

Hobby Electronics

November '80

ISSN 0142-6192

55p

**BUILD
OUR**

£30 SYNTHESISER

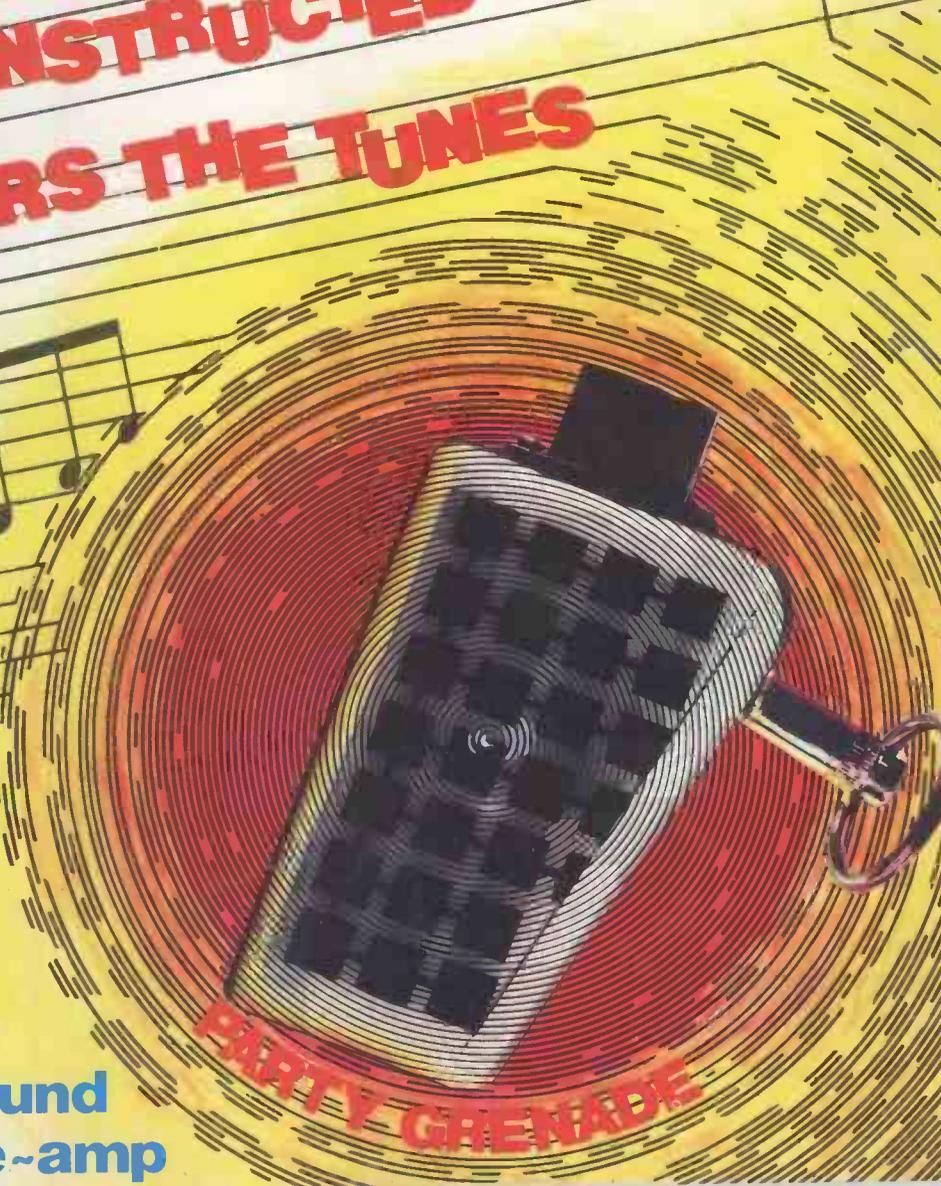
EASILY CONSTRUCTED

REMEMBERS THE TUNES

**Sort Out
The Good From
The Dud With Our
DIY Transistor Tester**

**Save ££££'s
With Our Simple
Battery Eliminator**

**Boost Your Guitar Sound
With Our Built-in Pre-amp**



WE'VE COME A LONG WAY...

and it didn't take very long either. Electronics have evolved faster than anything else. From Marconi's first crackling morse transmissions to minichip in a lifetime. But space-age technology poses it's own problems to dealers anywhere. The days you strung your own aerial with a length of copper wire bought just around the corner are over. Nowadays, if you want the best you'll probably have to go to the States, or Japan, or Denmark ...

or you can contact us. We're not just around the corner, but very nearly so.

Located just about an hour from London, near Schiphol airport in Holland we have one of Europe's largest collections of aerials, CB equipment, accessories, electronics etc. from all over the world. Whether it's Danish, Japanese, American or anything else, we've got all the top names at bottom prices. So, plug into the mains and contact

WINTJOY 103 High Street,
Ltd. Shepperton,
Middlesex TW17 9BL,
England Tel. Walton-
on-Thames (STD)
09322)
48145



Or just simply call us.



TON AHLERS ELEKTRONIKA
Aalsmeerderdijk 349, 1436 BH Rijsenhout -
Holland, telefoon 010 31 2977-28611 (4 lijnen),
telex 15181 tonel nl (vlak bij Airport Schiphol).

**ELECTRONICS HAVE GROWN UP
WHY DON'T YOU, TOO**

Hobby Electronics

NOVEMBER 1980
Vol.3 No. 1

Editor: Hugh Davies
Assistant Editor: Rick Maybury Editorial Assistant: Tina Boylan Project Editor: Keith Brindley
Drawing Office Manager: Paul Edwards Group Art Editor: Paul Wilson-Patterson B.A.
Managing Editor: Ron Harris B. Sc.

PROJECTS



MINI SYNTH	13
<i>Cheap tunes</i>	
BATTERY ELIMINATOR	24
<i>Save pounds</i>	
GUITAR PRE-AMPLIFIER	35
<i>Sounds good</i>	
PARTY GRENADE	41
<i>You'll get a bang from this one</i>	
TRANSISTOR TESTER	53
<i>Cheap checker</i>	
DOUBLE DICE	65
<i>Count on it</i>	

FEATURES

MONITOR	8
<i>Electronics news and views</i>	
STORY BEHIND STEREO	18
<i>For people with two ears</i>	
CLEVER DICK	27
<i>Your questions answered</i>	
INTO DIGITAL ELECTRONICS	29
<i>The gateway to understanding</i>	
WHAT'S IN A NAME	39
<i>The transistor story</i>	
O LEVEL Q & A	49
<i>Teach-in for technology</i>	
TALKING DESIGN	59
<i>Digital amplifiers</i>	
BREAKER ONE FOUR	71
<i>Citizens Band latest</i>	



NEWS & INFO

HE Next Month	10
ETI Next Month	62
Hobbyprints	78
PCB foil patterns	79
Books	80
Classified Ads	82

Advertisement Manager: Stephen Rowe Advertisement Representative: Roy Perryment
Creative Director: Diego Rincón Managing Director: T. J. Connell

Hobby Electronics is normally published on the second Friday of the month prior to the cover date.
Hobby Electronics, 145 Charing Cross Road, London WC2H 0EE, 01-437 1002. Published by Modmags Ltd. Distributed by Argus Distribution Ltd,
12-18 Paul St., London EC2A 4JS. Printed by QB Ltd., Colchester.

Copyright: All material in this publication is subject to world-wide copyright protection. Permission to reproduce printed circuit board patterns commercially or marketing of kits of the projects must be sought from the Publisher. All reasonable care is taken in the preparation of the magazine to ensure accuracy but Modmags cannot be held responsible for it legally. ©Copyright 1980 Modmags Ltd [ABC] Member of Audit Bureau of Circulation.



