4) Access and Barclaycard, where marked.
(5) See company listing.
(6) In pence unless otherwise noted.
N = NIL (no charge).

Company	PLUGS AND SOCKETS	ENCLOSURES, CASES	HEATSINKS	KNOBS, MISC. HARDWARE	CABLE AND WIRE	BREADBOARDS	TOOLS	PCBs and/or MATERIALS	CHEMICALS	CUSTOM KITS, MODULES	SURPLUS SUPPLIES	BARGAIN PACKS	BOOKS	CATALOGUE/PRICE LIST	MAIL ORDER MINIMUM (6)	P&P (6)	OVERSEAS ORDERS	CREDIT CARDS (4)	SHOPS	OTHER
NAMAL ASSOCIATES	■							■						■	£10	£1	■	(5)	■	■
PARNDON ELECTRONICS	■		■									■		■	£1	N	■			
P.A.T.H.	■	■	■	■	■	■	■	■	■		■	■	■	■	N	80	■	■	■	
PC ELECTRONICS														■	£10	£1	■			
PEATS ELECTRONICS	■			■	■		■						■			50	■	■		
PM COMPONENTS				■					■				■	■	N	50	■	■		■
T. POWELL										■		■	■	■	£1	50	■	■	■	
RAPID ELECTRONICS	■	■	■	■	■	■	■	■	■					■	1	(5)	■	■	■	
BRIAN J. REED	■	■	■	■	■		■	■			■	■	■	■	(5)	(5)	■		■	■
RELAY-A-QUIP		■	■				■							■	N	(5)	■	■	■	
RISCOMP LIMITED	■	■	■	■	■	■	■	■	■	■			■	■	N	50	■	(5)	■	■
ROADRUNNER PRODUCTS	■	■		■	■	■	■	■		■				■	(5)	(5)	■	(5)		■
SAMSONS ELECTRONICS			■		■						■	■			£2	■	■		■	■
SUMMIT ELECTRONICS														■	N	40	■			
SWIFT-SASCO LTD	■	■	■	■	■			■					■	■	25	£2				
TECHNOMATIC	■	■				■		■		■				■	N	40	■	■	■	■
TENNCO EXIM	■			■	■										£10	£1	■			■
THAMES VALLEY												■	■	■	N	45			■	
TITAN TRANSFORMERS														■			■			■
TK ELECTRONICS	■	■	■	■	■	■	■	■	■	■			■	■	N	55	■	■	■	

MIDWICH HAS MOVED!
OUR PRICES HAVE TOO — DOWN!

In order to maintain our standard of service and house our ever growing range of stock, we've moved to larger premises. You can still use our old telephone number for a limited period, but please make a note of our new one and our address.
To celebrate the move we have reduced our prices still further. We know this will displease our competitors, but we'd rather please our customers.
NB - NO SURCHARGE ON CREDIT CARD ORDERS.
Be happy — move with Midwich. And remember, we always try to give you the best deal and the best service. If we fail just let us know — we will always try to make amends.

MEMORIES ** NEW LOWER PRICES **

*2114 Low Power 200ns	0.80	*2732 350ns	4.40	*4164 200ns (TI)	4.65
*2716 450ns (5V)	2.10	*2532 450ns	3.60	*4816/4516 100ns	3.25
*2716 350ns (5V)	3.50	*4116 200ns	0.70	*5516 200ns	9.38
*2716 450ns (3 rail)	5.95	*4116 150ns	1.10	*6116P3 150ns	4.30
*2732 450ns	3.90	*4118 150ns	3.38	*6116LP3 150ns	5.75

BBC MICRO UPGRADE KITS ** NEW LOWER PRICES **

BBC1	4516/4816 × 8 100ns	25.50
BBC2	Printer/User I/O kit (IC69,70 + PL9,10)	8.00
BBC4	Analogue input kit (IC73, 77 + SK6)	6.70
BBC5	Serial I/O and RGB kit (IC74,75 + SK3,4)	11.45
BBC6	Expansion bus and tube kit (IC71, 72, 76 + PL11, 12)	8.25
BBC21	Printer cable complete	13.00
BBC22	Connector for user port with 36" cable	2.00
BBC44		
BBC55	Analogue Input plug with cover	2.25
	5 and 6 pin DIN plugs for	0.99
BBC66	Serial I/O and RGB input	
	Connector for bus port with cable	3.50

MOST KITS ARE NOW EX-STOCK!

**** We've done it again! Massive price reductions on LPS and CMOS ****

Device	Price
Z80 FAMILY	
*Z80CPU	3.15
*Z80ACPU	3.50
*Z80CTC	2.75
*Z80ACTC	2.95
*Z80ADART	5.70
*Z80ADMA	11.95
*Z80PIO	2.75
*Z80APIO	2.95
*Z80ASIO-0	11.99
*Z80ASIO-1	11.99
*Z80ASIO-2	11.99
*MK3886	11.00
*MK3886-4	14.47
6800 FAMILY	
*6800	2.99
*6802	3.49
*6803C	12.10
*6809	8.45
*6810	1.12
*6821	1.20
*6840	3.95
*6845	6.75
*6850	1.40
*6880	1.07
*6887	0.80
*68488	9.11
*6875	5.62
*6843	13.99
*68B00	6.30
*68B02	19.11
*68B21	2.29
*68B10	2.00
*68B40	4.70
*68B50	2.86
6500 FAMILY	
*6502	3.45
*6520	2.99
*6522	3.19
*6532	5.95
8080 FAMILY	
*8085A	4.40
*8212	1.55
*8216	0.60
*8251	3.10
*8255	2.95
BUFFERS	
81LS95	0.90
81LS97	0.90
81LS97	0.90
81LS98	0.90
8T26A	1.20
8T28A	1.20
8T95	1.35
8T97A	1.35
8T98	1.45
DATA CONVERTERS	
*ZN425	3.45
*ZN427	5.99
*ZN428	4.75
*ZN432	13.00
*ZN433	25.90
*ZN447/8/9	POA
*UPD7002	4.35
FLOPPY DISC CONTROLLERS	
*FD1771	17.12

Device	Price
*WD1391 KIT	45.50
*WD1393 KIT	45.50
*WD1395 KIT	45.50
*WD1397 KIT	45.50
(KITS INCLUDE FD179X + WD2143 + WD1691)	
MISC SUPPORT CHIPS	
*AY3-1015	2.99
*AY3-1270	7.95
*AY3-8910	5.99
*AY5-1013	2.99
*AY5-3600	7.95
*AY5-2376	5.99
*DP8304	4.50
*MC1488	0.55
*MC1489	0.55
*MC3446	2.95
*MC3448A	4.25
*MC3480	7.95
*MC3487	2.95
*MC14411	6.94
*MC14412	7.99
*R03-2513L	6.99
*R03-2513U	5.99
DVM CHIPS	
*ZN450E	7.61
*ZN450 KIT	17.35
LINEARS	
LM301AN	0.25
LM308N	0.89
LM311N	0.69
LM319N	2.14
LM324N	0.30
LM348N	0.59
LM555N	0.16
LM556CN	0.45
LM741 (8 PIN)	0.14
LM747CN	0.64
LM748(8 PIN)	0.34
LM725CN	3.20
REGULATORS	
7805	0.39
7812	0.39
7815	0.39
78L05	0.29
78L12	0.29
78L15	0.29
7905	0.55
7912	0.55
7915	0.55
LM309K	0.99
LM317K	3.20
LM323K	4.95
LM338K	POA
UHF MODULATORS	
6MHZ(UM1111)	3.70
8MHZ(UM1233)	4.40

Device	Price
CRYSTALS	
1MHZ	2.90
1 008MHZ	2.90
1 8432MHZ	2.20
3.6864MHZ	2.95
4MHZ	1.45
6MHZ	1.45
8MHZ	1.70
CMOS 4000'B' SERIES	
4001	0.10
4001	0.10
4002	0.12
4007	0.15
4011	0.11
4012	0.15
4013	0.24
4015	0.49
4016	0.19
4017	0.37
4020	0.49
4023	0.15
4024	0.31
4025	0.16
4027	0.23
4028	0.49
4040	0.49
4042	0.44
4046	0.64
4047	0.49
4049	0.24
4050	0.24
4051	0.44
4052	0.59
4060	0.59
4066	0.29
4069	0.15
4070	0.14
4071	0.14
4073	0.14
4075	0.14
4081	0.15
4093	0.25
4508	1.29
4511	0.44
4512	0.49
4518	0.39
4520	0.49
4526	0.69
4528	0.69
4541	0.99
4543	0.79
NB. Other devices available	
74LS SERIES	
00	0.10
01	0.11
02	0.11
03	0.11
04	0.11
05	0.11
08	0.11

Device	Price
09	0.11
10	0.11
12	0.11
13	0.15
14	0.33
15	0.12
20	0.12
21	0.12
26	0.12
27	0.12
28	0.12
30	0.12
32	0.12
37	0.12
38	0.12
40	0.12
42	0.27
47	0.34
51	0.14
54	0.14
74	0.16
75	0.19
76	0.17
83	0.34
85	0.51
86	0.15
90	0.28
92	0.31
93	0.25
109	0.27
122	0.35
123	0.35
125	0.24
126	0.25
132	0.39
136	0.23
138	0.31
139	0.31
148	0.69
151	0.39
153	0.28
155	0.34
156	0.34
157	0.25
158	0.29
161	0.35
163	0.34
164	0.39
165	0.54
166	0.63
173	0.64
174	0.40
175	0.44
191	0.44
192	0.44
193	0.44
194	0.34
195	0.34
221	0.54
240	0.64
241	0.64
242	0.64
243	0.64
244	0.59

Device	Price
245	0.69
251	0.29
257	0.34
259	0.57
266	0.19
273	0.59
279	0.59
283	0.39
365	0.29
366	0.29
367	0.29
368	0.39
373	0.59
374	0.64
377	0.69
390	0.49
393	0.44

DIL sockets low profile

Pins	Tin	Gold	W/W
8	7	22	25
14	9	29	35
16	9	31	35
18	13	33	52
20	14	35	60
22	17	40	70
24	19	42	70
28	25	54	80
40	29	81	99

Device	Price
DIL JUMPERS Single ended 24"	
14 PIN	1.40
16 PIN	1.60
24 PIN	2.35
40 PIN	3.25
Double Ended 6"	
14 PIN	1.90
16 PIN	2.05
24 PIN	3.10
40 PIN	4.85
Double Ended 12"	
14 PIN	2.00
16 PIN	2.15
24 PIN	3.25
40 PIN	5.10
Double Ended 18"	
14 PIN	2.05
16 PIN	2.25
24 PIN	3.40
40 PIN	5.25
ZERO INSERTION FORCE SOCKETS	
24 PIN	5.95
28 PIN	7.40
40 PIN	8.60
25 WAY 'D' CONNECTORS	
MALE-MALE (36" CABLE)	10.15
MALE-FEMALE (36" CABLE)	10.13
MALE S ENDED (18" CABLE)	5.83
FEMALE S ENDED (18" CABLE)	6.25

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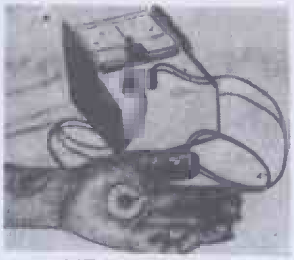
Dept HE, Rickinghall House, Rickinghall, Suffolk IP22 1HH
Telephone (0379) DISS 898751

Please make a note of our new address & telephone number

GREENWELD

443F Millbrook Road, Southampton SO1 0HX



LIE DETECTOR

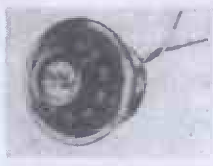
Not a toy, this precision instrument was originally part of an "Open University" course, used to measure a change in emotional balance, or as a lie detector. Full details of how to use it are given, and a circuit diagram. Supplied complete with probes, leads and conductive jelly. Needs 2 4½ batts. Overall size 155 × 100 × 100mm. Only £7.95 — worth that for the case and meter alone!!

DEVELOPMENT PACKS

These packs of brand new top quality components are designed to give the constructor a complete range so the right value is to hand whenever required. They also give a substantial saving over buying individual parts
K001. 50V ceramic plate capacitors, 5%, 10 of each value 22pF to 1,000pF, total 210. **£4.80.**
K002 Extended range 22pF to 0.1. Values over 1000pF are of a greater tolerance. 10 of each value 22 27 33 39 47 56 68 82 100 120 150 180 220 270 330 390 470 560 680 820 1000 1500 2200 3300 4700 6800 .01 .015 .022 .033 .047 .1. **PRICE: £7.66.**
K003 C280 or similar Polyester capacitors, 10 each of the following: .01, .015, .022, .033, .047, .068, .1, .15, .22, .33 and .47μF. **PRICE: £5.40.**
K004 Mylar capacitors. Small size, vertical mounting 100V. 10 each of the following: .001, .0012, .0015, .0018, .0022, .0027, .0033, .0039, .0047, .0056, .0068, .0082, .01. Total 130 capacitors. **PRICE: £4.70.**
K007 Electrolytic capacitors 25V working small physical size axial or radial leads. 10 each of the following: 1, 2.2, 4.7, 10, 22, 47, 100μF. Total 70 capacitors. **PRICE: £3.59.**
K008 Extended range, as above, also including 220, 470 and 1000μF all at 25V. Total of 100 capacitors. **PRICE: £6.36.**
K021 CR25 resistors or similar, miniature ¼ watt carbon film 5%, as used in nearly all projects. 10 of each value from 10 ohms to 1M, E12 series. Total 610 resistors. **PRICE: £5.95.**
K041 Zener diodes 400mW 5%. 10 of each of all the values from 2V7 to 36V. Total 280 zenners. **PRICE: £15.95.**
K061 LEDs — pack of 60, comprising 10 each red, green and yellow 3mm and 5mm, together with clips. **PRICE: £8.95.**

REGULATED PSU PANEL

Exclusive Greenweld design, fully variable 0-28V & 20mA-2A. Board contains all components except pots and transformer. Only £7.75. Suitable transformer and pots £6. Send SAE for fuller details.



ELECTRO-DIAL

Electrical combination lock — for maximum security — pick proof. 1 million combinations!! Dial is turned to the right to one number, left to a second number, then right again to a third number. Only when this has been completed in the correct sequence will the electrical contacts close these can be used to operate a relay or solenoid. Overall dia. 65 × 60mm deep. Only £3.96.

PANELS

Z521 Panel with 16236 (2N3442) opn small heat sink, 2N2223 dual transistor, 2 BC108, diodes, caps, resistors, etc. 66p.
Z527 Reed, relay panel — contains 2 × 6V reeds, 6 × 2S030 or 2S230, 6 × 400V rects + Rs. 50p.
Z529 Pack of ex-computer panels containing 74 series ICs. Lots of different gates and complex logic. All ICs are marked with type no. or code for which an identification sheet is supplied. 20 ICs £1; 100 ICs £4.00.

COMPONENT PACKS

K503 150 wirewound resistors from 1W to 12W, with a good range of values £1.75.
K514 100 silver mica caps from 5pF to a few thousand pF. Tolerances from 1% to 10% £2.00.
K520 Switch pack — 20 different, rocker, slide, rotary, toggle, push, micro, etc. Only £2.00.
K517 Transistor Pack. 50 assorted full spec marked plastic devices PNP NPN RF AF. Type numbers include BC114, 117, 172, 182, 183, 198, 239, 251, 214, 255, 320, BF198, 255, 394, 2N3904 etc etc. Retail cost £7+. Special low price 275p.

5mm RED LED SCOOP

Another company gone bust — to your advantage!! We've bought all their 5mm red LED's — GI type MV5754, and offer them as follows: 25 £1.95; 100 £6.00; 250 £13.50; 1k £39.50; 5k £185. Add 30% for 2-part clip if required.

TIL302 7-SEG DISPLAY

0.27in red common anode. Only 65p

FILAMENT DISPLAYS

Z653 7 seg display, 12.5mm high. Ideal for TTL operation, taking 5V 8mA per seg. Std 14 DIL package. Only £1 each, 4 for £3.00. Data supplied.

SOLENOIDS AND RELAYS

W921 Solenoid rated 48V at 25% duty cycle, but work well on 24V (700gm pull, 10mm travel) push or pull 27 × 18 × 15mm. 55p.
W922 Mains 240V ac solenoid, 10% duty cycle, push or pull, 16mm travel. 50 × 20 × 16mm. Only £1.50.
W895 9V DC relay 500R SPCO 28 × 24 × 19 50p.
W733 11 pin plug in relay, 240V ac, 3PCO 5A contacts £2.50. Base 36p.
W838 700R 24V 4PCO "continental" relay 35 × 30 × 18mm, only 84p; 10 £7.00.
W847 37R 5-10V relay, SP 3A contact, PCB mntg 11 × 33 × 20. 95p; 10 £7.50.
W893 Omron LY4 mains relay, 4PCO 5A contacts. £2.50.
W925 5V DIL reed relay. SP make 75p.
W924 6V reed relay, 500R coil, DP break contacts 60p.
W926 24V Omron relay type G2L 113P, PCB vert mntg. 28 × 25 × 10mm. 75p.

741 OP-AMP — 12 for £1

A recent purchase of Raytheon IC's included a large quanitty of 14 DIL 741 op-amps, so take advantage while stocks last! 12 741's £1.00.

1N4007 1000V 1A RECTS

Motorola bandoliered — lowest ever price!! 100 £2.95; 300 £8.50; 1k £27; 3k £72; 10k 220.

NICAD CHARGER

Versatile unit for charging AA, C, D and PP3 batteries. Charge/test switch, LED indicators at each of the 5 charging points. Mains powered. 210 × 100 × 50 mm £7.95.

COPPER CLAD BOARD

K522 All pieces too small for our etching kits. Mostly double sided fibreglass. 250gm (approx. 110 sq ins) for just £1.00.

1,000 RESISTORS, £2.50

We've just purchased another 5 million preformed resistors, and can make a similar offer to that made two years ago, at the same price!!! K523 — 1,000 mixed ¼ and ½W 5% carbon film resistors, preformed for PCB mntg. Enormous range of preferred values 1,000 for £2.50; 5,000 £10; 20k £36.

COMPUTER BATTLESHIPS

Probably one of the most popular electronic games on the market. Unfortunately, the design makes it impractical to test the PCB as a working model, although it may well function perfectly. Instead we have tested the SN76477 sound chip & sell the board at a very low price for its component value only. Apart from the sound IC, there's a TMS100 microprocessor chip, battery clips, switches, R's, C's, etc. Boards may have slight physical damage — i.e. cracks, the odd broken switch etc. Size 160 × 140mm. Instructions and circuit 30p. The PCB as described 150p.

STARBIRD

Gives realistic engine sounds and flashing laser blasts — accelerating engine noise when module is pointed up, decelerating noise when pointed down. Press contact to see flash and hear blast of lasers shooting. PCB tested and working complete with speaker and batt clip. (needs PP3). PCB size 130 × 60mm. Only £2.95

1982/3 CATALOGUE

Bigger! Better!! Buy one!!!
Only 75p inc. post — Look what you get!!

- Vouchers worth 60p
- 1st class reply paid envelope
- Wholesale list for bulk buyers
- Bargain List with hundreds of surplus lines
- Huge range of components
- Low, low prices

Sent free to schools, colleges etc.

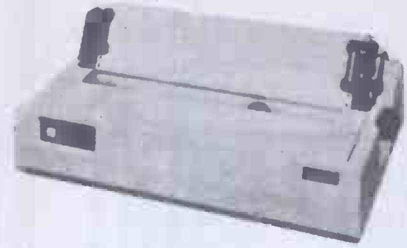
SEIKOSHA GP–100A GRAPHIC PRINTER

SPECIAL OFFER

Features: Graphics, double width char., standard char., speed CPS, selectable line spacing, adjustable paper width up to 10 inches, 80 columns, centronics compatible parallel interface. 90 day warranty.

Price £179 + VAT + £4.50 Carr.

OK1 MICROLINE PRINTERS



90 day warranty on all Microline printers (OK1)

MICROLINE 80
Features: 80 columns, 80 CPS, friction and pin feed, Unidirectional block graphics, Centronics parallel interface.
PRICE £249 + VAT + £4.50 Carr.

MICROLINE 82A
Features: 80 columns, 80 CPS, friction and pinfeed. bi-directional printing. parallel and serial (1200 bauds) interface.
PRICE £379 + VAT + £4.50 Carr.

MICROLINE 83A
Details as 82A but 120 CPS and includes tractor up to 15 inches width.
PRICE £569 + VAT + £4.50 Carr.

NEW EPSON TYPE 3 PRINTERS

MX80T-3
Features: 80 columns, 80 CPS, Bit image printing, super and sub scripts, Auto-underlining, tractor feed, 32 print fonts, Bi-directional, logic seeking, 9x9 matrix, centronics parallel interface.
PRICE £319 + VAT + £4.50 Carr.

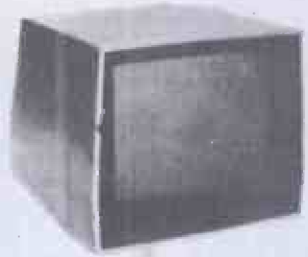
MX80 F/T–3
Features: As above but with tractor or friction paper feed.
PRICE £325 + VAT + £4.50 Carr.

MX100–3
Features: 136 columns, 100 CPS, Auto-underlining, 32 print fonts, friction or tractor paper feed, Bi-directional logic seeking, true decenders, adjustable paper width up to 15 inches, Centronics parallel interface.
PRICE £429 + VAT + £4.50 Carr.

MX82
Features: 80 CPS, plotter print, bit image printing, bi-directional printing with logic seeking.
PRICE £329 + VAT + £4.50 Carr.

MX82 F/T
PRICE £339 + VAT + £4.50 Carr.

GREEN MONITORS



SANYO PROFESSIONAL MONITOR
SM12H — Green/black 12 inches screen, 18 MHz bandwidth, removable antiglare filter, ideal for high res graphics, attractive beige case — illustrated above.
1 year warranty (SANYO)
PRICE £89 + VAT + £4.50 Carr.

BMC 12A GREEN MONITOR
12 inch green/black screen, 80 x 24 char. format, composit video input. 15 MHz bandwidth.
1 year warranty (BMC)
PRICE £69 + VAT + £4.50 Carr.

COLOUR MONITOR

BM1401 RGB COLOUR
Medium resolution RGB colour monitor, 15 MHz.
400 dots (at the centre)
40 x 25 characters, 5 x 7 dot format.
1 year warranty (BMC)
PRICE £219 + VAT + £4.50 Carr.

TOSHIBA DOUBLE SIDED/DOUBLE DENSITY 5¼" DISK DRIVES FOR THE PRICE OF A SINGLE SIDED/SINGLE DENSITY.

Industry standard interface, compatible with VIDEO GENIE, ATOM, TRS80, BBC COMPUTER, SUPER BRAIN, NASCOM, and lots of others. 3.5 MEGABITS. Unformatted storage capacity, track density 48 TPI. Daisy chain up to 4 drives.
90 day warranty.
DISK DRIVE ND-02D
£169 + VAT + £2.50 Carr.
SINGLE BOXED WITH POWER SUPPLY
£199 + VAT + £4.50 Carr.
DUAL BOXED WITH POWER SUPPLY
£369 + VAT +£4.50 Carr.
2 DRIVE CABLE
£15 + VAT + £1 Carr.

DOUBLE SIDED/DOUBLE DENSITY DISKETTES
1 – 9 £2.75 + VAT + 50p Carr.
10–49 £2.50 + VAT +£1 Carr.

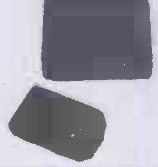
CASIO AX-210/AX-250 ANALOG AND DIGITAL WATCHES

Dual time, 12 or 24 hour option, countdown timer with memory function, chronograph with lap time, optional hourly time signal, daily alarm. 3 optional melodies or ordinary bleeper. Calendar display, lithium battery. Stainless steel brc.

THE BEST SELLING WATCH
AX-210 or AX-250 **£21 + VAT** + 50p Carr.

WATER RESISTANT ALARM/CHRONO
W20 Black resin case **£10 + VAT** + 50p Carr.
W30 Metal case **£16 + VAT** + 50p Carr.

SILENT ALARM/POCKET PAGER



This is an individually coded 4 WATTS Radio transmitter and pocket pager receiver. The alarm system has connections for door contacts and vibration sensors. 2 vibration sensors are included. It has a range of 2 miles. Ideal for protection of vehicle or property. Power requirements for transmitter is 12V dc. Not licensible in UK.
PRICE £78 + VAT + £2.95 Carr.

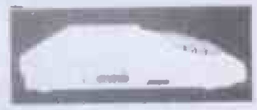
RECHARGEABLE BATTERIES

CODE	TYPE	CAPACITY	PRICE
S401	AAA	200 mAH	£1.10
S101	AA	500 mAH	£0.75
C1200	C	1200 mAH	£1.90
D1200	D	1200 mAH	£2.05
RX22	PP3	110 mAH	£3.50
BC2204	Universal Charger for AA, C,D & PP3		£9.50

Please add VAT to all above prices plus 75p Carr per order

6809 BASE MICRO COMPUTER

COMPLETE WITH 32K RAM



Extended micro soft, colour Basic parallel printer Interface. High resolution colour graphics (256 x 192) UHF or colour monitors, cassette recorder Interface and mains adapter included.

£169 + VAT + postage £4.50

AKHTER INSTRUMENTS LTD,
DEPT HE
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SOUTH ROAD, HARLOW, ESSEX. UK.
TEL: HARLOW (0279) 412639.

ORDERING INFORMATION:
Please add 15% VAT to all prices. All orders which accompany a cheque or cash are carriage free. Please add carriage for all other orders as specified on each item
WE ACCEPT BARCLAYCARD AND ACCESS

NOTES:
(1) Including ferrites, RF chokes etc.
(2) Discrete devices.
(3) Other than optoelectronic.
(4) Access and Barclaycard, where marked.
(5) See company listing.
(6) In pence unless otherwise noted. N = NIL (no charge).

	RESISTORS	CAPACITORS	POTENTIOMETERS	TRANSFORMERS	INDUCTORS	DIODES, SCRs TRIACS	TRANSISTORS (2)	LINEAR ICs	DIGITAL ICs	LINEAR MSI/LSI	DIGITAL MSI/LSI	OPTOELECTRONICS	VALVES	RELAYS	SWITCHES	FUSES AND PROTECTION	BATTERIES AND PSUs	ANALOGUE PANEL METERS	TRANSDUCERS (3)	PCB HARDWARE
A.C. TOWNLEY	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■
WATFORD ELECTRONICS	■	■	■	■	■	■	■	■	■	■	■	■		■	■	■	■	■	■	■
WILMSLOW AUDIO	■	■	■		■										■	■			■	■

DIRECTORY OF ELECTRONIC

Listing over 80 companies supplying electronic components

If the name of your favourite component supplier does not appear in these pages, please write and tell us about him.

Aitken Bros. and Co.,

35 High Bridge, Newcastle on Tyne, NE1 1EW. Tel. 0632 326729

Aitken Bros. can also supply schools, colleges and other companies, and can quote special prices for larger quantities. They also sell a good range of test equipment: analogue and digital multimeters, frequency meters, function generators, pulse generators, signal generators and oscilloscopes. Their shop is in Newcastle upon Tyne, at the above address. Post and packaging charges are 75p for orders under £10.

ACE Mailtronix Ltd.

3A, Commercial Street, Batley, West Yorks WF17 5HJ. Tel: 0924 441129.

ACE mention that they specialise in resistors, transformers, transistors, linear and digital ICs, optoelectronic devices and tools. "In addition, we specialise in 'hard to get' items. Enquiries for quotation should include an SAE".

Other items of electronic equipment include home computer monitors, PCB drafting aids (a speciality), data entry keyboards and switches, and loudspeakers. Post and packaging charges are 30p for orders under £3.

Akhter Instruments Ltd.,

Unit 19, Arlinghyde Industrial Estate, South Road, Harlow Essex. Tel. 0279 412639.

Microcomputer peripherals (floppy disc drives, monitors, printers etc.) are also carried. P&P is charged by weight.

Altek Microcomponents Ltd.,

22, Market Place, Wokingham, Berks RG11 1AP. Tel. 0734 791579.

Distributors for Mitsubishi and Sharp LSI products. Post and packaging is charged pro-rata.

Amaral Limited,

26, Highfields, Earley, Reading, Berks. Tel. 0734 864745.

P&P 50p minimum.

Ambit International,

200, North Service Road, Brentwood, Essex CM14 4SG. Tel. 0277 230909.

Specialists in inductors. ferrites etc, but, "it's all a bargain at Ambit". See for yourself at their Brentwood headquarters or at the franchised shop in Acton.

Aries Electronics Ltd,

159 Boyn Valley Road, Maidenhead, Berks SL6 4DT. Tel. 0628 37431.

"Specialists in optoelectronic devices and power diodes".

AWP Electronics Ltd.,

Dalma House, Kings Mill Lane, South Nutfield, REdhill, Surrey RH1 5ND. Tel. 073 782 3421.

AWP are specialists in coaxial and multiway plugs and sockets, ribbon and coaxial cables, crimp tools and custom made patch panels and cable assemblies.

"Whilst the majority of our business is applicable to industry, we find that the growth of electronics generally has created a need for assisting any customer, however large or small."

AWP's head office is in Surrey and they have further premises at Alva, in Scotland.

Bamber Electronics,

5, Station Road, Littleport, Cambs CB6 1QE. Tel. 0353 860185.

Specialists in surplus equipment and components, particularly for radio telephones and test equipment.

Barrie Electronics,

3, The Minories, London EC3. Tel. 01 488 3316.

Specialists in transformers; p&p charges are at cost.

Benning Cross Electronics,

67, Vicarage Road, Watford, Herts. Tel. 0923 36234.

"All brand new, full-spec components, manufacturer guaranteed". Other items stocked include test equipment, hand-held CB gear, headphones, aerials and audio tapes.

BICC-VERO Electronics Ltd.,

The Retail Department, School Close, Industrial Estate, Chandlers Ford, Hants SO5 3ZR. Tel. 04215 62829.

"The professional company with the personal touch!"

Vero are well known for their breadboarding systems, eg Verobloc and Veroboard, and their range of enclosures and cases.

Vero products are available world-wide from retail stockists and mail-order companies.

BI-PAK,

3, Baldock Street, Ware, Herts. Tel. 0920 3182.

NOTES:
(1) Including ferrites, RF chokes etc.
(2) Discrete devices.
(3) Other than optoelectronic.
(4) Access and Barclaycard, where marked.
(5) See company listing.
(6) In pence unless otherwise noted.
N = NIL (no charge).

	PLUGS AND SOCKETS	ENCLOSURES, CASES	HEATSINKS	KNOBS, MISC. HARDWARE	CABLE AND WIRE	BREADBOARDS	TOOLS	PCBs and/or MATERIALS	CHEMICALS	CUSTOM KITS, MODULES	SURPLUS SUPPLIES	BARGAIN PACKS	BOOKS	CATALOGUE/PRICE LIST	MAIL ORDER MINIMUM (6)	P&P (6)	OVERSEAS ORDERS	CREDIT CARDS (4)	SHOPS	OTHER
A.C. TOWNLEY	●	●	●	●	●	●	●	●			●	●		●	£5	(5)	●		●	●
WATFORD ELECTRONICS	●	●	●	●	●	●	●	●		●			●	●	N	50	●	●	●	●
WILMSLOW AUDIO	●	●			●		●	●		●			●	●	N	(5)	●	(5)	●	●

COMPONENT AND HARDWARE SUPPLIERS

and hardware to the electronic enthusiast.

RETAILERS! If your company is not included, please write and tell us about yourself, in time for the next edition of this Directory.

"BI-PAK have now been serving the public for 18 years, and the range of products over the years have ever increased — and continues to do so". From their shop in Ware, BI-PAK also supply CB accesories, radio aerials, leads, styli and cartridges, cassettes adn hifi accessories, headphones and multitesters. They are a specialist supplier of many components (see main listings).

B.K. Electronics,
Electronic Components and Equipments,
37 Whitehouse Meadows, Eastwood, Leigh-on-Sea, Essex SS9 5TY. Tel. 0702 527272.
"B.K. Electronics specialise in:
1. Loudspeakers and tweeters from 3" to 15", up to 150 watts RMS, with some speaker cabinet designs available in kit form; power amplifiers up to 300 watts RMS.
2. Test equipment, ie oscilloscopes, signal generators, pulse generators, frequency meters, digital and analog multimeters, digital thermometers etc."
Turntables and cassette decks, in chassis form, are also stocked at their shop in Southend, Essex. Post and packaging charges for mail order transactions range from 50p to £3.

Boss Industrial Mouldings Ltd.,
(David George Sales Ltd.), James Carter Road, Mildenhall, Suffolk. Tel. 0638 716101.
"We service the electronics industry mainly through a network of distributors, but we are also happy to accomodate the hobbyist".
B.I.M also carry a very large range of filament and neon indicators.

S & R Brewster,
86-88 Union Street, Plymouth, Devon. Tel. 0752 665011.
"We are soldering specialists, manufacturing our own range, and we can offer advice on any soldering problems. We are also the main specialist retailer of electronic components in the locality".
All components in the RS catalogue can be despatched by S & R Brewster within 48 hours of ordering; there is a 15% handling charge on this service. Normal P&p is charged at cost.

Bytech Ltd,
57, Suttons Industrial Park, Reading, Berks. Tel 0734 61031.
Bytech are franchised distributors of Fairchild components, Intel systems, single-board computers and components, Hitachi colour monitors and DEC, QUME and Centronics printers.

Chiltmead Ltd.,
Norwood Road, Reading, Berks. Tel. 0734 669656.
Specialists in surplus electronic equipment and components.

Chordgate Ltd.,
75, Farringdon Road, Swindon, Wilts. Tel. 0793 33877.
Their retail shops in Swindown and Deptford (London) carry a changing stock of new and surplus material. Mail order charges are dependent on the weight of the package, and Chordgate welcome official orders from schools, colleges etc.

Clef Electronic Music,
44A, Bramhall Lane South, Bramhall, Stockport, Cheshire SK7 1AH. Tel. 061 439 3297.
"Although we started out as custom kit suppliers, most of our products are now available as manufactured goods, too".

Collective Components,
Churchfield House, Churchfield Road, Chalfont St. Peter, Bucks. Tel 02813 89191.
Collective Components supply by mail order only; p&p charges are 25p for orders under £10.

Cricklewood Electronics,
40, Cricklewood Broadway, London NW2 3ET. Tel. 01 452 0161.
"Formerly a branch of A. Marshall (London) Ltd., we stock one of the widest ranges of components in the country".
A range of test equipment is also carried and American Express cards are accepted.

Crimson Components Ltd.,
66, J.F. Kennedy Estate, Washington, Tyne & Wear NE38 7AJ. Tel. 0632 467814.
"Our main role is that of an importer from France, Germany, Italy, Japan, Taiwan and the USA. Stocks include well over a million capacitors in 1500 values/types and just under half a million transistors in 2500 types".
A range of ferrites are stocked, and NiCad batteries with chargers capable of taking sizes between D and AA. Post and packaging charges are 20p for within the UK and 90p for overseas

MICRO TIMES

19 Mill St. Bideford, North Devon EX39 2JR, England
Telephone Bideford (023 72) 79798 or 5481 (10—12am)
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4019	30p
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4025	15p
4026	1.10p
4027	22p
4028	45p
4029	50p
4030	25p
4031	£1.25
4040	48p
4042	43p
4044	43p
4046	48p
4047	47p
4048	47p
4049	25p
4050	25p
4051	45p
4052	60p
4056	90p
4060	55p
4063	98p
4066	30p
4068	15p
4069	15p
4070	15p
4071	14p
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74LS73	18p
74LS74	18p
74LS75	24p
74LS86	22p
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74LS93	27p
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AY3-8910 G.I. SOUND COMPUTER CHIP

£5.95 Incl. data.