SIMPLY AHEAD
and staying there

The range grows bigger... better...

New Profile Amplifiers - Two New Series

MOSFET

CHOOSE AN I.L.P. MOSFET POWER AMP when it is advantageous to have a faster slew rate, lower distortion at higher frequencies, enhanced thermal stability, the ability to work with complex loads without difficulty and complete absence of cross-over distortion. I.L.P.'s exclusive encapsulation technique within fully adequate heatsinks has been taken a stage further with specially developed computer-verified 'New Profile' extrusions. These ensure optimum operating efficiency from our new MOSFETS, and are easier to mount. Connections via five pins on the underside. I.L.P. MOSFETS ARE IDENTICAL IN PERFORMANCE TO THE COSTLIEST AMPLIFIERS IN THIS EXCITING NEW CATEGORY BUT ARE ONLY A FRACTION OF PRICES CHARGED ELSEWHERE.

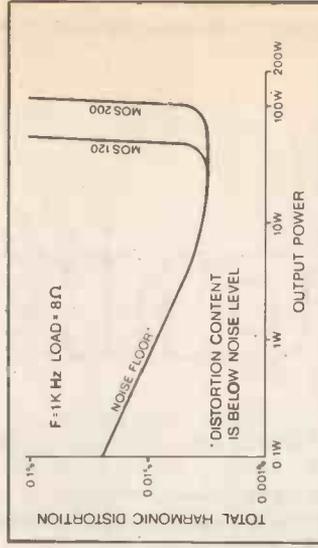
Model	Output Power RMS	Distortion Typical at 1kHz	Slew Rate	Rise Time	Signal/Noise Ratio DIN AUDIO	Price & VAT
MOS120	60W into 4-8Ω	0.005%	20V/μs	3μs	100dB	£25.88 + £3.88
MOS200	120W into 4-8Ω	0.005%	20V/μs	3μs	100dB	£33.46 + £5.02

BIPOLAR

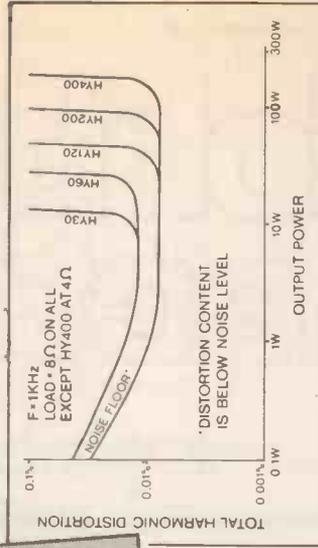
CHOOSE AN I.L.P. BIPOLAR POWER AMP where power and price are first consideration while maintaining optimum performance with high fidelity and wide choice of models. From domestic hi-fi to disco and P.A. for instrument amplification, there is an I.L.P. Bipolar to fill the bill, and as with our new Mosfets, we have encapsulated Bipolars within our New Profile extrusions with their computer-verified thermal efficiency and improved mounting lugs. Connections are simple, via five pins on the underside and with our newest pre-amps and power supply units, it becomes easier than ever to have a system layout housed the way you want it.

Model	Output Power RMS	Distortion Typical at 1kHz	Slew Rate	Rise Time	Signal/Noise Ratio DIN AUDIO	Price & VAT
HY30	15W into 4-8Ω	0.015%	15V/μs	5μs	100dB	£6.34 + 95p
HY60	30W into 4-8Ω	0.015%	15V/μs	5μs	100dB	£7.24 + £1.09
HY120	60W into 4-8Ω	0.01%	15V/μs	5μs	100dB	£15.20 + £2.28
HY200	120W into 4-8Ω	0.01%	15V/μs	5μs	100dB	£18.44 + £2.77
HY400	240W into 4Ω	0.01%	15V/μs	5μs	100dB	£27.68 + £4.15

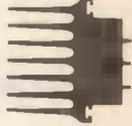
I.L.P. POWER AMPS ARE ENCAPSULATED FOR THERMAL STABILITY AND LONGER LIFE



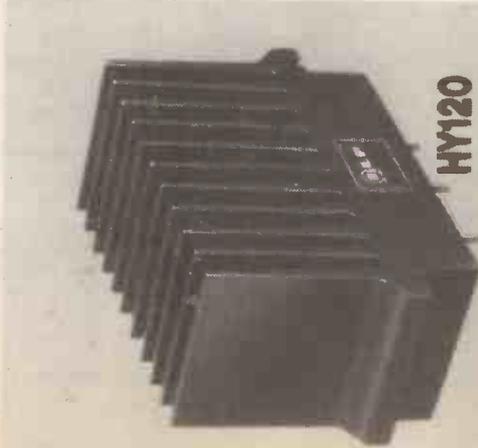
Load impedance both models 4Ω - ∞ Input impedance both models 100kΩ
Frequency response both models 15Hz-100kHz - 3dB



Load impedance all models 4Ω - ∞ Input impedance all models 100kΩ
Input sensitivity all models 500mV Frequency response all models 15Hz-50kHz - 3dB



THE NEW PROFILE EXTRUSIONS
The introduction of standard heatsink extrusion for all I.L.P. power amplifiers achieves many advantages - Research shows they provide optimum thermal dissipation and stability. Slotted shoulders allow easy mounting; standardisation enables us to keep our prices competitive. Surfaces are matt black, anodised for lower thermal conductivity. Extrusions vary in size according to module number.



HY120



HY60

NEW PRE-AMPS

HY6 (mono) and HY66 (stereo) are new to I.L.P.'s range of advanced audio modules. Their improved characteristics and styling ensure their being compatible with all I.L.P. power-amps both MOSFET and BIPOLAR, giving you chance to get the best possible reproduction from your equipment. HY6 and HY66 pre-amps are protected against short circuit and wrong polarity. Full assembly instructions are provided. Mounting boards are available as below.

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

HY6 mono £5.60 + 84p VAT Connectors included
 HY66 stereo £10.60 + £1.59 VAT Connectors included
 B6 Mounting Board for one HY6 78p + 12p VAT
 B66 Mounting Board for one HY66 99p + 15p VAT

NEW POWER SUPPLY UNITS

Of the eleven power supply units which comprise our current range, nine have toroidal transformers made in our own factory. Thus these I.L.P. power supply units are space-saving, more efficient and their better overall design helps enormously when assembling building. All models in the range are compatible with all I.L.P. amps and pre-amps with types to match whatever I.L.P. power amps you choose.

- PSU30 ± 15 V at 100mA to drive up to 12 x HY6 or 6 x HY66 £4.50 + 0.68p VAT
- THE FOLLOWING WILL ALSO DRIVE I.L.P. PRE-AMPS
- PSU36 for 1 or 2 HY30's £8.10 + £1.22 VAT
- PSU50 with toroidal transformer for 1 or 2 HY60's £9.75 + £1.46 VAT
- PSU60 with toroidal transformer for 1 HY120 £9.75 + £1.46 VAT
- PSU65 with toroidal transformer for 1 MOS120 £13.61 + £2.04 VAT
- PSU70 with toroidal transformer for 1 or 2 HY120's £13.61 + £2.04 VAT
- PSU75 with toroidal transformer for 1 or 2 MOS120 £13.61 + £2.04 VAT
- PSU90 with toroidal transformer for 1 HY200 £14.75 + £2.21 VAT
- PSU95 with toroidal transformer for 1 MOS200 £23.02 + £3.45 VAT
- PSU180 with toroidal transformer for 1 HY400 or 2 HY200 £24.20 + £3.63 VAT
- PSU185 with toroidal transformer for 1 or 2 MOS200

★ Freepost facility

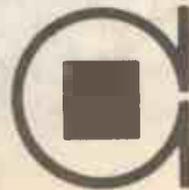
When ordering or writing about I.L.P. products, you do not need to stamp the envelope. Mark it FREEPOST plus the code shown in the address below. We pay the postage for you.