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2732 Intel	£4.00
2532	P.O.A.
MCM5101	£3.00

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7812	12v.	39p
7905	5v.	50p
7912	12v.	50p
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78L12	12v.	29p
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79M05	5v.	50p
79M12	12v.	50p
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ICL 7660 Voltage Converter. £2.25

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DATA AVAILABLE 75p

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Model CX17W	£5.30
Kit SK1.15W incl. Base Stand Solder.	£7.00
Kit SK3.17W	£6.90
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Kit MLX Repair	£5.50
Spare bits.	each £0.70p

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LOW NOISE EQUALIZER MODULE KIT

Board Size: 1.3" × 1.1"
Treble & Bass. ±15dB @ 10kHz & 50Hz.
Kit: £5.95.
Assem. & Tested £8.50

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- 6 Rhythms, each with 3 Sub-rhythm options.
- 5 Instruments: Snare, Hi-Hat, Tom-Tom, Cymbal and Bass Drum.
- Board 4" × 5" packed with components.
- Kit includes: Rhythm selection switch and Tempo control.

PRICE: Kit £25.95. Ass. & Tested £32.50. (excl. case)

6809 SINGLE BOARD COMPUTER IEEE S-100 STANDARD.

Uses Motorola's powerful MC6809 CPU.
4K/8K/16K ROM 2K RAM.
ACIA, PIA, 8080 simulated I/O
RS-232 Handshake.
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BARE BOARD:	£56.00
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PROMBLASTER (S-100)

Programming most families of Eproms. The ADS Promblaster is controlled by software running under either CP/M or stand alone with our 6809 S.B.C.I

BARE CARD WITH SOFTWARE: CP/M Version on 5¼" or 8" disk.	£98.00
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Please state clearly version required.	
COMPLETE KIT:	£195.00
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ASSEMBLED & TESTED:	£255.00
09 VERSION	£250.00

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Simplify your projects with a prototype Breadboard with extras.
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A speech synthesis board using the Votrax SC-01 speech synthesis chip.
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FOR ALL ADS. PRODUCTS PLEASE ALLOW 21 DAYS DELIVERY.
FOR KITS ADD £2.00. P.&P. PLUS 15% V.A.T.
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CATALOGUE 82. 70p POST FREE INC. 70p REFUND VOUCHER

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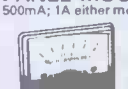
Large range of types in stock; also probes, leads, accessories, etc.

PANEL MOUNTING in 50, 100, 500μA; 1, 5, 10, 50, 100 500mA; 1A either model.



T Range 60 x 45mm £5.95

MU Range 50 x 45mm £2.68

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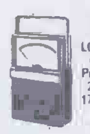
NH56A NEW – 20KΩ/V: AC/DC/-RES./dB in 23 ranges: 130 x 88 x 37mm £11.20N

YN 360TR 20KΩ/V: AC/DC/R/dB/Transistor Test: In 21 ranges: 145 x 96 x 45mm £16.45N



DMM DD601 LCD 3½ digit (1999) Push button 26 ranges 170 x 80 x 38mm £32.00N

SOLDERING IRONS

Also large stocks of bits, desoldering devices, accessories, etc.
ANTEX C-240V £4.60N; X.25-240V £5.30N; CSBP £5.45N; XSBP £5.55N; ST4 Stand £1.70N.
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SOLDER 500gm/18SWG £7.60N; Desolder braid 1.5m 54p.

SWITCHES — Wavechange

Type CK – 1P/12 way; 2P/6W; 3P/4W; 4P/3W 48p.
MIN. TOGGLES – S7101, SPDT 57p; S7201 DPDT 80p; S7301 3PDT £1.64; S7401 4PDT £2.75; 7211 1P3W £1.40; Centre off S7103 SPDT 71p; S7203 DPDT 96p.
Push button min 8531 make/8533 break 62p; 8225 DPDT £1.34–
DUAL IN LINE ERG colour coded 0.3"x0.1" format, On/Off single throw 2P SDS2 54p; 4P SDS4 95p; 6P SDS6 £1.36; 8P SDS8 £1.87; 10P SDSO £2.10.
LOW COST D-I-L 4P DNSO4 60p; 8P DNS08 £1.

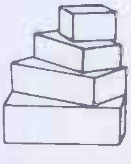
PROFESSIONAL KEYBOARD FOR USE WITH ZX81 £31.30N
Keyboard Case £13.46N

NICAD CHARGERS

For PP3 – NC75G £4.95N; for AA, C or D – NC1230 £8.20N; Power Units MW88 3/4.5/6/7.5/9/12V; 13A fitting 300mA out £3.45; HC244R DC Stabilised 3/6/7.5/9V 400mA out £6.25.

BOXES

High quality Black ABS plastic or diecast plain or stove grey.



L	W	D	ABS		PLAIN		STOVE GR	
50	50	25	–		5001P	88p	5001	116p
100	60	25	2002	67p	5002P	67p	5002	165p
113	63	31	2003	200p	5003P	130p	5003	190p
121	66	40	2004	106p	5004P	150p	5004	245p
152	82	50	2005	123p	5005P	195p	5005	322p
192	113	61	2006	216p	5006P	305p	5006	425p

VERO RANGE plastic boxes

L	W	D		
72	47	25	21024	50p
120	50	35	21390	78p
180	110	55	21391	145p

G RANGE professional Instrument Cases

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

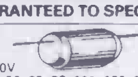
VEROBOX CASES

ABS, lt. grey top; dk. grey bottom + 2 ali. panels

L	D	H	TYPE	PRICE
205	140	40	21034	£4.52
205	140	75	21035	£5.02
205	140	110	21036	£6.54
180	120	39	21037	£4.11
180	120	65	21038	£4.40
180	120	90	21039	£4.69
155	85	39	21040	£3.31
155	85	60	21041	£3.61
155	85	80	21042	£4.30
125	65	30	21047	£2.22
125	65	39	21048	£2.82
125	65	50	21049	£3.18

ALL ITEMS BRAND NEW AND GUARANTEED TO SPEC.

CAPACITORS



POLYSTYRENE, SIEMENS 5% Tolerance. 160V
5, 7, 10, 12, 15, 18, 22, 27, 33, 39pF 12p; 47, 56, 68, 82, 100, 120, 150, 180, 220, 270, 330, 390, 470, 560, 680, 820pF; 1n, 1n2, 1n5, 1n8, 2n2, 2n7, 3n3, 3n9, 4n7 8p; 5n6, 6n8, 8n2, 10n 9p.

CERAMIC Very small. 1.8, 2.2, 2.7, etc. up to 1n 5p each. 1n5, 2n2, 3n3, 4n7, 6n8 5p; 10n, 22n 6p. 33n, 47n 7p; 100n 8p.

POLYESTER, SIEMENS LAYER-TYPE *7.5mm lead spacing 100V*
1n, 1n5, 2n2, 3n3, 6p; 4n7, 6n8, 8n2, 10n, 12n, 15n, 18n, 22n, 27n, 33n, 39n, 47n 7p; 56n, 68n 8p; 82n, 100n 9p; 120n, 150n. 11p; 180n, 220n, 12p; 270n, 330n, 15p; 390n, 470n 17p; 560n, 680n 24p; *100mm spacing* 1μF 26p; *15mm spacing* 2μ2 35p; *22.5mm spacing* 1μF 400V 47p; 3.3μF 100V 50p; In-depth stocks.

ELECTROLYTICS NON-polar (for LS X-overs) 50V peak 2μF 26p; 4μF 28p; 6, 8, 10, 16μF 32p; 25μF 37p; 40, 60μF 59p; 100μF 69p.
POLARISED, SIEMENS OR MULLARD FOR QUALITY
(μF/V) 10/40, 22/25, 47/10 11p; 47/25 12p; 100/10 13p; 10/63, 22/40, 100/16 14p; 22/63, 47/40, 100/25, 100/40 15p; 220/10, 220/16 16p; 220/25 18p; 220/40 20p; 470/10, 470/16, 470/25, 100/10 19p; 470/40, 1000/16 27p; 1000/25 36p; 1000/40, 2200/16 44p; 1000/63 76p; 2200/40, 4700/16 73p.

PLUGGABLE SIEMENS single ended
1/63, 2.2/63, 4.7/63 10p; 10/63, 22/63 12p; 22/40, 47/16 10p; 47/40 12p; 47/63 15p; 100/16, 100/25 12p; 100/40 15p; 100/63 20p. 220/10 13p; 220/16, 220/25 13p; 470/6.3 15p; 470/10 16p; 470/16 18p; 470/25 22p; 470/40 25p; 1000/10 22p; 1000/16 23p.

LARGE CANS – SIEMENS
2200/63 £1.77; 4700/40 £1.78; 4700/63 £2.96; 4700/100 £5.54; 10000/16 £1.93; 10000/25 £2.78; 22000/16 £3.20; 22000/25 £4.73.

TANTALUM
0.1/35, 0.22/35, 0.47/35, 1/35, 2.2/16 13p; 2.2/35, 4.7/16 18p; 10/6.3 18p; 4.7/35, 10/16, 22/6.3, 10/25 18p; 22/16, 22/25, 33/10, 47/6.3, 100/3 30p.

LOW LEAKAGE All single ended
0.1/50, 0.22/50, 0.47/50, 4.7/35 10p; 1/50, 2.2/50, 4.7/50 12p; 10/16, 22/6, 10p; 10/35, 22/10, 22/16, 22/35, 47/6, 47/10 12p; 47/16, 100/6 12p.

RESISTORS

¼, 1/3, ½, ¾ watt – all 2p each, 10 of one value 15p.
2% Mullard metal film 5.1 ohms – 300K 5p each, 10 of one value 40p.
5% wire wound 3W or 7W, most E12 values 1.2 ohms to 8K2 9p each. 10 for 70p.

POTENTIOMETERS

Carbon rotary (P20) 100 ohms–4M7 lin, 220 ohms–2M2 log 35p or w. switch – 90p; Dual gang (JP20) 4K7–2M2 lin. or log 89p or w. switch £1.44.

SLIDERS 58mm, low cost 10K–1M log only 29p; Std 58mm mono 4K7–1M lin or log 79p, stereo matched £1.29; Graduated bezels 34p.
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4001	13p	4016	25p	4028	50p	4070	22p
4002	14p	4017	42p	4029	67p	4071	18p
4006	59p	4018	55p	4030	50p	4072	18p
4007	14p	4019	36p	4041	60p	4081	18p
4008	15p	4020	53p	4042	52p	4082	18p
4009	35p	4021	50p	4043	55p	4093	36p
4010	35p	4022	18p	4044	55p	4510	59p
4011	14p	4023	18p	4046	75p	4511	55p
4012	15p	4024	44p	4049	25p	4516	53p
4013	29p	4025	18p	4050	28p	4518	45p
4014	60p	4026	104p	4060	90p	4520	68p

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on orders over £57.50 – 10%
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680 Burnage, Manchester M19 1NA
Computing at:
700 Burnage Lane, Manchester (061-431 4866)

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★ **5 YEAR NO QUIBBLE GUARANTEE**

TYPE	SERIES No.	SECONDARY Volts	RMS Current	PRICE
30 VA 70 × 30mm 0 45Kg Regulation 18%	1x010	6+6	2.50	**£5.12** +p/p £1 04 +VAT £0 92 TOTAL £7 08
	1x011	9+9	1 66	
	1x012	12+12	1.25	
	1x013	15+15	1.00	
	1x014	18+18	0 83	
	1x015	22+22	0.68	
	1x016	25+25	0.60	
	1x017	30+30	0.50	
50 VA 80 × 35mm 0 9 Kg Regulation 13%	2x010	6+6	4.16	**£5.70** +p/p £1 30 +VAT £1 05 TOTAL £8 05
	2x011	9+9	2 77	
	2x012	12+12	2 08	
	2x013	15+15	1 66	
	2x014	18+18	1.38	
	2x015	22+22	1 13	
	2x016	25+25	1.00	
	2x017	30+30	0.83	
	2x028	110	0.45	
	2x029	220	0.22	
	2x030	240	0.20	
80 VA 90 × 30mm 1 Kg Regulation 12%	3x010	6+6	6.64	**£6.08** +p/p £1 67 +VAT £1 16 TOTAL £8 91
	3x011	9+9	4.44	
	3x012	12+12	3.33	
	3x013	15+15	2.66	
	3x014	18+18	2.22	
	3x015	22+22	1.81	
	3x016	25+25	1.60	
	3x017	30+30	1.33	
	3x028	110	0.72	
	3x029	220	0 36	
	3x030	240	0 33	
120 VA 90 × 40mm 1 2 Kg Regulation 11%	4x010	6+6	10.00	**£6.90** +p/p £1 67 +VAT £1 29 TOTAL £9 86
	4x011	9+9	6.66	
	4x012	12+12	5.00	
	4x013	15+15	4.00	
	4x014	18+18	3.33	
	4x015	22+22	2.72	
	4x016	25+25	2.40	
	4x017	30+30	2.00	
	4x018	35+35	1.71	
	4x028	110	1.09	
	4x029	220	0.54	
	4x030	240	0.50	
160 VA 110 × 40mm 1 8 Kg Regulation 8%	5x011	9+9	8 89	**£7.91** +p/p £1 67 +VAT £1 44 TOTAL £11 02
	5x012	12+12	6.66	
	5x013	15+15	5.33	
	5x014	18+18	4.44	
	5x015	22+22	3.63	
	5x016	25+25	3.20	
	5x017	30+30	2.66	
	5x018	35+35	2.28	
	5x026	40+40	2.00	
	5x028	110	1.45	
	5x029	220	0 72	
	5x030	240	0 66	

TYPE	SERIES No.	SECONDARY Volts	RMS Current	PRICE
225 VA 110 × 45mm 2 2 Kg Regulation 7%	6x012	12+12	9.38	**£9.20** +p/p £2 00 +VAT £1 68 TOTAL £12 88
	6x013	15+15	7.50	
	6x014	18+18	6.25	
	6x015	22+22	5.11	
	6x016	25+25	4.50	
	6x017	30+30	3.75	
	6x018	35+35	3.21	
	6x026	40+40	2.81	
	6x025	45+45	2.50	
	6x033	50+50	2.25	
	6x028	110	2.04	
	6x029	220	1.02	
	6x030	240	0.93	
300 VA 110 × 50mm 2.6 Kg Regulation 6%	7x013	15+15	10.00	**£10.17** +p/p £2 00 +VAT £1 83 TOTAL £14 00
	7x014	18+18	8.33	
	7x015	22+22	6.82	
	7x016	25+25	6.00	
	7x017	30+30	5.00	
	7x018	35+35	4.28	
	7x026	40+40	3.75	
	7x025	45+45	3.33	
	7x033	50+50	3.00	
	7x028	110	2.72	
	7x029	220	1.36	
	7x030	240	1.25	
500 VA 140 × 60mm 4 Kg Regulation 4%	8x016	25+25	10 00	**£13.53** +p/p £2 35 +VAT £2 38 TOTAL £18 76
	8x017	30+30	8.33	
	8x018	35+35	7.14	
	8x026	40+40	6.25	
	8x025	45+45	5.55	
	8x033	50+50	5.00	
	8x042	55+55	4.54	
	8x028	110	4 54	
	8x029	220	2 27	
	8x030	240	2.08	
625 VA 140 × 75mm 5 Kg Regulation 4%	9x017	30+30	10.41	**£16.13** +p/p £2 50 +VAT £2 79 TOTAL £21 42
	9x018	35+35	8.92	
	9x026	40+40	7.81	
	9x025	45+45	6.94	
	9x033	50+50	6.25	
	9x042	55+55	5.68	
	9x028	110	5 68	
	9x029	220	2.84	
	9x030	240	2 60	

IMPORTANT: Regulation – All voltages quoted are FULL LOAD. Please add regulation figure to secondary voltage to obtain off load voltage.

The benefits of ILP toroidal transformers

ILP toroidal transformers are only half the weight and height of their laminated equivalents, and are available with 110V, 220V or 240V primaries coded as follows:

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Greenweld's cataloge costs 75p, including postage, and contains 60p worth of discount vouchers.
They accept orders from overseas, but prefer them to be accompanied by either local currency or a bank draft. Local postal orders or cheques are not acceptable.
As well as items mentioned in the main listings, Greenweld also supply speakers, headphones, mics, buzzers and bells, morse keys, multimeters, and storage containers. See the full range at their shop, in Southampton!

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They also stock tape heads, mechanisms and test cassettes. P&P charges are based on a sliding scale.

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Their products are sold by Watford Electronics, Marshalls in Bristol, London and Glasgow, and by Technomatic.
ILP will also make one-off toroidal transformer for a nominal charge.

Intel Electronics Group Limited,

Henlow Trading Estate, Henlow, Beds SG16 6DS. Tel. 0462 812505.
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Langrex Supplies Ltd.,

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Post and packaging on mail orders is 50p minimum.

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All orders receive careful and prompt attention and all parts are, of course, new and full specification. P&P is a single standard charge and all prices include VAT. Our price list is free with orders or on receipt of an SAE. The illustrated catalogue is 80p, in stamps or added on to your order".
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Shops at: 159-161 King Street, Hammersmith, London, (Tel. 01 748 0926); 284 London road, Westcliff-on-Sea, Essex. (Tel. 0702 554000); Lynton Square, Perry Bar, Birmingham (Tel. 021 356 7292).

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4028	48p
4029	60p
4032	90p
4033	150p
4034	130p
4035	65p
4038	105p
4040	50p
4042	50p
4043	50p
4044	50p
4046	55p
4049U	24p
4050	24p
4051	45p
4052	50p
4053	50p
4060	60p
4066	35p
4068	16p
4069U	16p
4070	16p
4071	16p
4072	16p
4073	16p
4075	16p
4076	50p
4077	16p
4078	16p
4081	16p
4082	16p
4093	30p
4094	95p
4099	95p
4160	80p
4161	80p
4162	80p
4163	80p
4174	80p
4175	100p
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4494	320p
4495	320p
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4514	120p
4515	120p
4516	60p
4517	290p
4518	45p
4519	36p
4520	60p
4521	140p
4522	110p
4526	70p
4527	70p
4528	60p
4529	120p
4530	90p
4531	95p
4532	90p
4534	450p
4536	290p
4538	90p
4539	90p
4541	110p
4543	85p
4544	175p
4547	130p
4549	380p
4551	105p
4553	250p
4554	165p
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BC213A	10p
BC213C	10p
BC214	10p
BC214C	10p
BC237A	12p
BC237C	12p
BC238	12p
BC238A	12p
BC238B	12p
BC238C	12p
BC239	12p
BC307A	15p
BC307C	15p
BC308	15p
BC308A	15p
BC308B	15p
BC308C	15p
BC309	15p
BC309C	15p
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MPSA92	30p
TIP29	35p
TIP29A	35p
TIP29B	35p
TIP29C	55p
TIP29C	40p
TIP30	50p
TIP30A	35p
TIP30B	50p
TIP30C	40p
TIP31A	40p
TIP31B	42p
TIP31C	45p
TIP32	50p
TIP32A	45p
TIP32B	60p
TIP32C	65p
TIP33	66p
TIP34A	75p
TIP34B	99p
TIP34C	90p
TIP35	160p
TIP35A	165p
TIP35B	170p
TIP35C	185p
TIP36	170p
TIP36A	175p
TIP36B	185p
TIP36C	199p
TIP41	50p
TIP41A	50p
TIP41B	60p
TIP41C	50p
TIP42	58p
TIP42A	60p
TIP42B	75p
TIP42C	65p
TIP47	50p
TIP48	50p
TIP49	50p
TIP50	48p
TIP110	30p
TIP111	75p
TIP112	50p
TIP115	40p
TIP116	73p
TIP117	45p
TIP120	39p
TIP121	80p
TIP122	75p
TIP125	45p
TIP126	80p
TIP140	130p
TIP141	140p
TIP142	130p
TIP145	140p
TIP146	180p
TIP147	170p
TIP2955	70p
TIP3055	70p
TIS43	30p
TIS88A	48p
TIS151	50p
2N1613	25p
2N1711	25p
2N1893	35p
2N2218A	45p
2N2219	25p
2N2221	30p
2N2221A	30p
2N2222	25p
2N2222A	25p
2N2369A	20p
2N2904A	25p
2N2905	25p
2N2905A	25p
2N2906A	25p
2N2907A	25p
2N3053	30p
2N3054	70p
2N3055	45p
2N3439	80p
2N3440	60p
2N3771	160p
2N3772	160p
2N3773	250p
2N3819	25p
2N3821	120p
2N3822	120p
2N3823	95p
2N3824	95p
2N3866	90p
2N3903	15p
2N3904	15p
2N3905	15p
2N3906	15p
2N4123	25p
2N4125	25p
2N4391	70p
2N4392	70p
2N4400	20p
2N4401	25p
2N4402	25p
2N4403	25p
2N4410	45p
2N4416	95p
2N4856	80p
2N4857	80p
2N4918	95p
2N4919	120p
2N4920	130p
2N4921	105p
2N4922	95p
2N4923	95p
2N5190	75p
2SC495	60p
2SC1306	95p
2SC1678	105p
2SC2028	75p
2SC2078	105p

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741 14 pin	25p
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748	35p
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CA3130E	75p
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LF356	90p
LF357	100p
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LM307	50p
LM308A	95p
LM311N	66p
LM324	35p
LM339	50p
LM348	75p
LM358	60p
LM380	95p
LM393	90p
LM3909	85p
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MC1455	66p
MC1456	135p
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NE565	155p
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TL064	98p
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68B21	215p
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6850	140p
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6854	680p
6875	490p
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8T28	120p
8T95	90p
8T96	90p
8T97	90p
8T98	90p
8080A	360p
8085A	450p
8155	450p
8212	155p
8216	100p
8224	160p
8226	195p
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8259	450p
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MC1488	55p
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78M08	55p
78M12	50p
78M15	50p
78M18	55p
78M24	55p
1A	
7805	45p
7806	65p
7808	65p
7812	45p
7815	45p
7818	65p
7824	65p
– Ve 100mA	
79L05	35p
79L12	35p
79L15	35p
1A	
7905	60p
7906	70p
7908	70p
7912	60p
7915	60p
7918	60p
7924	60p
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CB Squelch Unit

R.A. Penfold

A handy little device for CBers and radio enthusiasts alike.

WHEN USING a transmitter in a noisy environment (such as a moving vehicle or a room in which a television set is operating, for example) the intelligibility of the transmitted signal can be severely impaired by the high background noise level. Even if the words can be heard, the background noise is rather tedious for anyone trying to copy the transmission!

This problem can become more severe when using a speech processor, a transmitter having built-in speech processing or automatic modulation level control. During the brief pauses that occur during normal speech, the audio sensitivity can rise quite significantly as the audio processing circuits try to modulate the transmitter with the signal produced by the background noise!

There are several ways of combatting this problem, such as the use of a noise cancelling microphone which phases out signals that emanate some distance from the microphone, but not those which originate quite close to the microphone. There is also an electronic method of giving an apparent reduction in the transmitted ambient noise level, and this is achieved using a form of Squelch or Noise Gate circuit. A circuit of this type normally attenuates the

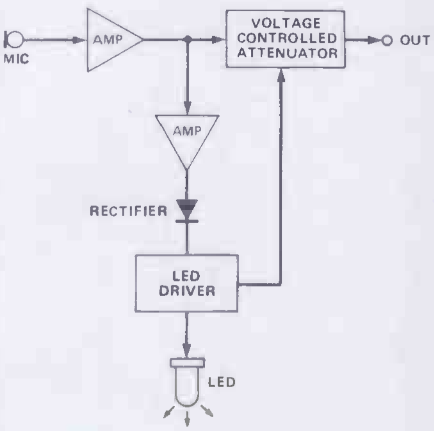
How it Works

The Block Diagram of the Squelch Unit is very similar to that of the Stereo Noise Gate and, in fact, it operates in a similar manner, too. The main signal path contains an amplifier, a voltage controlled attenuator and a fixed attenuator. The gain of the amplifier is balanced by losses through the attenuator so that the unit has unity gain overall. Preamplification is necessary to provide a high signal level to the VCA input, so that unwanted switching pulses generated by the circuit are small in comparison to the speech signal. The attenuator then restores the signal to its original level.

Some of the preamplifier output is amplified further, then rectified and smoothed to give a DC signal which is proportional to the average input level. This drives a trigger circuit whose output switches from a high to a low when the DC signal is more than about 2V5 positive. The output from the trigger controls the VCA and an indicator LED; a low output turns on the LED and switches the VCA to its zero attenuation state. When the trigger output is high, the LED is switched off and the VCA gives about 20 dB or so attenuation of the audio input.

The unit is adjusted so that with only noise present, the VCA is in the high attenuation condition, but when there is a voice signal, the trigger switches the VCA to zero attenuation. The LED is ON when the unit is passing a signal.

The smoothing circuit is designed to give a fast attack time, switching rapidly as soon as it detects a speech signal, but a slow decay so that the ends of words are not chopped off by too rapid switching back to the high attenuation state.



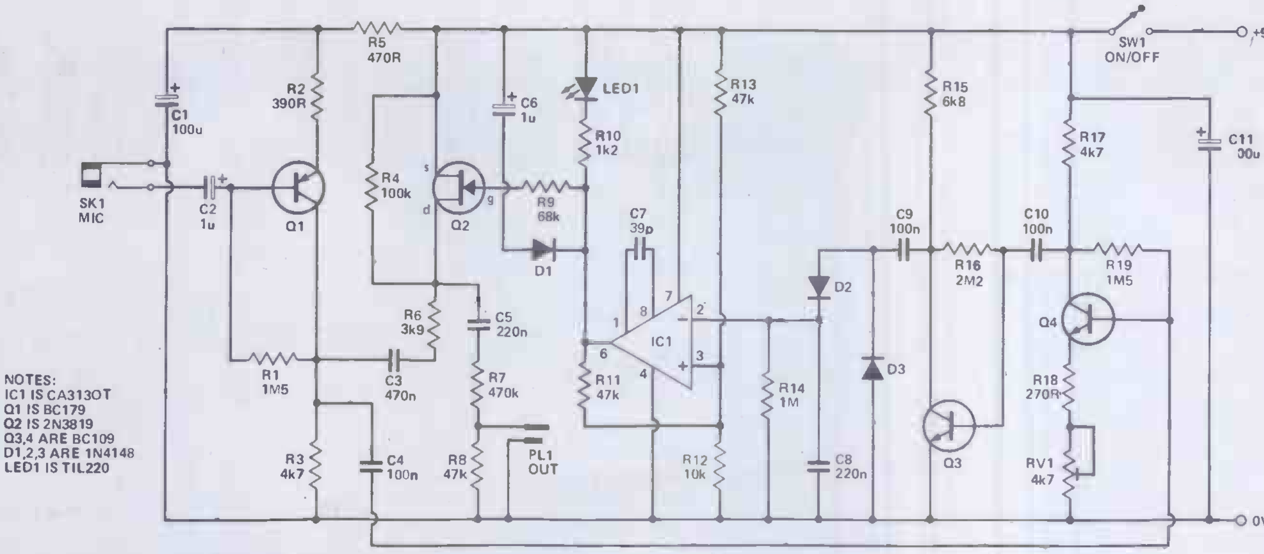


Figure 1. The circuit for the CB Squelch Unit.

processed signal, say by about 20 dB, but gives no attenuation when the operator is speaking into the microphone and there is somewhat higher input level.

This greatly reduces the background noise level during pauses in the speech signal, which is when the noise is most obtrusive. There is no reduction when the speech signal is present, but this signal tends to largely mask the noise and make it comparatively unimportant. The result is an apparent reduction in the noise level, with the wanted signal tending to stand out more clearly.

This Squelch Unit is designed for use with a high impedance dynamic microphone,but its sensitivity is high enough to permit its use with most low impedance dynamic types as well. The circuit is battery powered and simply connects between the microphone and the transceiver. Of course, the unit could possibly be used to advantage with public address or disco equipment, though its companion unit, the Stereo Noise Gate, which is specifically designed for wide-band audio rather than narrow-band communications use, will give much better results. It is based on special ICs, which have excellent noise and distortion figures, operated as voltage controlled *amplifiers,* rather than as attenuators.

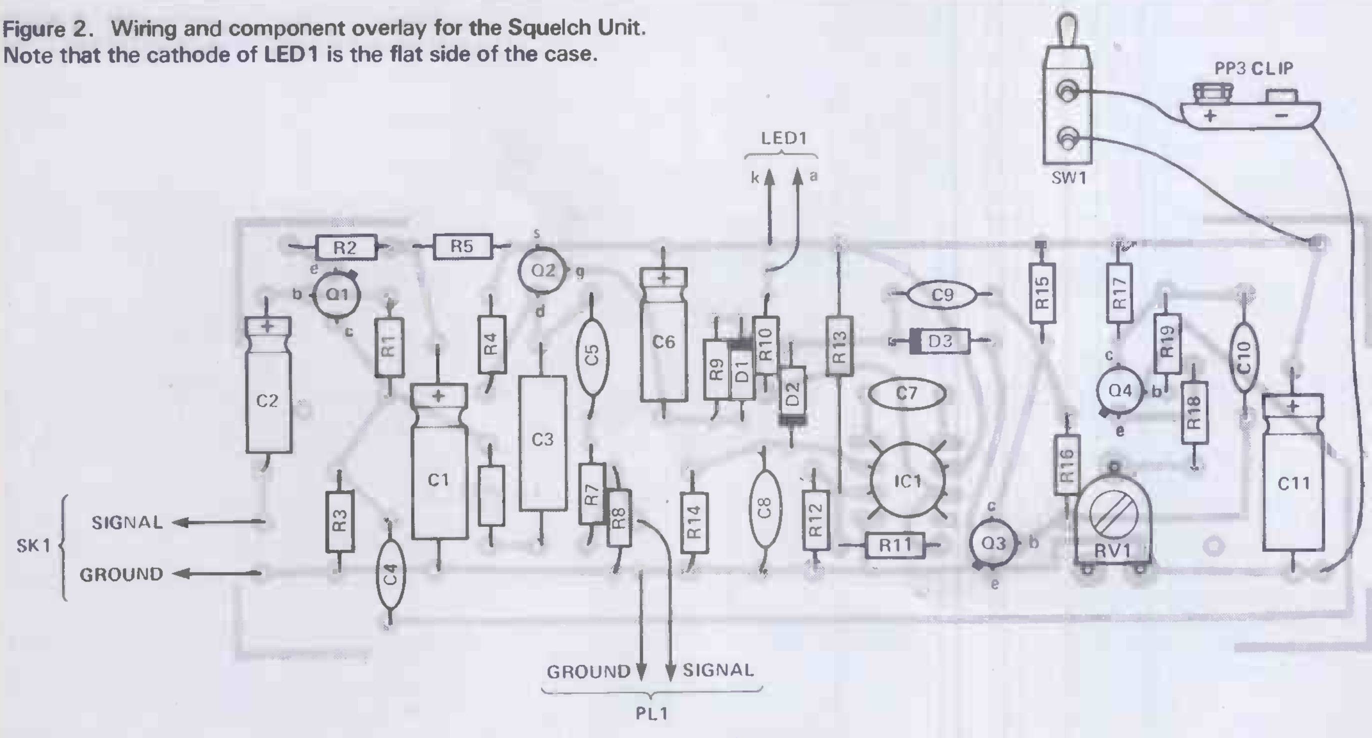
The Circuit

The full circuit diagram of the Squelch Unit is shown in **Figure 1**. The input preamplifier uses Q1 in the common emitter mode, with R2 to provide negative feedback; this boosts the input impedance of the unit to a suitably high level to match a high impedance dynamic microphone.

A simple JFET VCA is used, formed by R6 and the drain-to-source resistance of Q2. With the gate of Q2 at or near the positive supply potential, Q2 is biased hard on and has a drain-to source resistance of only a few hundred ohms; this gives a loss of about 20 dB or so through the VCA. When Q2 is cut off, it exhibits a drain-to-source resistance of about a thousand megohms (if its gate is taken to almost the negative supply potential) and losses through the VCA are then negligible. R7 and R8 form the output attenuator.

Some of the output from Q1 is coupled by C4 to another common emitter stage based on Q4, and from here the signal is coupled by C10 to a further common emitter amplifier, this time using Q3. A controlled amount of negative feedback is applied to Q4 by RV1 so that the gain of this stage can be varied from a little less than unity, at

Figure 2. Wiring and component overlay for the Squelch Unit. Note that the cathode of LED1 is the flat side of the case.



maximum value, to around 24 dB (16) at minimum resistance. By adjusting RV1 it is possible to set the sensitivity of the unit at the correct level.

The output of Q3 is fed to the inverting input of op-amp IC1 via a rectifier and smoothing circuit consisting of D2, D3, R14 and C8. The positive output of this network will be sufficient to activate IC1 when there is a speech signal present, but not when there is only the weaker, background noise signal.

The op-amp, IC1, is used here as a variety of Schmitt Trigger. When there is no speech signal, the output is in a high state so that indicator LED1 is switched off. The JFET Q2 is biased on, providing a low impedance path to OV through Q2 and the battery, thus heavily attenuating the input (noise) signal. However, when the inverting input goes more than about 2V5 positive, as it will when there is a speech input, the output of IC1 goes low; LED1 turns on and Q2 is biased off, removing the low impedance path to OV and producing minimum attenuation of the signal.

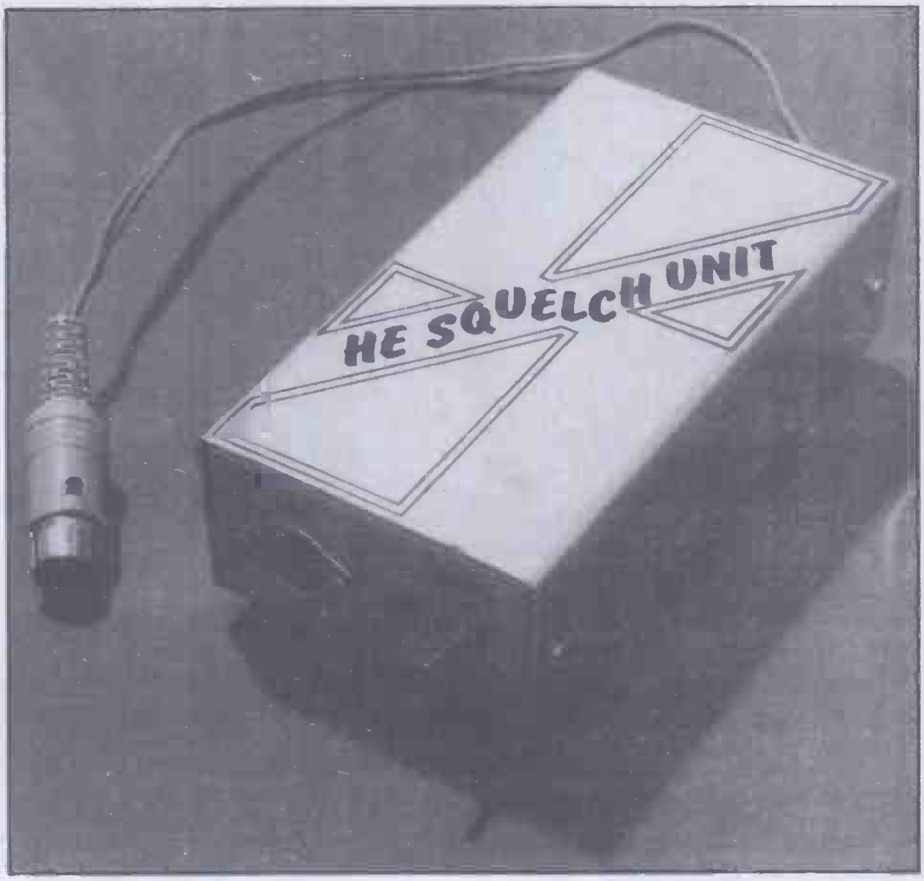
The attack time—the time taken by the VCA to switch from low to high impedance—is very rapid, whereas the decay time is slowed down by R9 and C6; this ensures that there is minimal noise generated by the VCA as it returns to the high attenuation (low impedance) state. It can sometimes happen that, due to the nature of the input signal, the VCA will switch rapidly between states, several times in succession, the slow decay time set by R9 and C6 also prevents this undesirable effect. Diode D1 ensures that R9 and C6 do not effect the rapid attack time.