★ **TO ORDER** Send cheque or money order payable to I.L.P. Electronics Ltd and crossed. Or pay by ACCESS or BARCLAYCARD. Cash payments must be in registered envelope. If C.O.D. payments are wanted, please add £1.00 to TOTAL value of order.



PSU

NO QUIBBLE 5 YEAR GUARANTEE
7-DAY DESPATCH ON ALL ORDERS
BRITISH DESIGN AND MANUFACTURE
FREEPOST SERVICE

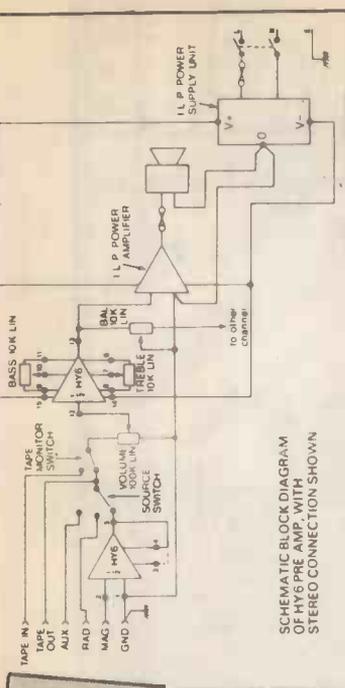


Available also from MARSHALLS, WATFORD ELECTRONICS and certain other selected retailers

FREEPOST 6, Graham Bell House, Roper Close,
Canterbury, Kent CT2 7EP
 Telephone (0277) 54778 Telex 965780

I.L.P. ELECTRONICS LTD.

COMPATIBLE WITH ALL I.L.P. MODULES



SCHEMATIC BLOCK DIAGRAM OF HY6 PRE-AMP, WITH STEREO CONNECTION SHOWN

- **LATEST HIGH QUALITY CONNECTORS**
- **ONLY POTS, SWITCHES AND PLUGS/SOCKETS NEED ADDING**
- **NEEDS ONLY UNREGULATED POWER SUPPLY ± 15 to ± 60 V Mag. P.U.**
- **DISTORTION TYPICALLY 0.005%**
- **S/N RATIO - 90dB (Mag. P.U. - 68 dB)**
- **38 dB overload margin on Mag. P.U.**

IN A RANGE OF 11 MODELS USING LATEST TOROIDAL TRANSFORMERS

1971-1980 TEN YEARS OF PLANNED PROGRESS

When, as a young man in 1971, Ian L. Potts founded his now world-famous company, he realised the need for a different and more rational approach to exploiting to the maximum, the potential of modular construction. New thinking was badly needed. The result was a range of modules completely revolutionary in concept. The richness of Ian Potts' thinking is shown in the size of the company today, its new factory, its vast exports, its acceptance by constructors as the modules to build with. The range grows bigger and better. New lines (in no way replacing existing ones) are well past drawing board stage. This is why I.L.P. are simply ahead and staying there - we don't rest on our laurels.

BRITAIN'S FASTEST GROWING MODULE SUPPLIERS

To: I.L.P. ELECTRONICS LTD, CANTERBURY CT2 7EP

Please supply Total purchase price £.....
 I enclose Cheque Postal Orders International Money Order
 Please debit my Access/Barclaycard Account No.

NAME
 ADDRESS
 Signature

ALL U.K. ORDERS DESPATCHED FREEPOST

SOUTH WALES

FOR TTL, CMOS, LINEARS, DISCRETES, PASSIVES, HARDWARE, TOOLS, CASES, TRANSFORMERS ETC. LEKTROKIT, BREADBOARDING AND VERO DEALERS

BOOKS BY NATIONAL, IOR, BABANI

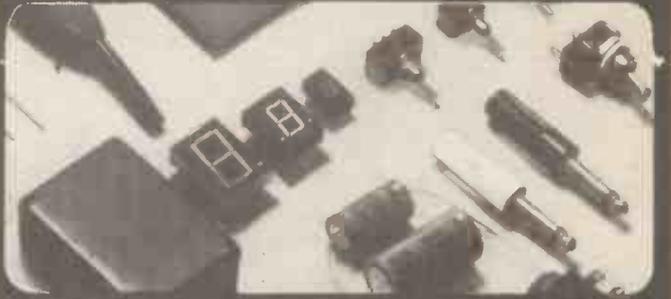
Come to:
**STEVE'S ELECTRONICS
 SUPPLY COMPANY**
 (Formerly Steve's Electronics)

15/17 THE BALCONY, CASTLE ARCADE
 CARDIFF, CF1 2BU. TEL: (0222) 41905

VISIT US AT THE SHOP —
 OPEN MONDAY TO SATURDAY 9-5.30
 Mail and Official Orders Accepted

ELECTROVALUE

FOR COMPONENTS THAT COUNT



SIEMENS
 SEMI-CONDUCTOR
 CAPACITORS
 FERRITES

NASCOM
 MICRO COMPUTERS
 AND
 ANCILLARIES

VERO
 BOARDS
 CASES &
 KITS

ISKRA
 RESISTORS

RADIOHM
 POTENTIOMETERS

BREADBOARDS

SOLDER TOOLS

OPTO-ELECTRONICS

SWITCHES

CATALOGUE 10

**ALL GOOD PROJECTS START WITH CATALOGUE 10
 IT'S FREE FOR THE ASKING**

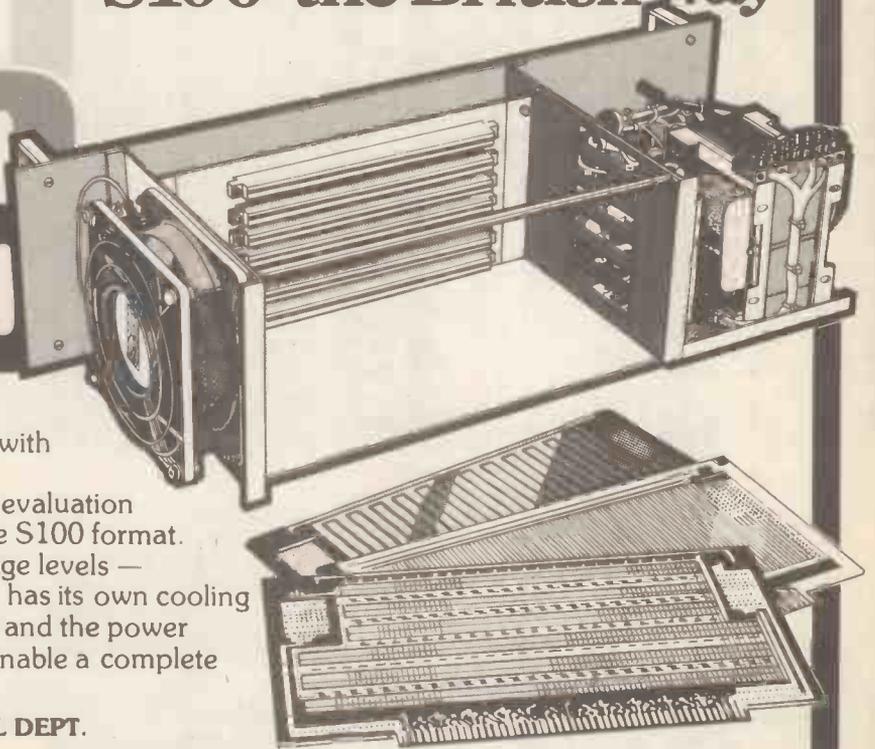
128 pages packed with almost everything everyone wants. There are attractive discounts and free postage in UK on orders £5.75 and upwards

ELECTROVALUE LTD. HEAD OFFICE (Mail Orders)
 28(H) St Judes Road, Englefield Green, Egham, Surrey TW20 0HB. Phone: Egham 33603 Telex 264475.