Construction

All the components, including the battery, will readily fit into an aluminium box measuring about 133 x 70 x 38mm. SK1, D4, and SW1 are mounted on the front panel; SK1 is a four-way DIN type on the prototype, however, this should obviously be varied to suit the plug fitted to the particular microphone used. An exit hole for the output lead is drilled in the rear of the case and this lead is fitted with a plug of the same type as fitted to the microphone. Many communications microphones have a press-to-talk switch and consequently use a 4 way lead and plug. If the unit is used with a microphone of this type, the appropriate two pins of SK1 simply connect direct to the corresponding two leads of the output cable.

The printed circuit board is detailed in Figure 2. Construction is mostly straight forward; IC1 is a CMOS device, though, and it is thus necessary to observe the normal handling precautions. Use pcb pins at points on the board which will later be connected to off-board components.

Mount the finished board on the base panel of the case using 6BA fixings, including spacers to prevent connections on the underside of the board short circuiting through the case. Leave sufficient space for the PP3 battery at one side of the component board. The remaining wiring is then completed, as shown in Figure 2.



Parts List

RESISTORS
(All ¼ watt 5% carbon)

R1, 19	1M5
R2	390R
R3, 17	4k7
R4	100k
R5	470R
R6	3k9
R7	470k
R8, 11, 13	47k
R9	68k
R10	1k2
R12	10k
R14	1M
R15	6k8
R16	2M2
R18	270R

POTENTIOMETERS

RV1	4k7 miniature horizontal preset

CAPACITORS

C1, 11	100u 10V axial electrolytic
C2, 6	1u 63V axial electrolytic
C3	470n C280 polyester
C4, 9, 10	100n C280 polyester
C5, 8	220n C280 polyester
C7	39p ceramic disc

SEMICONDUCTORS

IC1	CA3130T MOSFET op-amp
Q1	BC179 silicon PNP transistor
Q2	2N3819 silicon N-channel FET
Q3, 4	BC109 silicon NPN transistor
D1, 2, 3	1N4148 signal diode
LED1	TIL220 5mm red light emitting diode

MISCELLANEOUS

SW1	SPST miniature toggle switch
SK1	4-pin DIN socket (see text)

Aluminium case; PP3 battery clip; PCB LED fixing washer; output lead; output plug (as required); wire, solder etc.

BUYLINES 30

Setting Up

It is only necessary to set RV1 to the correct level before the finished unit is ready for use. This is adjusted by trial and error so that the ambient noise level does not trigger the VCA but the speech signal does so reliably. Indicator LED1 lights up when the unit is activated and this greatly simplifies setting up. Ten-Four!

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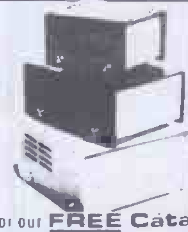

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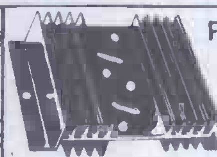

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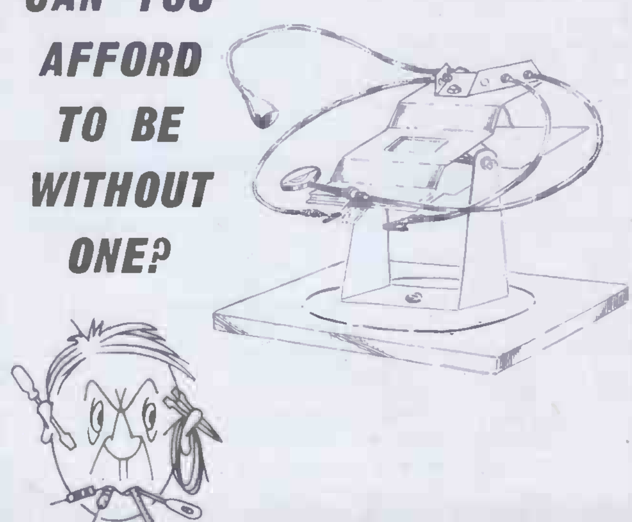

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Owen Bishop

CM100 CIRCUIT MAKER REVIEW

Can you resist this new photo-etching kit?

IT EVOKED the atmosphere of a Christmas Day many years ago, the day on which I was given my first chemistry set. Today, the postman dumped this enormous package on the doormat and I was soon picking over the exciting assortment of items inside. In some ways the CM100 Circuit Maker *is* a chemistry set, for there is a lot of chemistry in the process of making a PCB by photo-etching techniques. But instead of the slightly squashed cardboard box full of logwood chips (do they still have those in modern chemistry sets?) and the little packet containing six strips of rather blotchy litmus paper, I now had in my hands a bottle of photoresist etchant crystals and a packet of autopositive film. Then there were all the fascinating variety of bits and pieces (what's that for? And what on Earth is *that* for?) one hopes to find in a really good kit. And it turned out that this kit contains everything that you need for making your own photo-etched PCBs, even including a couple of high-speed twist drill bits for making the holes in the board after it is etched.

Why PCBs?

Before going on to discuss the process in detail and the merits or otherwise of this kit, let us look into the question of why we use PCBs at all. At some time between the arrival of my chemistry set and the arrival of the CM100 kit there was the arrival of the PCB, an invention that was hailed as a major break-through in electronics construction techniques. Until then all electronic circuits had to be laboriously hand-wired. This meant long assembly time, high labour costs and a high rate of defective circuits due to wiring mistakes, bad joints and all the other bugs which attend hand-wiring. The great advance of the PCB was that it was now possible to virtually print them by the tens of thousands; all exactly alike and free from defect. All that had to be done was to drop the components into the holes and solder them in place. The new technique meant lower labour costs, more rapid production and fewer faults. It lent itself to automation of the assembly of electronic circuits and has been a prominent factor in the lowering of their price, coupled with the improvement in specification and performance over the past few decades.

The PCB owes its success to the demands and rewards of mass production. It seems strange, therefore, that it has found favour with the lone hobbyist who rarely builds more than one device of any given design. There are several reasons for this:

1) It gives the amateur's product a professional appearance. But we don't expect a home-cooked apple pie to look or taste like a factory-made one, and would be rather disappointed if it did! So is this a valid reason?
2) It makes it easier for firms to mass-produce PCBs of popular designs published in magazines such as HE, and sell them to amateurs who are too busy (or lazy?) to make their own. Without decrying the excellent service these firms render to their thousands of customers, my personal view is that using ready-made PCBs almost reduces electronics construction to the level of painting by numbers.
3) Editors of magazines prefer them (I'll have to be very careful what I say here!). Once a master overlay has been drawn, and a prototype built using that master then, if the prototype works, all other models built using that master will work. At least, all the connections will go to the right places and odd effects dependent upon component layout (eg, inter-lead capacitance) will be the same for all. It is notoriously difficult to ensure that a circuit diagram or strip-board layout drawing is entirely free from errors, but a verified master overlay can be reprinted in a magazine without error of any kind. This is a valid reason for favouring PCBs, but is it sufficient to account for their wide popularity?
4) It's fun. For me, it is reason number four which counts. I'll leave you to make your own choice, or to think up some other reasons of your own!

Making PCBs

Having found a PCB design in a magazine, or having designed one of your own, how can you get it on to the copper-clad board, ready for etching? Except for the very simplest of circuits, the hand-drawn design using a special resist pen or nail-varnish is almost out of the question. Most circuits rely on at least one IC and it becomes very difficult to lay out the terminal pads with sufficient accuracy. The use of rub-down etch-resist transfers does a lot to improve appearance, gives accurate registration for ICs and edge-connector patterns, and makes it possible to cram lots of narrow tracks into a relatively small space. In an hour or so you can copy a published design on to your copper-clad board and have it ready for etching. This is the method I have used for several years with very satisfactory results. There really is a sense of achievement when the board is done and this is even more the case when working out one's own designs. The preliminary laying out of the main components, followed by the art-work with the transfers are something a little different from the usual run of electronics construction techniques. They are a refreshing change, though there is always the worry of making a mistake which can not easily be corrected once the board is etched. Unfortunately, thorough checking before etching does not necessarily reveal all the errors!

Copying by photographic means is a little more complicated and requires more equipment. It costs more to set yourself up with the equipment, but remember that this kit includes expendable materials such as a plentiful supply of double-sided copper-clad fibre-glass boards and the chemicals for etching, which you would have to buy for *any* method of PCB production. The special equipment costs relatively little.

It takes longer to produce a board by photo-etching than by other means, though if you also have photography as a hobby (developing your own film and making your own prints, I mean, not simply snapping away and sending the film to Kodak!), you will find that the processing of the film and the resist-coated board are already familiar. A reasonable degree of judgement is required, but the process is not over-dependent on this. It is certainly an interesting procedure and gives yet another dimension to that fabulous hobby, electronics.

There is the advantage that once the master film is developed, you can produce dozens or hundreds of identical etched boards. You will probably not find this feature of benefit, unless you are intending to enter the PCB business, but a friend might appreciate a copy of one of your boards, on occasion.

One advantage of the photo-resist method is that the master drawing can be made on plain white paper. You can draw with pen and black ink, and use rub-down transfers for the more complex items. It is much easier to do this than to work directly on a copper surface as with the ordinary rub-down method. For instance, there is no need to worry about keeping greasy fingers away from the copper. If you make a mistake, you can easily correct it by scraping away the transfers or whiting out the error with Tipp-Ex or Liquid Paper. If a mistake is discovered *after* a board has been etched you do not have to start all over again, as with the rub-down-on-copper method. You simply modify the original master drawing (no need to re-draw the whole thing unless you have made a really ghastly error) and then quickly make a new photo-positive copy of this and etch a new board. The same applies if you subsequently improve the design. The original master drawing can be revised to provide the master drawing for the improved version.

The Kit

The discussion above is intended to help you to decide whether or not you wish to delve further into the subject of photo-resist etching. If you have already decided that it is not for you, then please read no further. If, as is likely, you are keen to find out more, or are still undecided, read on. We will look at the CM100 kit in particular, to see how well it caters for the process and, in doing so, describe the main steps.

The kit is packed in a strong cardboard carton, well able to stand up to the ravages of postal transport and suitable for storing all the items of the kit before and after use. Inside, there are a number of stout cardboard trays to hold the various items, to make sure that they all stay in place and remain undamaged during transit. Some items are packed in plastic envelopes and the processing solutions are in five plastic screw-topped bottles. Each has an inner plastic plug to keep the bottle securely sealed during transit. The solutions are all concentrates, so the kit contains enough for making plenty of boards. The photoresist developer is a solution of sodium hydroxide (caustic soda) but, for safety, this is supplied in its bottle as a quantity of sodium hydroxide flakes. You are required to prepare the solution by adding water (more about this later).

The sleeve around the carton carries a full list of contents. One section of it is printed as a work-chart suitable for mounting on your workshop wall. It summarises every stage of operations, including what to do with everything at the end of the session.

Making PCBs by this method is done in four main stages. The first of these is drawing the master. You can do this on paper, using pen and black ink, rub-down transfers or any other method which produces a sharp black-and-white result. You could also make the drawing on transparent film. Alternatively you can, as I did for this review, cut a PCB design from a magazine. At this point the kit takes over.

Making the Film

This consists of making a copy of the master drawing on positive film. The copy is the same size as the master, and is a positive copy, not a negative. In other words, the tracks and pads (black on the master) come out black on the film. The kit includes a supply of auto-positive film and a special frame for holding the film and master in contact. You do not need a dark-room. You can work in an ordinary kitchen with curtains drawn during the day, or with artificial light coming through an open doorway from an adjacent room at night. The film is exposed by placing it face-down on the master (reflex printing) and exposing it to the light from a photoflood lamp (included in the kit, but you need to supply the lamp-holder, flex and plug). Full instructions are given in the manual supplied with the kit, which includes several trouble-shooting charts. It tells you how to find the correct exposure by exposing a test-strip and special test-strips are included in the packet of film (you see? They have thought of everything! — well almost). Having found the best exposure time, you can then expose a piece of film cut to the same size as the PCB design. A full sheet of film measures 100 mm x 160 mm (Eurocard size), so this is the largest size of board that can be made with this kit. The boards provided measure 127 mm x 160 mm, thus allowing extra at the long edges for mounting the boards.

Processing the exposed film follows the normal photographic sequence of developing, rinsing and fixing. Development time depends on temperature; there is a liquid crystal thermometer in the kit and using this I found it easy to ascertain the correct time for development and soon had a crisp, high-contrast copy of the master design drying beside the sink. Incidentally, the kit includes developing dishes, film, forceps and plastic gloves (substantial ones, not the flimsy throw-away kind supplied with home perm kits).

Should the clear areas of the positive show a slight mistiness, this may be cleared by treating the film with the special Clearing Solution. The film may then be set aside to dry.

Photo-resist

At this stage it is necessary to prepare the boards by coating the copper with a photo-resist. This comes as a blue solution which is applied to the cleaned and scoured copper surface using a plastic sponge applicator. Coating must be done in a semi-darkened room and the coated boards must be stored in a light-proof box. Coating was the operation I found most difficult — especially obtaining an even coating. However, this would probably become easier with practice; if I failed to improve it is possible to buy boards already coated with resist, though these are rather more expensive than ordinary boards. You can coat several boards at once and keep them for several months.

Making the PCB

When the film and coated boards are dry, the next step is to find the correct

TROUBLE SHOOTING CHART FOR PRODUCTION OF PRINTED CIRCUIT BOARDS

FAULT	CAUSE	REMEDY
1. PHOTORESIST WILL NOT 'TAKE' ON PARTS OF BOARD	GREASY PATCHES ON COPPER, PROBABLY CAUSED BY HANDLING	CLEAN BOARD THOROUGHLY, AVOID TOUCHING SURFACE BEFORE COATING
2. DIRT BURIED IN PHOTORESIST COATING	(a) SURFACE OF BOARD DUSTY BEFORE COATING (b) DUST SETTLING BEFORE PHOTORESIST COATING DRY	(a) INSPECT BY OBLIQUE LIGHT. CLEAN WITH LINT-FREE CLOTH (b) DRY IN DUST FREE CONDITIONS
3. BACKGROUND WILL NOT CLEAR COMPLETELY	(a) UNDER EXPOSURE (b) DEVELOPER EXHAUSTED (c) DEVELOPER COLD	(a) GIVE MORE EXPOSURE (sometimes an under-exposed result can be saved by slightly increasing developer concentration). (b) CHANGE DEVELOPER (c) WARM TO 20°C
4. PARTS OF COPPER WILL NOT ETCH	(a) UNDER EXPOSED PHOTORESIST (b) CONTAMINATED BOARD	SEE 3a) ABOVE SEE 1 ABOVE
5. COPPER TRACKS BROKEN AND RAGGED	(a) FAULT ON FILM MASTER (b) PHOTORESIST COATING TOO THIN (c) GROSS OVER EXPOSURE OR FILM MASTER NOT DENSE ENOUGH (d) DEVELOPER TOO STRONG	(a) INSPECT AND CORRECT (b) APPLY THICKER COATING (c) REDUCE EXPOSURE — THIS MAY ALSO 'SAVE' A THIN FILM MASTER (d) USE WEAKER DEV. AND/OR SHORTER TIME.
6. COPPER SPECKS BETWEEN TRACKS AFTER ETCHING	(a) DIRT ON EXPOSURE FRAME GLASS OR FILM MASTER (b) DIRT IN PHOTORESIST COATING	(a) CLEAN GLASS OR SCRAPE SPOTS FROM FILM MASTER (b) SEE 2 ABOVE.
7. PHOTORESIST COMES OFF COMPLETELY IN DEVELOPER	(a) PHOTORESIST 'FOGGED' BY TOO MUCH EXPOSURE TO ROOM LIGHT OR DAY-LIGHT BEFORE OR AFTER EXPOSURE (b) DEVELOPER TOO STRONG (c) BADLY CONTAMINATED COPPER SURFACE	(a) THE COATED BOARD SHOULD BE PROTECTED COMPLETELY FROM DAY-LIGHT OR STRONG FLUORESCENT LIGHT (b) FOLLOW RECOMMENDED DILUTION (c) CLEAN BOARD THOROUGHLY AND RINSE. TRACES OF DEVELOPER OR ALKALINE ON THE BOARD BEFORE COATING WILL ALSO GIVE THIS EFFECT.

exposure for the photo-resist. A coated board is used for this; its coating can be removed after the test and the board re-used. The resist is sensitive to ultra-violet radiation; you can use a UV lamp or place the exposure frame outdoors in sunlight. I used sunlight and found that an exposure time of 20 minutes was correct. During this time the film is held in contact with the coated board — make sure the film is placed emulsion-side down on the board!

On the first time of use, the resist-developer solution has to be made up. Although the manual and the labels of each chemical container prominently display warnings of hazards of a general kind ("avoid eye, mouth or skin contact", "keep out of reach of young children"), there was no reference to the *specific* hazard of adding water to the sodium hydroxide flakes. When sodium hydroxide dissolves in water, a large amount of heat is generated and the solution becomes very hot; in fact the bottle could become too hot to hold and this should have been mentioned in the manual. Luckily I was prepared for this event and added the water gradually, keeping the solution cool by holding the bottle under a running cold tap. The instructions stated that the cap of the bottle was to be screwed on securely, so I did this. When the cap was released the expansion of the air inside the bottle caused an outrush, carrying with it a spray of droplets of caustic soda solution. This could have damaged clothing or furniture if I had not been holding it in a sink at the time. Here we have an example of the present pre-occupation with blanket warnings covering unlikely events (such as the 1 person in 10000 who might have a skin allergy to one of the chemicals) or events which should not occur (such as bringing up children who think it within their rights to fiddle with anything placed within their reach) while overlooking a real source of danger. It is a case of 'crying wolf'; my chemistry set had no blanket warnings yet I never came to grief! In this instance, the making up of the developer solution requires full specific warnings, especially as the identity of the solution is not disclosed. Adding water to flakes generates excessive heat; to avoid overheating, the flakes should be added to the water, a few at a time. But do not touch the flakes with bare fingers!

Once the board is exposed, it is developed for a few minutes. This removes the resist from the exposed areas (between tracks and pads), which show up as bright copper. The unexposed areas remain covered and the resist becomes black. I found that the recommended development time was rather short and that it could be trebled or quadrupled to clear the copper area completely without danger of removing the resist from unexposed areas.

Etching

The CM100 kit includes a complete PCB etching kit almost identical to the Seno System which was reviewed in HE earlier this year. I have used the Seno System for several years with good results; it avoids any handling of the ferric chloride etchant, which is very corrosive, allowing the process to be safely carried out in the kitchen. As in the Seno Kit, the CM100 kit includes a pack of neutraliser for solidifying the exhausted etchant solution; the instructions for safe disposal of the spent etchant were comprehensive, and included clear warnings of all possible hazards.

After cleaning the etched boards of photoresist, you coat the copper with the flux laquer provided. This refinement protects the copper from atmospheric corrosion and also assists the flow of solder when the components are being mounted. All you have to do then is to drill holes for the components and terminal pins (bits provided) and a perfectly etched board is ready for receiving the components.

Summing Up

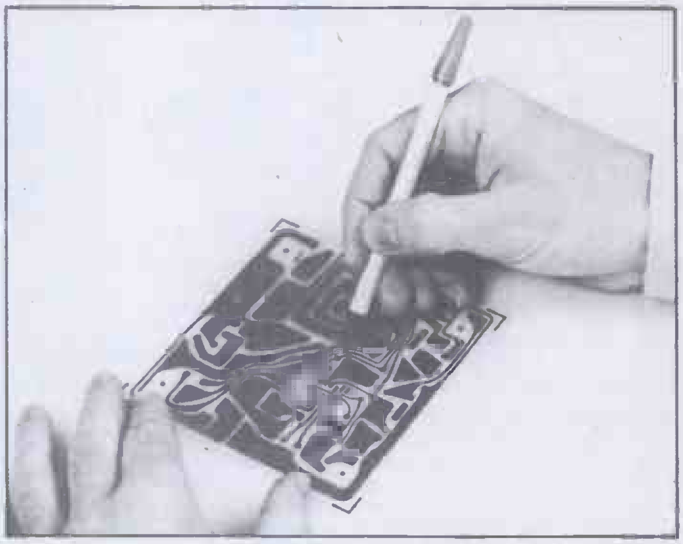
This is a most comprehensive kit with clear step-by-step instructions. It can be considered to be good value for money. Any person capable of assembling an electronic cirucit should be able to use the kit effectively and safely and enjoy this new aspect of the hobby. Although the process involves more stages (which at least gives you something extra to do to occupy your spare time) it has several advantages over the other methods of PCB preparation.

The CM100 Circuit Maker kit is manufactured and distributed by Electrolube Limited, Blakes Road, Wargrave, Berkshire RG10 8AW. Phone Wargrave (073 522) 3014. Contact them for the name of a retail supplier near you. Recommended retail price is £69.95 including VAT and handling. Our thanks to Electrolube Limited for supplying the kit which was the subject of this review.

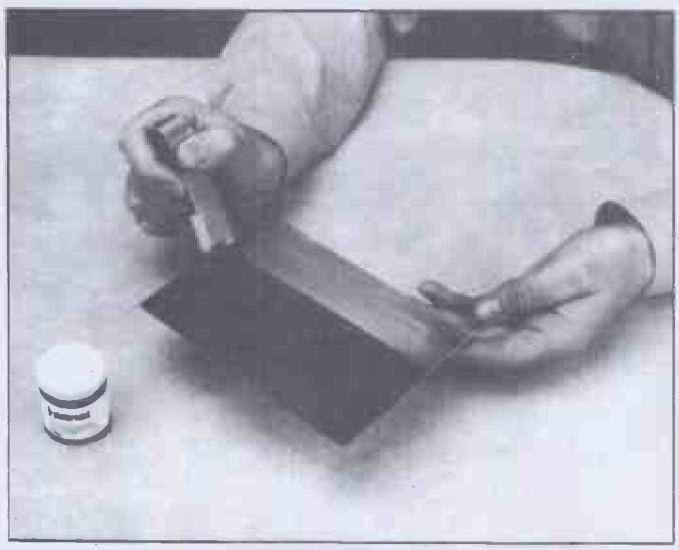
Selected stages in the production of printed circuit boards using the CM100 Circuit Maker kit.

Exposing the auto-positive film to produce a film positive master. The circuit layout can be from a publication, or your own design.

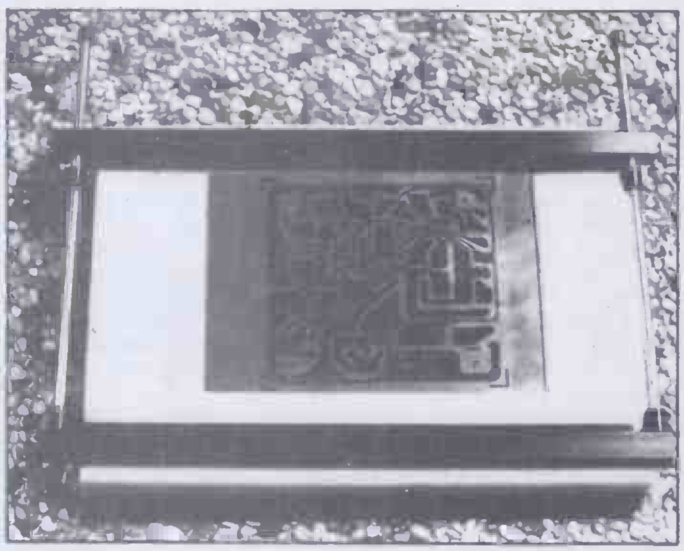
Developing and fixing the positive master film.



After cleaning, small flaws can be touched-up with the retouching pen.



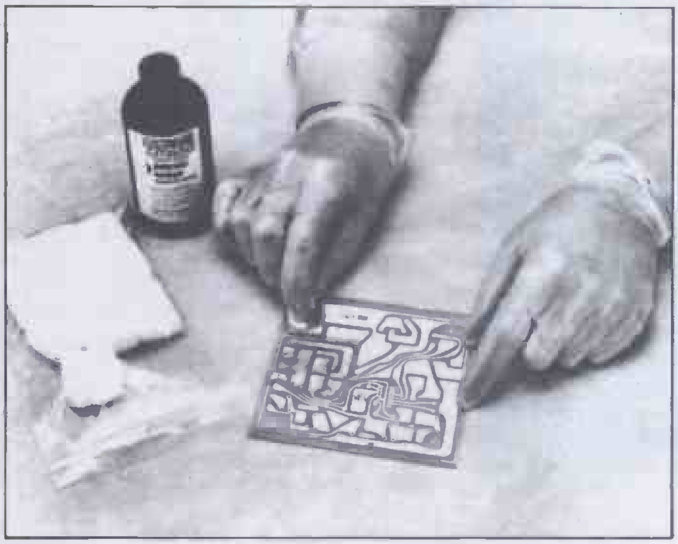
The copper-clad board is cleaned and the photo-resist solution wiped on with a sponge applicator.



The film master and resist-coated board are exposed to transfer the layout to the PCB.

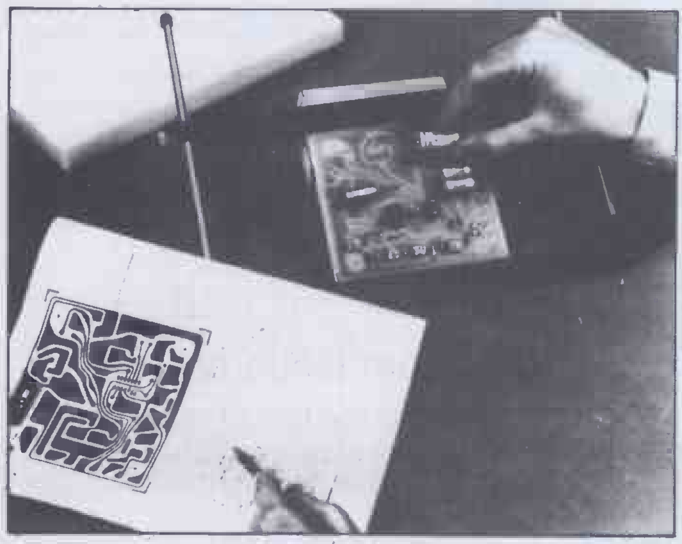
The exposed board is developed to reproduce the circuit layout.

Etching the board in the sealed bag.



After etching, the board is washed and dried and the remaining photo-resist is removed to expose the copper tracks.

Coating the copper with a protective laquer/solder flux solution.

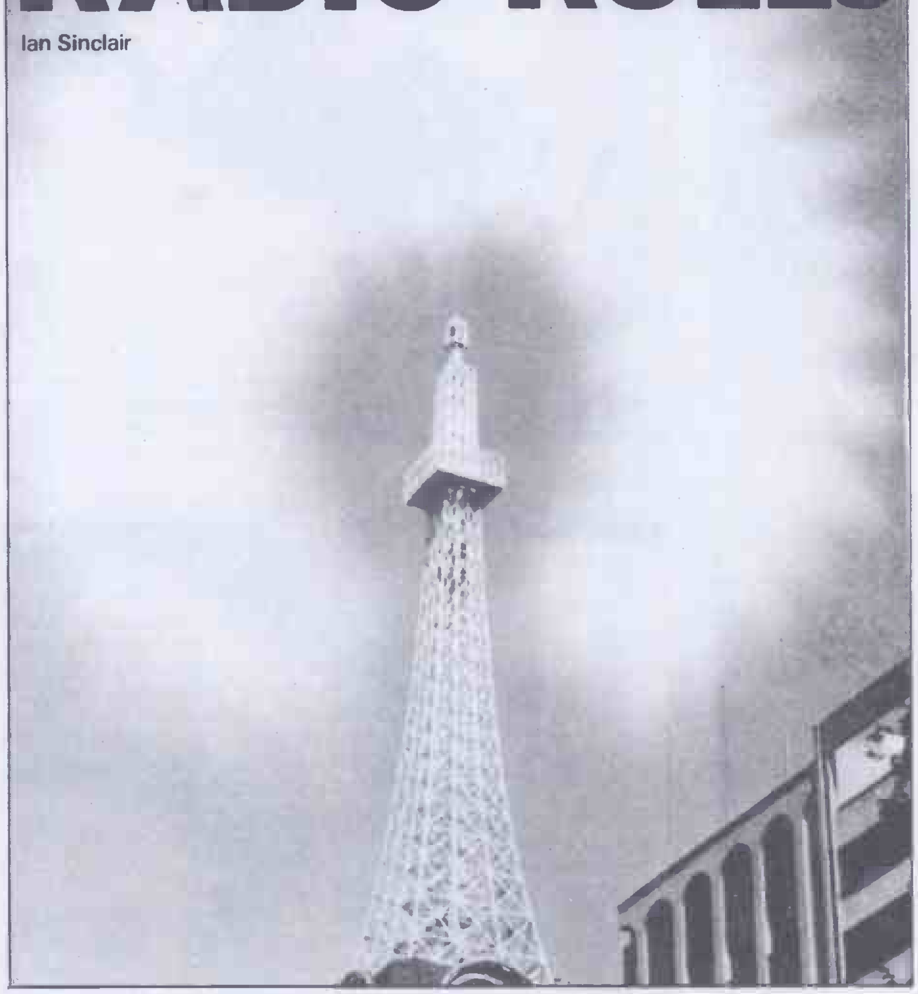


The universal exposure frame doubles as an assembly jig for mounting components.

Finally, the component leads are cropped, ready for soldering. **HE**

RADIO RULES

Ian Sinclair



Modulation and other matters

NOW we're getting a bit closer to real radio! This month, we're going to look at AM transmitters; how they work, and what's involved. We'll kick off with a block diagram, **Figure 1**.

It shows a master-oscillator, which could be crystal controlled if you are operating on one frequency only, but is more likely to be variable so that you can use a number of frequency bands and be able to shift frequency within a band, to avoid interfering with somebody else. The master oscillator may be followed by buffers and multipliers, to generate the correct frequency. The signal which is to be modulated onto the carrier is your voice, so a microphone is the starting point for this signal, which is amplified and applied to the modulator. The traditional position for this kind of modulator is at the final output (power amplifier) stage, where the carrier is at its maximum amplitude.

It all looks fairly straightforward, as it was, once, but with the increasing use of radio wavebands, there are problems and restrictions which have been attended to. One restriction is 'input power', the maximum permitted DC power fed to the final amplifier (PA) stage for operation on the popular amateur radio bands (between 3.5 MHz and 29.7 MHz) is set by regulation at 150 W. This power level is more likely to be achieved by the use of valves,rather than transistors, in the PA stage, but it must not be exceeded. That's a legal restriction which isn't difficult to keep to—but some other factors are more of a worry. One major problem has been TVI (Television Interference), particularly on the older Band 1 frequencies between 45 MHz and 67 MHz, because these frequencies lie in the range of harmonics of the 14 MHz and 28 MHz amateur bands.

Harmonics, remember, are frequencies which are multiples of the operating frequency to which you are tuned, and these are generated in substantial quantities by any stage which is not operating in pure Class A conditions. Since the efficiency of a Class C final stage is a particularly attractive feature of an AM transmitter, the usual way of dealing with the TVI problem is by filtering harmonics from the output, between the final amplifier and the aerial. Filtering will also deal with another interference problem, pickup by stereo amplifiers—though a lot of this is due to poorly-designed and poorly earthed stereo equipment which would pick up anything around it!

The other major problem is frequency stability. The operating frequency of the transmitter must not stray outside the limits of the amateur bands, but even smaller changes of frequency are undesirable because they can cause the transmitter frequency to drift outside the bandwidth of a receiver. Your transmissions won't be popular if anyone who wants to hear them has to keep retuning his receiver! This isn't likely to happen with crystal control, but if you want to be able to roam over the amateur bands at will using a simple Variable-Frequency Oscillator (VFO) cirucit which is not crystal controlled, frequency stability can be quite a problem. In particular, if you want to call up a station that you have been listening to, you will have to 'net' to its frequency—make your transmitter frequency approximately equal to his.

VFO Not UFO

A variable frequency oscilLator is, therefore, an essential part of an AM transmitter for amateur use. Since the frequency stability of the whole transmitter is determined by the stability of the VFO, this a stage on which a lot of effort must be devoted

Circuitry is not the main problem. The traditional Colpitts oscillator circuit (**Figure 2**) is one which still gives excellent results, as do several other circuits, ancient and modern—but a good circuit is not the whole story. For the highest possible frequency stability, components have to be carefully constructed (eg inductors) or selected (eg capacitors) and the layout of

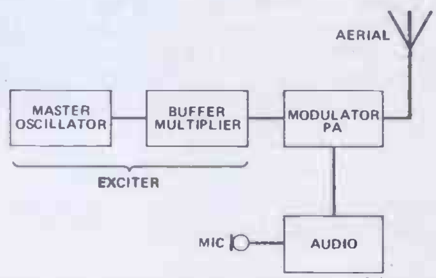
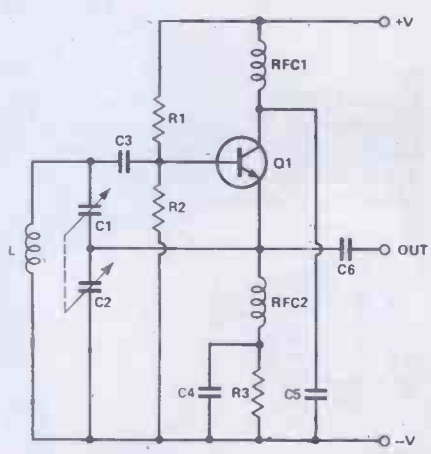


Figure 1. A simplified block diagram or an amplitude modulated (AM) transmitter.



NOTES:
RFC1,2 ARE RADIO FREQUENCY CHOKES
C1,2 ARE CENTRE TAPPED GANGED VARIABLE CAPACITORS

Figure 2. A Colpitts oscillator, suitable for use as a VFO

the circuit must be good; considerable care is needed over the location of the VFO within the transmitter.

Basically, the frequency of the VFO is set, as we've seen earlier, by the L and C values of the tuned circuit. How can these vary? To start with, any change in the dimensions of the coil will cause a change of inductance, and thus a change of frequency. A self-supporting coil is unacceptable at frequencies below VHF because they carry a lot of turns, and even normally imperceptible vibration can cause the coil to behave like a spring, causing the oscillator output to be frequency-modulated by the vibration! Coils should be tightly wound on to low-loss formers, preferably high-grade ceramics, rather than being self-supporting. If the coil is wound really tightly, the turns will not shift as the wire heats and expands; it's not a bad idea to wind the coils with warm wire, so that the coils will tighten as the wire cools! If, however, you run the VFO section in a place where the temperature can be raised by, for example, a hot valve operating near it, then expansion problems are likely. Always use air-cored, as distinct from ferrite coils (ceramic counts as 'air', in this context) because a coil with a metal or dust core does not have a constant inductance; the permeability of the core can be very greatly affected by temperature and less obvious effects, like sharp knocks.