NORTHERN BRANCH (Personal Shoppers Only)
 680 Burnage Lane, Burnage, Manchester M19 1NA. Phone: (061) 432 4945

vero

S100-the British way



The Vero S100 Sub Rack is a 19" rack mountable development kit, complete with its own power supply and backplane motherboard, for the construction and evaluation of microprocessor based systems to the S100 format. The power supply provides three voltage levels — +8V, +18V and -18V. The Sub Rack has its own cooling fan providing airflow across the boards and the power supply. A full range of allied items to enable a complete system to be constructed are available.



VERO ELECTRONICS LTD RETAIL DEPT.
 Industrial Estate, Chandler's Ford,
 Hampshire SO5 3ZR
 Tel: (04215) 62829

WATFORD ELECTRONICS

35 CARDIFF ROAD, WATFORD, HERTS., ENGLAND
MAIL ORDER, CALLERS WELCOME. Tel. Watford 40588/9

ALL DEVICES BRAND NEW, FULL SPEC. AND FULLY GUARANTEED. ORDERS DESPATCHED BY RETURN OF POST. TERMS OF BUSINESS: CASH/CHEQUE/P.O. OR BANKERS DRAFT WITH ORDER. GOVERNMENT AND EDUCATIONAL INSTITUTIONS' OFFICIAL ORDERS ACCEPTED. TRADE AND EXPORT INQUIRY WELCOME. P&P add 40p to ALL ORDERS UNDER £10. OVERSEAS ORDERS POSTAGE AT COST, AIR/SURFACE. ACCESS ORDERS WELCOME.

VAT Export orders no VAT. Applicable to U.K. Customers only. Unless stated otherwise, all prices are exclusive of VAT. Please add 15% to all prices.
We stock thousands more items. If you wish to visit us, we are situated behind Watford Football Ground. Nearest Underground/BR Station: Watford High Street. Open Monday to Saturday, 9 a.m. to 6 p.m. Ample Free Car Parking space available.

POLYESTER CAPACITORS: Axial lead type.
400V: 1nF, 1.5n, 2n, 3n, 4n7, 6n8, 10n, 15n 9p, 18n 10p, 22n, 33n 11p, 47n, 68n 14p, 100n 17p, 150n, 220n 24p, 330n, 470n 33p, 680n 52p; 1µF 64p; 2µ 82p; 4µ 7 85p.
160V: 39F, 50n, 100n, 220n 11p, 330n, 470n 19p, 680n, 1µF 22p; 1µ5, 2µ 32p; 4µ 7F 36p.
1000V: 10nF, 15n 20p, 22n 22p; 47n 26p; 100n 38p; 470n 80p; 1µF 175p.

POLYESTER RADIAL LEAD CAPACITORS: 250V:
10nF, 15n, 22n, 33n, 47n, 68n, 100n 17p, 150n 10p, 220n, 330n, 470n 17p, 680n 19p; 1µF 22p; 1µ5 30p; 2µ 34p; 4µ 7 60p.

ELECTROLYTIC CAPACITORS: Axial lead type (Values are in µF). 500V: 10 50p; 47 78p; 280V: 100 65p; 63V: 0.47, 1, 1.5, 2.2, 2.5, 3.3, 4.7, 6.8, 8, 10, 15, 22, 47, 32, 50 12p; 63, 100, 270, 50V: 50, 100, 220, 250, 300, 400, 500, 40V: 22, 33, 100, 12p; 220, 330, 85p; 470, 88p; 35V: 33, 10p; 330, 470, 32p; 25V: 10, 22, 47, 100, 8p; 150, 220, 250, 15p; 470, 250, 64, 1000, 35p; 150, 40, 220, 54p; 330, 77p; 470, 85p; 16V: 10, 47, 68, 7p; 100, 125, 8p; 220, 330, 16p; 470, 20p; 1000, 1500, 30p; 2200, 36p.
TAG-END TYPE: 450V: 100µF 180p; 70V: 4700, 165p; 64V: 3300 150p; 250 110p; 50V: 3300 135p; 200 90p; 40V: 4700 130p; 4000 28p; 3300 95p; 2000+2000 120p; 30V: 4700 110p; 25V: 15,000 195p, 6400 120p; 4700 100p; 3300 85p; 2200 60p.

TANTALUM BEAD CAPACITORS
35V: 0.1µ, 0.22, 0.33, 0.47, 0.68, 1.0µ; 2.2µ, 3.3µ; 4.7, 7.8µ; 10µ.
60V: 6µ; 16V: 2µ; 4.7, 7.8, 10, 20p.
16V: 2µ, 3.3µ; 4.7, 10 58p; 220 86p.
10V: 15n, 22n, 33n, 33p, 100 40p; 6V: 4.7µ; 68; 100 32p; 3V: 100 23p.

MYLAR FILM CAPACITORS
100V: 0.001, 0.002, 0.005, 0.01, 0.1µF 6p
0-015, 0-02, 0-04, 0-05, 0-056µF 7p
0.1µF 8p, 50V: 0.47µF 12p

MINIATURE TYPE TRIMMERS
2.5 5pF; 3.1 10pF; 10-40pF 28p
5-25pF; 6.5-5pF; 60pF; 88pF 35p

COMPRESSION TRIMMERS
3-40pF; 10-80pF; 25-190pF 33p
100-500pF 45p 1250pF 55p

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

SILVER MICA (Values in pF) 3.3, 4.7, 6.8, 10, 12, 15, 18, 22, 33, 47, 50, 68, 75, 82, 85, 100, 120, 150, 180 11p each; 220, 250, 270, 300, 330, 360, 390, 470, 600, 800, 820 16p each; 1000, 1200, 1800, 2200 26p each.

CERAMIC CAPACITORS 50V: 0.5pF to 10nF 4p; 22n to 47n 6p, 100n, 7p.

EURO BREADBOARD £5.20.

VOLTAGE REGULATORS

1A TO3	+ve	-ve	
5V 7805	145p	7905	220p
12V 7812	145p	7912	220p
15V 7815	145p		
18V 7818	145p		

1A TO220 Plastic Casing

5V 7805	65p	7905	65p
12V 7812	60p	7912	65p
15V 7815	60p	7915	65p
18V 7818	60p	7918	65p
24V 7824	60p	7924	65p

100mA TO92 Plastic Casing

5V 7805	30p	7905	65p
6V 7812	30p		
8V 7812	30p		
12V 7812	30p	7912	65p
15V 7815	30p	7915	65p

CA3085 95p LM323K 625p TAA550 50p
LM3004 170p LM325N 240p TBA625B 50p
LM3085 140p LM328N 240p TOA1412 150p
LM3093 135p LM327 270p 78H05 595p
LM317K 350p LM723 39p 78HG65 650p

JACKSONS VARIABLE CAPACITORS

Dielectric	0.2 365pF with slow motion drive	450p
100/300pF	205p	500p
500pF	250p	600p
8:1 Split Drive	00 208/176 with 4511/OAF	145p
Dial Drive 4103	slow motion drive	410p
6:1/36:1	775p	CB04-5pF: 10, 15, 25, 50pF
Drum 64mm	59p	25-50pF
0.1-365pF	325p	100, 150pF
00.2-365pF	395p	L'3k310pF
		00.3k25pF