Capacitance is the other half of a resonant circuit. Some of the capacitance is in the form of physical components and we need to select high-quality capacitors, such as silver-mica types. In addition, though, there are 'invisible' capacitors—the capacitance across transistor terminals, for example, which will vary as the temperature and the operating voltage change, and the stray capacitance in the circuit. The amount of stray capitance is very much affected by the circuit layout and vibration can cause any such capacitance to vary; rigid construction, with short thick connecting wires, is very desirable.

One of the bonus features of the Colpitts oscillator is that the main tuning capacitors are placed across the transistor base-emitter capacitance, so that it is possible to arrange for these capacitors to have a value much greater than the transistor capacitance. When this is done, any change in the transistor capacitance has much less effect on frequency; the transistor capacitance has been 'swamped'.

We can still find that changes of frequency occur, however, as the circuit warms up. One reason is that silver-mica capacitors have a small positive temperature coefficient. This means that the capacitance increases as the temperature of the capacitor increases, there's nothing we can do to stop it. The only measure we can take is to connect a small ceramic capacitor in parallel with each silver-mica, because ceramic capacitors have a fairly large *negative* temperature coefficient, meaning that their capacitance values will *decrease* as the temperature increases. The type of ceramic has to be carefully chosen; some have a very large variation of capacitance with voltage, which can be troublesome to the extent of preventing oscillation if all the capacitance consists of such devices. One refinement, which can be helpful, is to use a stabilised voltage supply of the VFO.

If you are transmitting CW (Continuous Wave, ie morse code) it is not a good idea to 'key' the VFO, because the interruptions can cause frequency drifting. It is sometimes useful to make the VFO frequency as low as possible, because a low frequency is easier to keep stable. Against this, there is the fact that a low frequency VFO may need many stages of multiplication following it, and any change of frequency at the VFO will be multiplied, also. There's no easy way out! Finally, one last word on mechanical rigidity. One component which is very diffficult to make sufficiently rigid is the tuning capacitor. Don't count your pennies here—buy the best you can get, because a vibrating set of plates on the tuning capacitor will make all you constructional efforts quite useless. If you are buying rather than constructing, look inside the case and check the construction round the VFO is rigid. Ask around—fellow amateurs will tell you in no certain terms if a make has a good reputation or not!

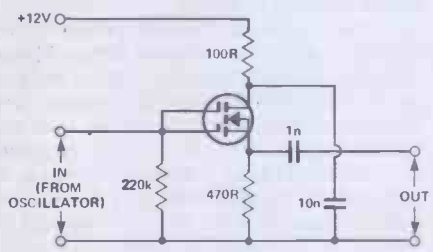


Figure 3. A buffer stage using a FET—this has very high input impedance so that it places very little load on the oscillator.

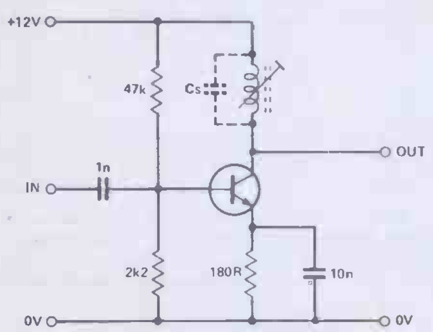


Figure 4. A frequency multiplier. The transistor bias has been arranged so that it is not quite conducting and it will square off the sine wave input, generating harmonics.

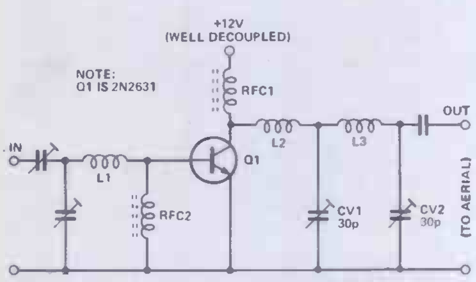


Figure 5. A simple low-power transistor PA stage operating in Class C.

Buffers And Multipliers.

Our problems aren't over yet. The VFO signal must be passed on to the next stage of the transmitter. Any circuit connected to the VFO will have resistance (so that it draws current) and capacitance (so that it affects tuning) and so will affect the frequency of the VFO. If, in addition, it drains too much power from the VFO, it can cause very large frequency changes, even to the extent of stopping the VFO from oscillating. The stage following the VFO should, ideally, be a buffer operating in Class A, with high input impedance (impedance, not just resistance) and comparatively low output impedance. A typical buffer circuit is shown in **Figure 3**.

The VFO normally operates on the lowest frequency band that is to be covered, so that the higher band frequencies have to be obtained by frequency multiplication. As mentioned earlier, this is accomplished by operating a low-power Class B or C stage to generate harmonics, and tuning the output of the stage to the harmonic frequency that is desired. You didn't think that these amateur band frequencies came about by accident, did you!

Multiplication implies that a separate tuned circuit is needed, operating over the whole of the required band (unless you can adjust the multiplier tuned circuit each time you alter the VFO). The most usual method is to use a variable inductor(dust cored), tuned by stray capacitance to around the middle of the band, as shown in **Figure 4**. The really critical tuning problem is that of the VFO.

The Power Amplifier

The combination of VFO, buffers and multipliers is often known as the 'exciter' stage, because it exists simply to generate the frequency which will be used by the power amplifier (PA), the output stage of the transmitter. The design of most AM transmitters provides for modulation of this particular stage, so that PA and modulator can be considered together.

It's here that many of you may have to move into unfamiliar territory. Though transistors can offer useful output powers, very careful construction and design is needed for really high power output. The main problem with transistors is that even a momentary overload (one cycle!) can kill a transistor; valves are very much more tolerant. Overload for a transistor can be a current overload, blowing out a junction, a voltage overload, with the same effect, or a thermal overload, causing a junction to overheat. Transistor PA circuits demand a lot of attention to efficient heatsinks and mechanical construction, as well as to derating of the transistors. Derating means that the maximum power that a transistor can handle is greatly reduced when the transistor is working near its limits of frequency, voltage or temperature. This derating can be very considerable; a transistor which is rated at 40 W in ideal conditions (the conditions that the manufacturers quote—sometimes called infinite heatsink conditions) may be capable of 10 W or less under actual operating conditions. Features such as circuit layout and careful impedance

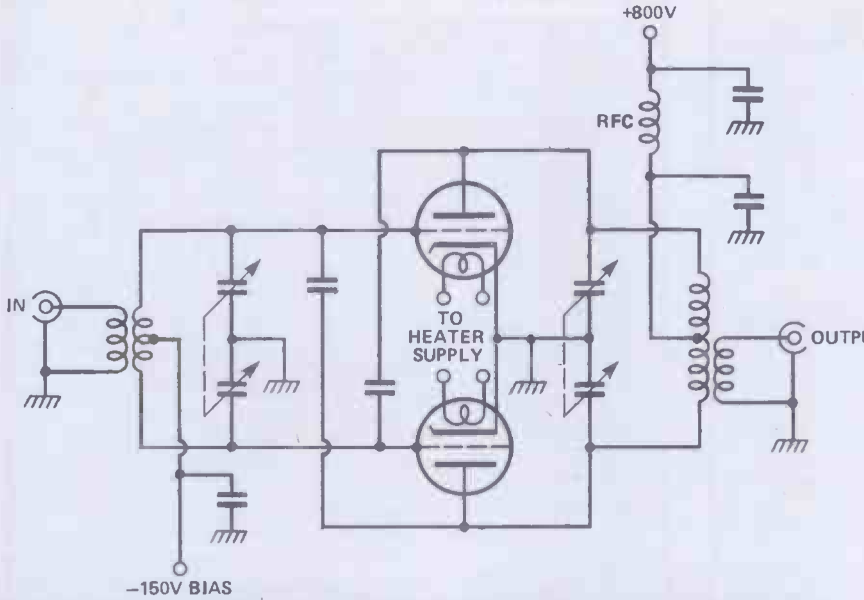


Figure 6. A high-power Class B transistor PA. The step-up and step-down auto-transformers are 4:1 ratio and are wound on small ferrite cores, using only a few turns of wire.

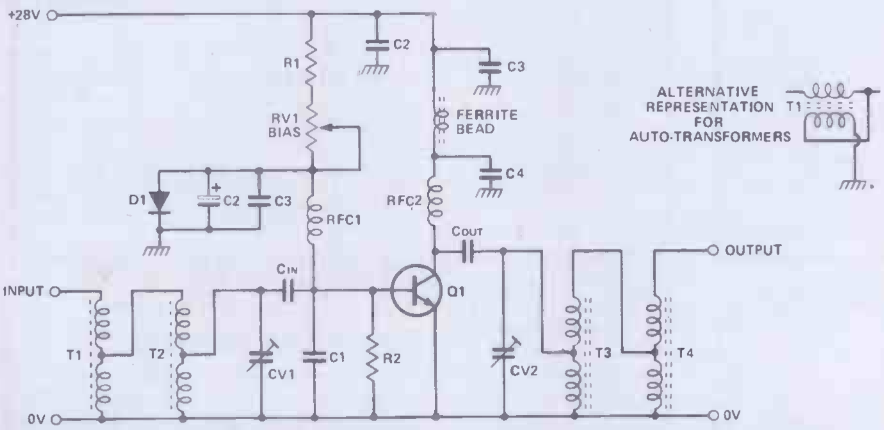
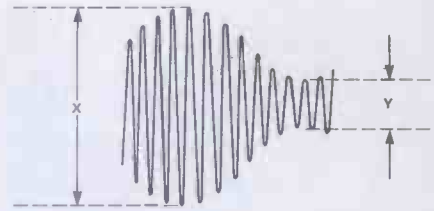


Figure 7. A push-pull valve output stage. Maximum permitted power can be easily acheived with a simpler one-valve stage.



$$\text{MODULATION \%} = \left(\frac{X-Y}{X+Y}\right) \times 100$$

Figure 8. Calculating modulation index—this method requires the use of an oscilloscope.

matching of the PA to the aerial are very much more critical for transistor PA stages than they are for valve stages, because unless the RF power from the PA is all absorbed by the aerial, it will be reflected back and will cause overheating of the transistor.

Transistor Power Amplifiers

Transistors are particularly useful as power amplifiers for low powers (25 W or less) and where mobile operation is needed, since operation from a 12 V battery does not cause any design problems. The transistor type must be carefully selected because the construction of a transistor which is intended to deliver medium power output at high frequencies is quite different from the construction that serves well for audio frequencies. The US type of '2N' transistor coding gives no clue about the purpose of a transistor, whereas the European system is more informative; any transistor suitable for RF power will carry a set of code letters starting with BL, where B indicates silicon, and L means that the transistor is intended for RF uses. These letters may be followed by X, Y or Z, and then a number.

One important point of safety needs to be stressed here: NEVER, under any circumstances, cut open a transistor of this type. One major problem in designing a PA transistor is heat dissipation; many designs make use of a remarkable material called beryllium oxide, which is a good electrical insulator but also a good conductor for heat (a combination usually said to be impossible).

Beryllium oxide, however, is one of the world's nastiest poisonous materials, especially if it's powered (as it would be if you were to saw through it). One speck of this substance in your lungs, and you should see to your last will and testament. In general, transistors which make use of beryllium oxide come with disposal instructions which specify where the defective transistor must be sent. Disregard this at your peril.

The lower the output power, the simpler the circuit, so for a few watts, circuits such as the one illustrated in Figure 5 can be used. The input is a series resonant circuit using the transistor's base-emitter capacitance as part of the series tuning capacitance. The output uses a choke load, with a filter of the type called a pi filter (from its shape, like a Greek letter pi), tuned to pass the frequency of transmission and reject harmonics—it's a low-pass filter, in fact. The pi filter also provides impedance matching between the output stage and the aerial.

Things start to get difficult when higher powers are needed. It is possible to get transistors which will operate at higher power levels in the lower frequency bands, but they are much more difficult to work with. To start off, the very large currents that flow when high-power transistors are used will call for well-stabilised and decoupled power supplies. At these current values, though, transistors have very low input and output impedances; unlike ordinary Class A preamp circuits, values of only a few ohms are common. We can't use the pi-network filter at these impedance levels, because the values of L and C that would be needed to match the low impedances would be highly impractical.

What has to be done, therefore, is to use matching transformers; wideband auto-transformers in fact, as shown in Figure 6. These step-down the signal voltage at the input and step up the current, so transforming the impedance to the correct level, and a similar device performs the opposite action at the output. The transformers are very different in construction from conventional AF, IF, or RF transformers, and usually consist of a few turns of wire with the primary and secondary wound together (bifilar winding) on a core, to ensure tight coupling. Their design and construction is one of the hardest tasks in all amateur radio so the beginner should stick to ready-made components—even with experience, you can become badly unstuck and lose a valuable transistor through mismatching, or find yourself causing disasterous interference.

Valve PA Stages

High power (150 W) PA stages using valves are so simple, by comparison with transistor high power stages, that it isn't surprising that most designers prefer valves for such purposes. There are complications, however, including the need for a comparatively high voltage power supply (350 V to 1000 V), and a heater supply which will require decoupling with low-resistance chokes and capacitors.

A typical high-power valve PA stage is shown in Figure 7. It uses a push-pull circuit of the type that can also be used for linear amplifiers for CB, in countries where this is permitted. The design is simple, and the inductors are straightforward to construct, with few really critical points of construction or of setting-up. **HE**

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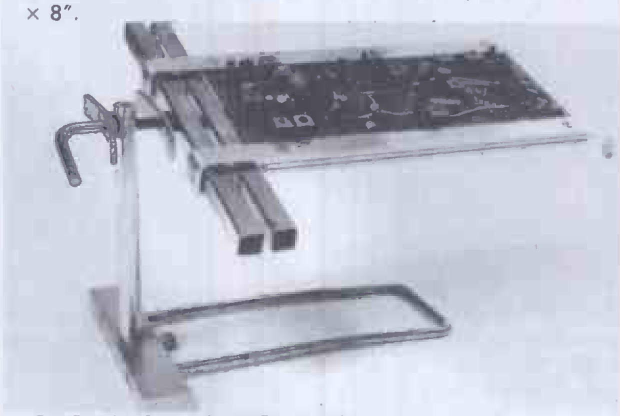

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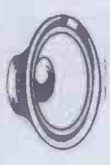

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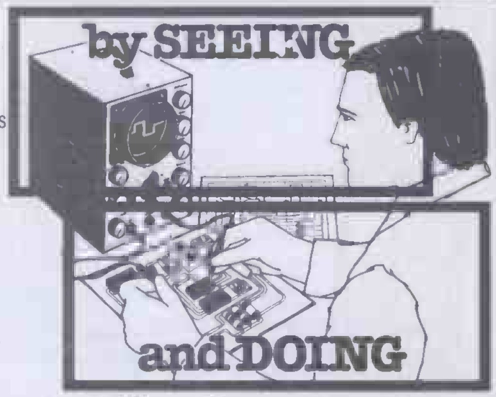

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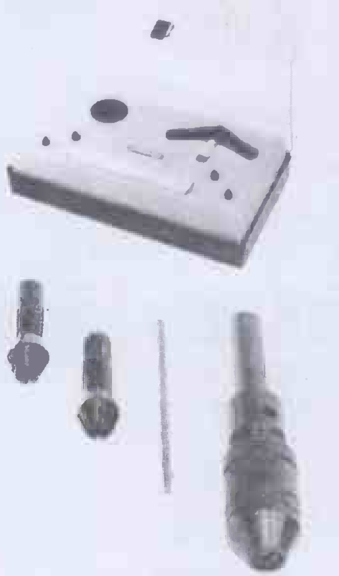

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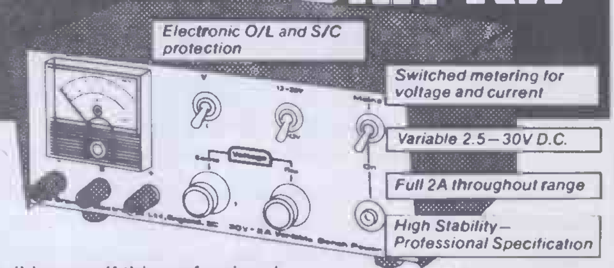

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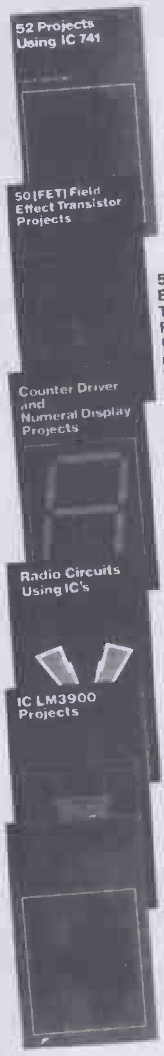

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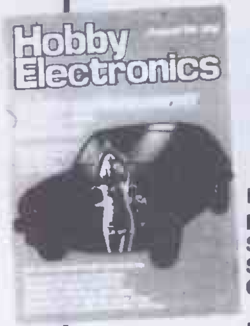

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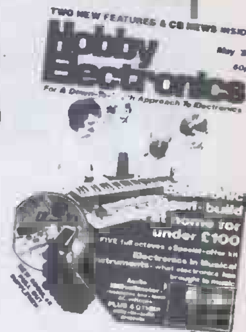

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May 1981
Electronic Organ, Voice-Operated Switch, Infra-Red Controller, Pre-Amplifier Part 2, Audio Millivoltmeter.