DENCO COILS
RFC VALVE TYPE
Range 1 to 5 Bl.
Rd. Tl. Whl. 106p
6.7 BYR 95p
1.5 Green 130p
T type 1 to 5, Bl.
Rd. Whl. Yr 130p
89A Valve Holder 35p
RD2T 120p

DIODES

BA100	15	BA100	15
BY126	12	BY126	12
CR033	158	CR033	158
OA9	45	OA9	45
OA47	18	OA47	18
OA70	12	OA70	12
OA79	15	OA79	15
OA81	15	OA81	15
OA85	15	OA85	15
OA90	8	OA90	8
OA91	8	OA91	8
OA95	8	OA95	8
OA200	9	OA200	9
QA202	9	QA202	9
IN914	6	IN914	6
IN916	6	IN916	6
IN4001/2	5	IN4001/2	5
IN4003	6	IN4003	6
IN4004/5	7	IN4004/5	7
IN5408	4	IN5408	4
IN5401/2	15	IN5401/2	15
IS44	20	IS44	20
3A/100V	18	3A/100V	18
3A/400V	20	3A/400V	20
3A/600V	27	3A/600V	27
3A/1000V	30	3A/1000V	30

ZENERS
Range: 2V7 to 39V 400mW
0.8A100V 30
0.8A200A 35
1A/100V 42
33V, 1.3W 15p each

SCRs Thyristors
0.6A/200V 30
0.8A100V 30
0.8A200A 35
1A/100V 42
1A/200V 47
1A/400V 29
1A/600V 34
2A/50V 35
2A/100V 46
2A/200V 46
2A/400V 53
2A/600V 65
6A/100V 73
6A/200V 78
6A/400V 85
6A/600V 108
12A/100V 80
12A/200V 80
12A/400V 80
12A/600V 80
16A/100V 95
16A/200V 95
16A/400V 95
16A/600V 95
25A/100V 120
25A/200V 120
25A/400V 120
25A/600V 120

BRIDGE RECTIFIERS
(plastic case) p
1A/50V 20
1A/100V 22
1A/200V 25
1A/400V 29
1A/600V 34
2A/50V 35
2A/100V 46
2A/200V 46
2A/400V 53
2A/600V 65
6A/100V 73
6A/200V 78
6A/400V 85
6A/600V 108
12A/100V 80
12A/200V 80
12A/400V 80
12A/600V 80
16A/100V 95
16A/200V 95
16A/400V 95
16A/600V 95
25A/100V 120
25A/200V 120
25A/400V 120
25A/600V 120

TRIACS
3A/100V 48
3A/200V 49
3A/400V 50
3A/600V 50
8A/100V 64
8A/200V 64
8A/400V 64
8A/600V 64
12A/100V 80
12A/200V 80
12A/400V 80
12A/600V 80
16A/100V 95
16A/200V 95
16A/400V 95
16A/600V 95
25A/100V 120
25A/200V 120
25A/400V 120
25A/600V 120

DIAC
ST2 25
T28000D 120

TTL 74

7400	11	74125	45	74LS74	40	4021	105	4432	1050	LM3801	80
7401	12	74126	55	74LS75	45	4022	95	4435	1050	LM381	135
7402	12	74132	70	74LS76	45	4023	25	4438	95	LM382	125
7403	14	74136	68	74LS83	105	4024	75	4450	350	LM386	99
7404	14	74141	85	74LS85	105	4025	25	4451	350	LM387	150
7405	18	74142	195	74LS90	50	4026	180	4452	—	LM1458	40
7406	48	74143	150	74LS95	50	4027	48	4490F	750	LM3900	60
7407	48	74145	90	74LS97	75	4028	82	4490V	750	LM3909N	70
7408	22	74147	180	74LS99	115	4029	105	4501	258	LM3911	125
7409	22	74148	145	74LS96	180	4030	60	4502	125	LM3914	240
7410	19	74150	150	74LS98	180	4031	225	4503	75	M252	625
7411	25	74151	75	74LS107	48	4032	125	4506	75	M253A	1150
7412	28	74152	195	74LS109	75	4033	178	4507	60	MC1304P	260
7413	30	74153	195	74LS112	80	4034	210	4508	325	MC1310D	140
7414	32	74156	80	74LS113	65	4035	125	4510	99	MC1312P	195
7415	32	74157	75	74LS114	49	4036	365	4511	150	MC1458	45
7416	31	74159	185	74LS122	70	4037	115			MC1488	85
7417	31	74160	90	74LS123	95	4038	118			MC1489	90
7418	31	74161	99	74LS124	180	4039	360			MC1495	350
7419	36	74162	99	74LS125	60	4040	105			MC1496	92
7420	36	74163	99	74LS126	60	4041	80			MC1710	79
7421	32	74164	120	74LS132	95	4042	80			MC3340P	130
7422	32	74165	120	74LS136	55	4043	95			6502	995
7423	32	74166	120	74LS138	70	4044	95			6800	800
7424	32	74167	155	74LS139	90	4045	175			709C 8 pin	35
7425	30	74168	155	74LS145	120	4046	130			710	67
7426	32	74169	240	74LS147	210	4047	98			723	225
7427	30	74170	230	74LS148	175	4048	65			741C 8 pin	17
7428	30	74172	420	74LS149	175	4049	45			747C	78
7429	20	74173	120	74LS151	96	4050	48			748C	36
7430	20	74174	105	74LS153	85	4051	80			753	150
7431	35	74175	82	74LS155	96	4052	80			81D	158
7432	35	74176	90	74LS157	76	4053	60			81LS95	130
7433	38	74177	90	74LS160	120	4054	130			81LS96	130
7434	38	74178	149	74LS162	110	4055	135			81LS97	140
7435	38	74179	149	74LS163	118	4056	135			81LS98	140
7436	38	74180	149	74LS164	118	4057	190			81LS99	140
7437	38	74181	149	74LS165	115	4058	190			81LS100	140
7438	38	74182	149	74LS166	115	4059	190			81LS101	140
7439	38	74183	149	74LS167	115	4060	190			81LS102	140
7440	38	74184	149	74LS168	115	4061	190			81LS103	140
7441	38	74185	149	74LS169	115	4062	190			81LS104	140
7442	38	74186	149	74LS170	115	4063	190			81LS105	140
7443	38	74187	149	74LS171	115	4064	190			81LS106	140
7444	38	74188	149	74LS172	115	4065	190			81LS107	140
7445	38	74189	149	74LS173	115	4066	190			81LS108	140
7446											

Monitor

Cellular Construction

How many times have you been faced with a suspect 'dud' battery with no way of testing it? There's absolutely no excuse any more with this ingenious battery/cell tester/charger/bulb and fuse checker. No, it won't make the tea but that is about the only omission we can see. As you can see from the picture it will accept any cell or battery from the largest to the smallest (including watch and calculator batteries). The bulb tester section will happily accommodate any size of torch or instrument bulb

and the test leads can check fuses and filaments for continuity. With the addition of a simple battery eliminator the unit will charge virtually the whole range of Ni-Cad cells and batteries. By now you should be asking the price of this marvel. You won't be disappointed because it will only cost £11.95 (plus VAT). It should be in the better electrical and electronics shops about now, ask for the X10 Battery Tester/Charger. If you have any difficulty then contact the importers who are: Northern Technical & Chemical Services Ltd of Liverpool.



Déjà Vu

Just as the sun rises each morning you can predict with equal certainty that somebody would try and copy the incredibly successful Sony Stowaway stereo cassette player.