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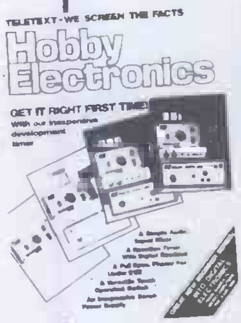
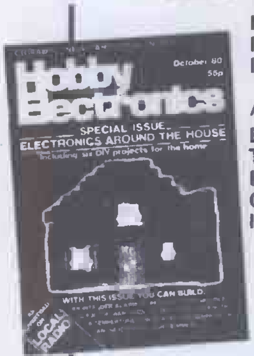
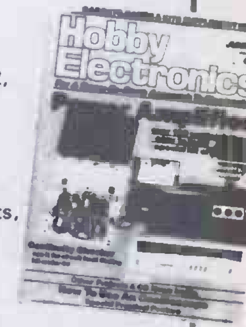
Power Amplifier Part 1, Continuity Checker, Envelope Generator, Early Radio, Gadgets, Games and Kits Supplement.

July 1981
Burglar Alarm, Doorbuzzer, Treble Booster, Electronic Aids for the Disabled, Power Amplifier Part 2.

August 1981
Electronic Ignition, Thermometer, Electronic Organ (final part), RPM Meter, Bench Power Supply, Radio Control Survey, Into Electronic Components Part 1.







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This is a voltage controlled oscillator (VCO) with a wide frequency range, which uses a transconductance op-amp. The other is a logical probe or two, for checking states in TTL or CMOS circuitry. Both the probe's and the VCO need very few components, apart from the ICs, so they shouldn't take long to wire up. Furthermore, all three chips contain at least two devices, leaving you something to expedriment with. . .and we want to see the results, remember!

A voltage controlled oscillator convert's a varying voltage into a varying frequency —this principle underlies the operation of modern synthesisers.

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The frequency of the output is determined by the current passing through R3 into pin 1. This can be anything from a few microamps up to a milliamp or so, thought the range will be restricted by other factors such as output power and supply voltage. Our VCO required a bias current of between 100uA and 1mA, provided by the potential divider RV1, R4 and D3—the diode ensuring a minimum control voltage of OV7. Negative feedback is supplied by R2 to the inverting input, pin 4. This controls the gain and therefore the output level. If you want variable output then replace R2 with a 10k resistor in series with a 100k pot. The non-inverting input is connected to two level clamping diodes D1 and D2, which prevent overloading from the positive feedback through C1. The value of C1 determines the range of frequencies that can be output, so you should experiment with different capacitors, to to a few C hundred picofarads.

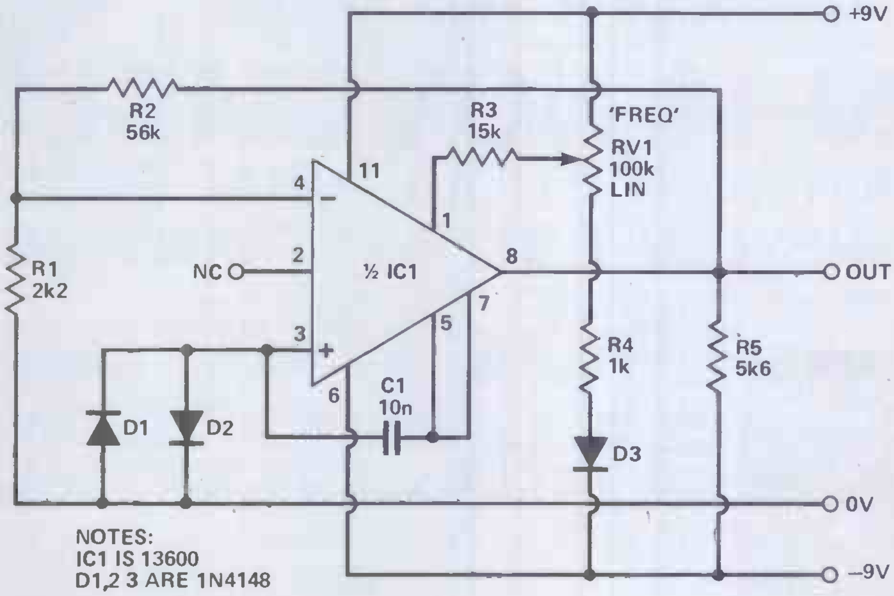

Figure 1. Circuit diagram for the VCO.

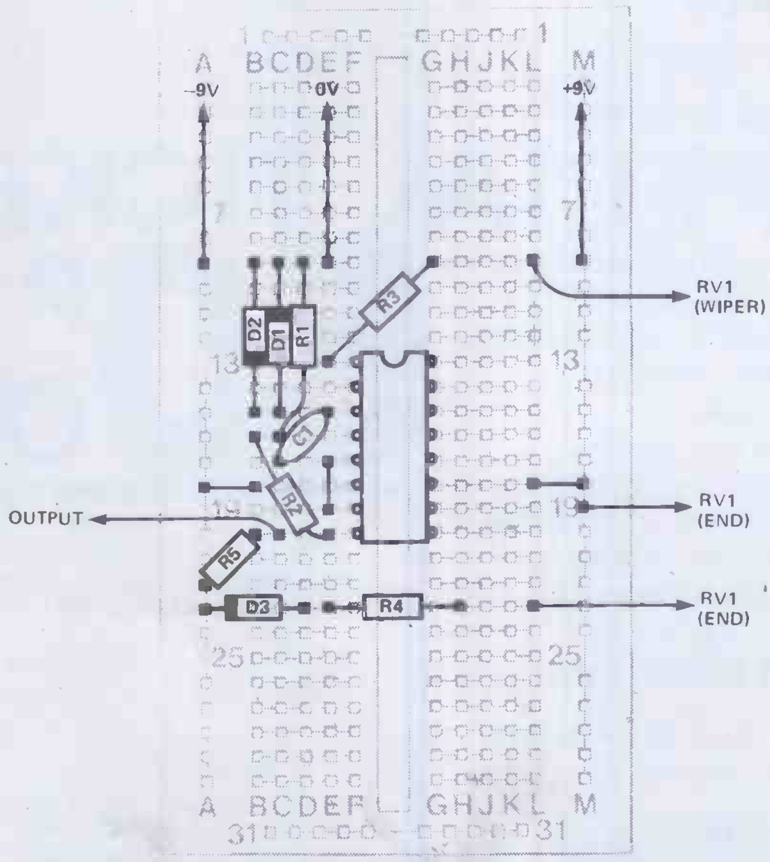

Figure 2. The breadboard layout for the Voltage Controlled Oscillator.

The 13600 can be powered from a wide variety of supplies in the range ± 2 to ± 22 volts. Current consumption in our circuit (± 9 V) was around 6mA per rail; the output, 14 V peak-to-peak, is a flattened triangle wave.

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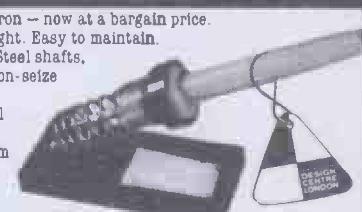

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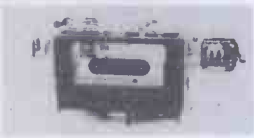

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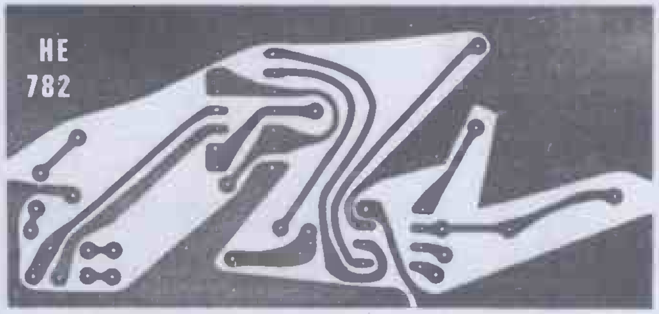
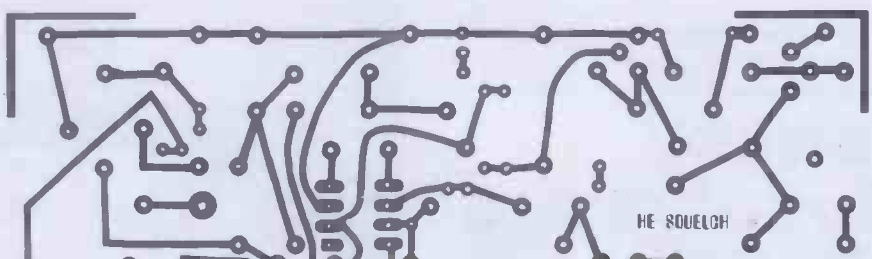
Left: The foil pattern for the Negative Voltage Generator – mind you don't lose it !



The Flash Point Alarm PCB foil pattern (left) and the PCB pattern for the Squelch Unit (below). Both boards have tracks running fairly close to component pads, so make sure all the unwanted copper is etched away.



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A superb sound at a relatively low cost. Complete with instructions. Price £14.90 + £1.50 p&p per kit.

New 5" 30 watt mini version of above now available. Recommended cabinet size 180 × 155 × 295 mm.
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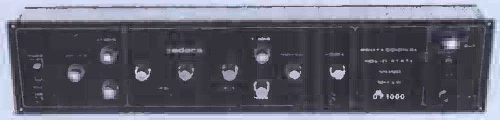

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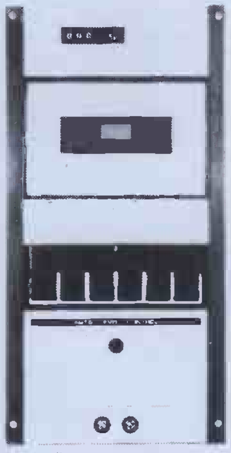

6 piano type keys

STEREO CASSETTE TAPE DECK MODULE. Comprising of a top panel and tape mechanism coupled to a record/play back printed board assembly. Supplied as one complete unit for horizontal installation into cabinet or console of own choice. These units are brand new, ready built and tested.
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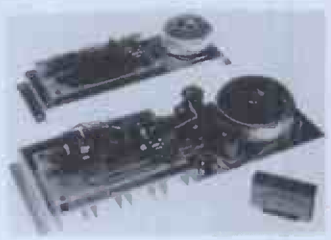
OMP POWER AMPLIFIER MODULES



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Power Amplifier Modules with integral toroidal transformer power supply, and heat sink. Supplied as one complete built and tested unit. Can be fitted in minutes. An LED Vu meter is available as an optional extra.
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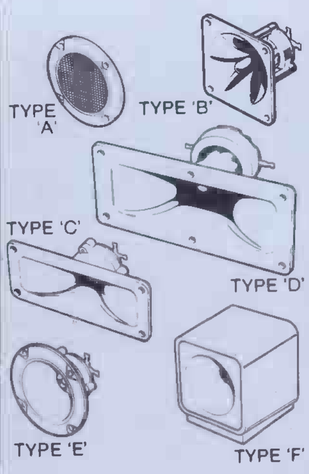

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4021	46p
4022	55p
4023	13p
4024	42p
4025	13p
4027	26p
4028	40p
4029	60p
4030	13p
4035	66p
4040	50p
4042	40p
4044	46p
4047	50p
4049	20p
4050	20p
4051	50p
4052	60p
4053	50p
4066	28p
4067	447p
4069	13p
4070	13p
4071	13p
4076	50p
4081	13p
4086	45p
4093	30p
4098	70p
4503	42p
4510	52p
4511	45p
4512	50p
4516	60p
4518	40p
4520	60p
4528	64p
4539	64p
4555	45p
4556	45p
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7410	14p
7411	14p
7412	18p
7413	22p
7414	26p
7416	18p
7417	22p
7420	15p
7421	20p
7425	20p
7426	27p
7427	15p
7430	15p
7432	18p
7437	18p
7438	18p
7439	24p
7440	16p
7442	24p
7445	50p
7446	68p
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7448	55p
7450	15p
7451	15p
7453	15p
7454	15p
7470	30p
7472	25p
7473	25p
7474	22p
7475	23p
7476	22p
7483	47p
7485	60p
7486	25p
7490	26p
7491	45p
7492	38p
7493	28p
7495	50p
7496	45p
74107	25p
74121	20p
74122	35p
74123	40p
74125	38p
74126	38p
74132	30p
74145	50p
74150	90p
74151	40p
74153	45p
74154	75p
74155	45p
74157	35p
74158	30p
74161	45p
74163	45p
74164	60p
74165	65p
74166	70p
74167	120p
74170	120p

TTL contd.

74173	60p
74174	50p
74175	50p
74180	50p
74190	60p
74191	60p
74192	70p
74193	60p
74194	60p
74195	46p
74196	46p
74197	50p
74221	75p
74279	40p
74290	60p
74298	60p

TTL LS

74LS00	14p
74LS01	14p
74LS02	14p
74LS03	14p
74LS04	14p
74LS05	14p
74LS08	14p
74LS09	14p
74LS10	14p
74LS11	14p
74LS13	21p
74LS14	21p
74LS15	14p
74LS20	14p
74LS21	14p
74LS26	14p
74LS27	14p
74LS28	22p
74LS30	14p
74LS32	14p
74LS33	14p
74LS37	19p
74LS38	14p
74LS40	19p
74LS42	40p
74LS47	44p
74LS48	44p
74LS51	14p
74LS54	14p
74LS74	18p
74LS83	42p
74LS86	14p
74LS90	30p
74LS92	30p
74LS93	30p
74LS95	40p
74LS109	40p
74LS112	30p
74LS113	30p
74LS125	28p
74LS126	28p
74LS132	40p
74LS133	25p
74LS136	20p
74LS138	30p
74LS139	30p
74LS151	40p
74LS153	40p
74LS155	45p
74LS156	45p
74LS157	30p
74LS158	30p
74LS160	35p
74LS161	35p

TTL LS contd.

74LS162	35p
74LS163	35p
74LS164	45p
74LS165	50p
74LS168	60p
74LS169	60p
74LS170	70p
74LS173	40p
74LS174	45p
74LS175	45p
74LS181	110p
74LS190	45p
74LS191	45p
74LS192	45p
74LS193	45p
74LS194	50p
74LS196	35p
74LS197	50p
74LS240	70p
74LS241	70p
74LS244	70p
74LS245	80p
74LS247	60p
74LS249	40p
74LS251	40p
74LS253	35p
74LS256	55p
74LS257	40p
74LS258	40p
74LS259	65p
74LS260	30p
74LS266	22p
74LS273	60p
74LS279	40p
74LS283	40p
74LS290	34p
74LS293	34p
74LS295	52p
74LS299	83p
74LS322	90p
74LS323	130p
74LS347	55p
74LS352	60p
74LS353	60p
74LS365	30p
74LS366	35p
74LS367	30p
74LS368	30p
74LS373	75p
74LS374	75p
74LS375	40p
74LS377	70p
74LS378	60p
74LS379	60p
74LS390	50p
74LS393	50p
74LS395	48p
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Red	150p
Green	248p
Yellow	260p

Common Cathode R.H. decimal point

Red	150p
Green	248p
Yellow	260p

3"

Red	127p
Green	196p

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UA7805	45p
UA7812	45p
UA7905	54p
UA7912	54p
UA723	37p
ULN2003AN	100p

Bridge Rectifiers

50v 1.5A	23p
200v 1.5A	22p
400v 1.5A	30p
600v 1.5A	32p
800v 1.5A	35p

TOGGLE SWITCHES

SPDT on/none/off	48p
SPTD on/off/on	52p
DPDT on/none/off	56p
DPDT on/off/on	60p

SPECIAL

2N 3055 10 for 450p

Micro's Memories & Specials

Z80ACPUPS	550p
Z80ACTCPS	440p
Z80APIOPS	440p
Z80ADARTPS	550p
Z80ASIOPS	440p
8080A	335p
8035HL	500p
8085A4	500p
8202A	2200p
8253	750p
8255	299p
8251	310p
8224	250p
8228	250p
ICL7106	795p
ICL7107	975p
2732A-4	520p
2114A(450ns)	100p
2716	340p
2764	1592p
M108 single chip organ	1330p
M086 Tone generator	300p

Transistors & Diodes

IN4001	4p
IN4007	6p
IN5401	13p
IN5404	16p
IN5406	16p
IN4148	3p
IN914	3p
IN916	5p
BZY88C2V7	8p
BZY88C3V3	8p
BZY88C3V6	8p
BZY88C4V7	8p
BZY88C6V8	8p
BZY88C8V2	8p
BZY88C12	8p
BZY88C15	8p
BC107	11p
BC107A/B	11p
BC108A/B/C	11p
BC109A/B/C	12p
BC182	9p
BC183	9p
BC184	9p
BC212	9p
BCY70	17p
BCY71	18p
BCY72	18p
BFY50	28p
BFY51	28p
BFY52	28p
TIP29/A	30p
TIP30/A	35p
TIP31/A	45p
TIP32/A	45p
TIP/41A	50p
TIP42/A	50p
2N708	24p
2N918	26p
2N2218/A	26p
2N2219/A	28p
2N2221/A	24p
2N2222/A	28p
2N2904/A	29p
2N2905A	28p
2N2906A	28p
2N2907A	28p
2N3053	28p
2N3055	46p
2N3442	130p
2N3715	57p
2N3716	65p

'D' TYPE Connectors

	ml.	fml.
9	58p	78p
15	78p	1.12p
25	1.10p	1.60p
37	1.148p	2.63p
50	1.97p	3.02p

CAPACITORS

Tant Beads 16v

.1uf	11p	6.8uf	18p
.22uf	11p	10uf	18p
.47uf	11p	15uf	30p
1.0uf	11p	22uf	35p
2.2uf	14p	33uf	48p
3.3uf	14p	47uf	80p
4.7uf	18p	68uf	110p

Tant Beads 35v

.1uf	13p	1.00uf	15p
.15uf	13p	1.5uf	15p
.22uf	13p	2.2uf	17p
.33uf	13p	3.3uf	17p
.47uf	13p	4.7uf	20p
.68uf	13p	6.8uf	20p
		10.0uf	27p

Plate Ceramics 63v

10pf	5p	47pf	5p
100pf	5p	220pf	6p
150pf	6p		

Disc Ceramics

.01 50v	2p	.1 50v	5p

Polystyrene 160v

100pf	9p	2200pf	8p
220pf	9p	3300pf	8p
470pf	9p	4700pf	8p
1000pf	9p	6800pf	8p

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