A couple of months ago we told you how the Stowaway was becoming a craze, even at £99.00! Sony couldn't make enough of them. Now, entering stage left is the Binatone Company with its Hipfi. We had to look at it very closely indeed to make sure it was not a Stowaway with different makings, they're as similar as that! At the time of writing we haven't had a chance to cast a critical ear to the device but at only £59.95 it's bound to be a winner. It may even

persuade Sony to drop its price. All of the features of the Stowaway are there, even a 'Talk Line' which bears more than a passing resemblance to the Sony 'Hot Line'. (This is a facility which will allow you to listen to the tape and nearby conversation via the built-in microphone.) The only real difference is the headphones: obviously Binatone couldn't use the amazing MDR3s from Sony. Instead they have developed their own look-alikes which we'll report on in the next issue. Meanwhile if you want to try them out for yourself then get along to Selfridges in Oxford Street. Binatone may be contacted direct at: Binatone House, 1 Beresford Avenue, Wembley, Middlesex HA0 1YX.

Notes From Casio

Our friends at Casio are back with a vengeance this month with no less than three singing and dancing boxes full of electronic wizardry.

First (and smallest) is an interesting new calculator that not only plays tunes but boasts a devastating and compulsive game that you just cannot put down. The MG-880 is fairly conventional in the calculator department with memory and percentage etc. Numerical keys are all designated with a musical note (do, re, me etc.) so even the most mundane calculations become a musical experience. The game is really clever. You control a 'laser' weapon that must destroy the alien hords that attempt to cross the LCD screen from right to left. Each alien is represented by a single digit. To destroy the alien you must match the digit with your aim button which steps through the numbers 0-9 sequentially. When the correct digit has been selected the fire button will eliminate the monster. As you might

expect the game starts relatively slowly and speeds up to a superfast speed that is virtually impossible to defeat.

So much for the brainy stuff, the other offerings from Casio are much less demanding. They are a pair of very good-looking electronic organs. The smaller of the two is called the Casiotone M-10. It is a fully polyphonic musical instrument offering 2½ octaves via 32 keys. Four effect keys give piano, violin, flute and organ voices. The M-10s larger brother is called the Casiotone 201 and covers four octaves. There are something like 30 different voices and effects that should keep the neighbours annoyed for weeks.

Now for the important bit (all bank managers please avert their eyes at this point). The MG-880 game can be yours for just £10.95. The M-10 is a very reasonable £69.00 and the 201; a paltry £245.00. All these prices are inclusive of VAT and P & P from our good friends Tempus. Find them at: 164-167 East Road, Cambridge CB1 1DB.



News from the Electronics World



Tale Of Two Meters

No not 2 metres, but a couple of digital multimeters, the TS1000 from Eagle International, and the TM352 from Thandar.

Taking the TS1000 first, it has a 3½-digit LED display (8 mm characters) and provides 16 ranges covering DC and AC voltage, DC current and resistance. Features include h_{FE} and diode test. Despite having an LED display, the four HP7 batteries, claims Eagle, last between 150 and 200 hours. It can also be powered from an external 9 V DC supply. The TS1000 has a two-year guarantee and costs around £60 including VAT.

By comparison, the TM352 has an LCD display (12.5 mm characters). It also has 16 ranges, but in addition to h_{FE} and diode tests it includes a continuity check, where a buzzer sounds if measured resistance is less than $130R \pm 50R$. Life of the 9 V PP3 battery is claimed to be in excess of 150 hours. The TM352 has a one-year warranty and costs around £50.

Both meters incorporate overload protection and are supplied with test leads. A brief, and almost identical, specification for each is given below. Lower figures (such as 100 μ V from 100 μ V to 1 kV) apply to limits of lowest ranges.

	TS1000	TM352
Input impedance	10MR	10MR
DC voltage	200 mV to 1 kV	200 mV to 1 kV
AC voltage	200 V to 1 kV	200 V to 1 kV
DC current	200 μ A to 10 A	200 μ A to 10 A
Resistance	2k Ω to 2MR	2k Ω to 2MR
Accuracy	$\pm 1.2\%$ ± 2 digits all ranges	$\pm 1\%$ on 10 A and resistance ranges, $< \pm 1\%$ on all other ranges

Mobile Mayhem

Now be honest with yourself, how much money have you spent on pub Space Invader machines? At ten pence a go you would have been able to buy your very own Space Invader game after only 220 plays. Admittedly this new hand-held version isn't exactly the same as the pub game but it is easily the best portable machine we've seen. It's called Electronic Space Invaders and comes from a company called Entex. The Entex version has two columns of aliens, two laser bases and the obligatory flying saucer, worth 10, 20 or 30 points when hit. Two levels of play are available. Our best score to date is 450 on the 'Pro' level. As the top score is 999 you can see we've a long way to go. The only real criticism of the game is the lack of brightness on the display. When we first tried it out we thought the batteries were dead, a new set proved us wrong. It only becomes a nuisance in strong light but it is a minus point on an otherwise excellent game. Space Invaders is available from our old friend NIC



for £21.95. Keep a look out for more Entex games: we've had some samples in the office and can say with confidence that this is one games company with a lot of original ideas.

Tip Top Shape

Announcing the latest four-hour VHS video tape from JVC. Until now the best you could get was a mere three hours recording time. This new tape, designated the E240 will be undergoing a market trial in the next few months. What am I bid for the Betamax system, do I hear five hours.



Ancient Audio

Way back in the September issue we told you all about the Vintage Wireless Company's interesting publication. Well, if you are interested in vintage radios then you may like to subscribe to the Vintage Wireless Company's newsletter. This is available for just £2.50 per year (£4.00 overseas) from: The Vintage Wireless Company, 64 Broad Street, Staple Hill, Bristol BS16 5NL.

Just In Case

Project housings continue to look more and more like commercial boxes — here is a prime example from Vero. It is called simply the Pocket-Size, Hand-Held Box, and measures about 80 x 110 mm. The cut-out in the top will happily accommodate an LED display or switch panel. In the underside, Vero have sectioned off a battery compartment just right for PP3s or Ni-cads. The slide-off cover allows for easy battery replacement. Inside the case there is room for a PCB measuring up to 71 x 107 mm in the bottom section whilst the top half can take another board up to 56 x 105 mm. The top and bottom sections are held together by four self-tapping screws. For more information on this box and Vero's extensive range of attractive casings contact them at: Vero Electronics Ltd, Industrial Estate, Chandlers' Ford, Eastleigh, Hampshire SO5 3ZR.

Clever Clock

Have you noticed the new clock on BBC 2 lately? Chances are you haven't because it looks quite ordinary. Actually it's not what it seems, it is generated electronically, totally solid-state and of course very accurate. Next time it comes on your screen have a close look, it really is ingenious.

Errata

Guess what. There is no Errata this month. We actually got it right. Is this the shape of things to come?



TH. NEXT MONTH. NEXT MONTH. NEXT MONTH. NEXT MONTH. NEX

Hobby Electronics

ON SALE NOVEMBER 14th

Video Disc Systems

Just as video cassette machines are becoming firmly established next to the family TV, a relatively new method of video playback has been announced. We look at what it is, how it works and what it is likely to cost.



Battery Charge Indicator

Let's face it, not every car has an ammeter, voltmeter or other indication of battery state. But many motorist-readers will have suffered problems with their generators, alternators, regulators, or, of course, batteries. With this second HE car project for the December issue you can have a clear visual display of battery voltage.

Jack Lead Tester

Ever been let down on the job? Ever been stuck with a faulty jack plug lead? Many a musician has, that's for sure. The HE jack lead tester is pocket-sized and tells you instantly what the fault is. Not only that, it only costs around £2.



Audio Power Meter

Is your hi-fi amp LOUD enough for the neighbours? Our stereo bar-graph power meter shows you at a glance your watts-per-channel. It can be calibrated either in watts or nuisance units.

Dynamic Digital Speedo

Would you like your dashboard to look like that of an Aston Martin Lagonda? (Unless you've already got a Lagonda, that is.) Well, at least you can make a start with our digital speedo. If you get the calibration right you should keep closer to the legal speed limits. (No, it's not electronically coupled to the throttle.)

Model Train Controller

'Not another train controller!' you may say, but wait and see — this one's different. It uses pulsed control to give you a s-m-o-o-t-h chug response rather than the unrealistic lurch produced by some conventional controllers.

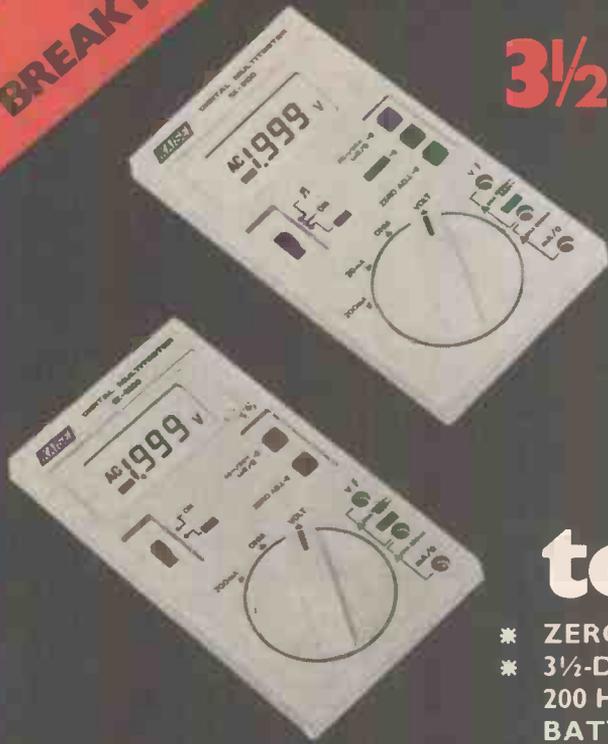
We are also planning another train modellers' project for the New Year which will work in conjunction with the HE train controller.



TH. NEXT MONTH. NEXT MONTH. NEXT MONTH. NEXT MONTH. NEXT MO

items mentioned here are those planned, but unforeseen circumstances may affect the actual contents.

**DMM
BREAKTHROUGH**



If you want an Autoranging 3½-digit LCD DMM For only

£39.95

(inc VAT)

We've got to hand it to you!

- * ZERO ADJUSTMENT
- * 3½-DIGIT LCD WITH 200 HRS CONTINUOUS BATTERY LIFE
- * AUTO 'BATT' WARNING
- * FULL AUTORANGING
- * AUTO UNIT DISPLAY
- * CONTINUITY TEST (6110 and 6100 only)
- * 10 AMP AC/DC (6110 and 6220 only)

Introducing the latest professional state-of-the-art 3½-digit DMM – at really old-fashioned prices! From just an unbelievable £39.95 inc. VAT, plus £1.15 p&p!

	6100	6110	6200	6220
RESOLUTION	1mV, 10µA, 0.1Ω on all models			
FULL AUTO RANGING	✓	✓	✓	✓
RANGE HOLD	✓	✓	✓	✓
UNITS OF MEASUREMENT DISPLAYED	mV, V, mA	mV, V, mA, A	mV, V, mA	mV, V, mA, A
FUNCTIONS DISPLAYED	Ω, kΩ, AUTO, BATT, ADJ, LO, – and AC			
MEASURES DC VOLTAGE TO	1000V	1000V	1000V	1000V
MEASURES AC VOLTAGE TO	750V	750V	750V	750V
MEASURES AC DC CURRENT TO:	200mA	10A	200mA	10A
ZERO ADJUSTMENT	Zeros out minute test-lead resistances for precise measurements			
ACCURACY	0.5%	0.5%	0.8%	0.8%
LOW POWER OHM RANGES	For in-circuit resistance measurements on all models			
BUZZER – Continuity Test	✓	✓	✓	✓
BUZZER – Over Range Indicator	✓	✓	✓	✓
COMPLETE WITH	Batteries, pair of Test Leads, Spare Fuse, One Year's Guarantee			
PRICE	ONLY £64.95	ONLY £74.95	ONLY £39.95	ONLY £49.95
p&p	£1.15	£1.15	£1.15	£1.15

Why such a low, low price? Because the A/D converter and display are custom built! This is a genuine top-spec DMM. Check these features for unbeatable value – you won't find a hand-held DMM with these features at these prices again!

I believe you! Please send me the DMM/s as marked.

_____ 6200 @ £41.10 each, inc. VAT, p&p. Total price £ _____
 _____ 6220 @ £51.10 each, inc. VAT, p&p. Total price £ _____
 _____ 6100 @ £66.10 each, inc. VAT, p&p. Total price £ _____
 _____ 6110 @ £76.10 each, inc. VAT, p&p. Total price £ _____

Total cash/cheque enclosed £ _____
 Cheques payable to
 Maclin-Zand Electronics Ltd., please.

Available from the company that gives you tomorrow's technology today, and from other reputable dealers.
 38 Mount Pleasant, London WC1X 0AP.
 Tel. 01-278 7369/01-837 1165.

ACCESS orders taken. Please write card no: and signature.

ACCESS NO _____ 

Name _____

Address _____

Signed _____



Maclin-Zand

Making state-of-the-art affordable.

To: Maclin-Zand Electronics Ltd., 38 Mount Pleasant, London, WC1X 0AP.
 Allow 4 to 6 weeks for delivery. For overseas orders, please add £5 to cost of total order package.



COMPUTER WAREHOUSE

NOW OPEN
MONDAY-SATURDAY
9.30-5.30

SCOOP PRINTER PURCHASE
PROFESSIONAL EQUIPMENT AT HOBBYIST PRICES
SO LOW EVEN OUR COMPETITORS GASP!

In stock now test equipment, microprocessors, teletypes, transformers, power supplies, scopes, sig. gen's, motors, peripheral equipment, I.C.'s, tools, components, variacs, keyboards, transistors, microswitches, V.D.U.'s sub-assemblies + thousands of other stock lines. Just a mere fraction of our vast range, is displayed below: 100's of bargains for callers.

TELETYPE ASR33 I/O TERMINALS



£235 + CAR
+ VAT

Fully fledged industry standard ASR33 data terminal. Many features including: ASCII keyboard and printer for data I/O, auto data detect circuitry, RS232 serial interface, 110 baud, 8 bit paper tape punch and ready for off line data preparation and ridiculously cheap and reliable data storage. Supplied in good condition and in working order. Options: Floor stand **£12.50 + VAT**
Sound proof enclosure **£25.00 + VAT**

ICL TERMIPRINTER 300 BAUD TERMINALS



£325 + CAR
+ VAT

Made under licence from the world famous GE Co. The ICL Termiprinter is a small attractive unit with so many features it is impossible to list them in the space available! Brief spec. as follows: RS232 serial interface, switchable baud rates 110, 150, 300, (30 cps), upper and lower case correspondence type face, standard paper, almost silent running, form feed, electronic tab settings, suited for word processor applications plus many more features. Supplied in good condition and in working order. Limited quantity.

MAKE YOUR COMPUTER TALK!!!

VIA OUR EX-GPO MODEM UNITS

Well, not exactly talk, but communicate over a standard dial-up G.P.O. line with any other modem. The modem unit 2A is housed in an attractive fibre glass case measuring only 15" w x 13" d x 5" h, inside are the electronics and mains power supply which enable serial duplex data communication between terminal/computer etc. at any speed up to and in excess of 250 baud (300 at a push). Made to the most stringent, exacting specification for the G.P.O. These units feature Modular plug in P.C.B.'s, internal test points, Standard tone frequencies, Configurable to terminal or computer end, Auto unattended answer, RS232/V24 interface on standard 25 way 'D' socket, etc. etc., supplied complete with diags., at a fraction of **£55.00 + £4.50 CARR.** their original cost at only

NOTE: Units believed working, but untested, unguaranteed. Permission may be required for connection to G.P.O. lines.

EX STOCK

SOFTY

SOFTWARE DEVELOPMENT SYSTEM, INVALUABLE TOOL FOR DESIGNERS, HOBBYISTS ETC.
Enables "open heart surgery" on 2708, 2716, etc, Blows, Copies, Reads EPROMS or emulates EPROM/ROM IN-SITU whilst displaying contents off ROM/RAM on a domestic TV receiver. A host of other features.

Write or phone for more details.
£115 + VAT & CARR
You'll never regret buying a SOFTY!

THE CHIPS ARE DOWN MOSTEK, INTEL, NEC, MOTOROLA I.C. PRICES SLASHED!

A massive purchase of brand new "state of the art" data processing equipment enables us to offer the following chips at never, and we mean never to be repeated prices.

8085A	Central Processor	£11.99
8155C	256x8 Static Ram	£8.95
8253C	Programmable Interval Timer	£8.95
8255A	Programmable Peripheral Interface	£9.95
8259A-8	Programmable Interrupt Control	£4.75
8755A	2Kx8 Eprom 16 I/O Lines	£34.50
MC6850P	ACAI	£3.75
2652	MPCC Comms. Controller	£24.00
2102 1K	Static 650ns Rams 8 for	£5.25
1702	256x8 Eprom	£3.75
5101 L-1	256x4 Static Ram 450ns	£4.95

And Remember All Chip Prices Include V.A.T.

All above ICs are brand new or removed from new unused socketed P.C.B.'s. Eproms supplied washed.

All full spec. and guaranteed

SEMICONDUCTOR 'GRAB BAGS'

Amazing value mixed semiconductors, include transistors, digital, linear I.C.'s, triacs, diodes, bridge recs. etc. etc. All devices guaranteed brand new, full spec. with manufacturers markings, fully guaranteed.
50 + BAG £2.95 100 + BAGS £1.15

MUFFIN FANS

Keep your equipment Cool and Reliable with our tested ex-equipment "Muffin Fans" almost silent running and easily mounted. Available in two voltages. 110 V.A.C. £5.05 + pp 65p OR 240v A.C. £6.15 + pp 65p DIMENSIONS 4 1/2" x 4 1/2" x 1 1/2"

**ELECTRONIC
COMPONENTS
& EQUIPMENT**

66%
DISCOUNT

Due to our massive bulk purchasing programme which enables us to bring you the best possible bargains, we have thousands of I.C.'s, Transistors, Relays, Cap's., P.C.B.'s, Sub-assemblies, Switches, etc. etc. surplus to our requirements. Because we don't have sufficient stocks of any one item to include in our ads., we are packing all these items into the "BARGAIN PARCEL OF A LIFETIME" Thousands of components at giveaway prices! Guaranteed to be worth at least 3 times what you pay plus we always include something from our ads. for unbeatable value!! Sold by weight

2.5kls £ 4.75+pp £1.25 5kls £ 6.75+pp £1.80
10kls £11.75+pp £2.25 20 kls £19.99+pp £4.75

★ SHUGART SA800 ★
8" Floppy Disk Drives
as new £225.00 + VAT

★ RAM AND EPROM STAR OFFERS ★

2716 Single 5v rail EPROMS	£10.25
2716 Three rail EPROMS	£ 8.50
2708 EPROMS	£ 4.95
4116 16kx1200 ns RAMS 8 for	£28.50

32K x 8 DYNAMIC/STATIC RAM CARDS

A masterpiece of electronic engineering and our own advantageous buying enables us to bring you a complete memory system at a giveaway price. Originally made for a large processor the RAM card has many features, including on board refresh, internal parity generation and checking. Standard TTL inputs/outputs, +5, +12, -15v supply rails and its effective STATIC capability make it useable with many CPU's. A fast cycle time of approximately 400ns make this a snip at only **£90.00 + £3p & p.** Supplied complete with circuits.

DISPLAY I.C. AND TRANSISTOR BARGAINS NEVER CHEAPER

All I.C.'s and Transistors by well known manufacturers and fully guaranteed. No fall outs. Comprehensive data on I.C.'s 15p per type.
2N4351 N channel MOS FET
2N4352 P channel MOS FET
60p each £1.00 per pair.

HIGH VOLTAGE NPN POWER SWITCHING transistors BVcbo 600v BVceo 500v BVebo 15v Ic 5 amps Pc 125 watts HFE 60 typ ft 2.5 mhz ideal invertors, etc. TO3 £1.60 each 4 for £5.40.

BF258 NPN 250v @ 200ma 45p each 3 for £1.08
I.R. BSB01 2.5 amp 100v bridge rec.
P.C. mount long leads 35p each 4 for £1.08

IN4998 4 amp 100v P.C. mount diodes
long leads 14p each 10 for £1.10

LM309K +5v 1.2 amp regulator £1.10
each 8 for £5.35

AGFA C10 computer grade cassettes complete with library cases 68p each, 10 for £5.50

IN4004 SD4 1 amp 400v diodes 7p
each 18 for £1.00.

I.R. 12 amp BRIDGE RECS. 400 volt
£1.25 each

POWER DARLINGTON SCOOP!
MJ1000 NPN 90v 90w 8 amps TO3 95p each
2N6385 NPN 80v 100w 10 amps TO3 £1.25 each
MJ4030 NPN 60v 150w 16 amps TO3 £2.25 each

BARGAINS GALORE!

In our walk round Warehouse
NOW open Monday to Saturday 9.30-5.30



Dept. HE, 64-66 Melfort Rd., Thornton Heath, MAIL ORDER
Craydon, Surrey. Tel: 01-689 7702 or 01-689 6800 INFORMATION

Unless otherwise stated all prices inclusive of VAT. Cash with order. Minimum order value £2.00. Prices and Postage quoted for UK only. Where post and packing not indicated please add 40p per order. Bona Fide account orders minimum £10.00. Export and trade enquiries welcome. Orders despatched same day where possible. Access and Barclaycard Visa welcome.

SUPERVALUE P.C.B. SPECIAL

Another great buy. Board contents include 62 Digital I.C.'s all located in 14 pin D.I.L. sockets. Original cost over £90, our price only **£4.95 + pp 65p**

5v D.C. POWER SUPPLIES

Following the recent "SELL OUT" demand for our 5v 3 amp P.S.U. we have managed to secure a large quantity of ex-computer systems P.S.U.'s with the following spec.: 240 or 110v A.C. input. Outputs of 5v @ 3-4 amps, 7.2v @ 3 amps and 6.5v @ 1 amp. The 5v and 7.2v outputs are fully regulated and adjustable with variable current limiting on the 5v supply. Unit is self contained on a P.C.B. measuring only 12" x 5" x 3". The 7.2v output is ideal for feeding "on board" regulators or a further 3 amp LM323K regulator to give an effective 5v @ 7 amp supply. Supplied complete with circuit at only **£10.95 + £1.75pp.** Believed working but untested, unguaranteed.

KEYBOARDS

★ LOW PRICE CHASSIS ★



A special bulk purchase enables us to offer the above keyboard at a lowest ever price. 49 coded keys encoded into a direct TTL compatible 7 bit output. Features such as delayed strobe, 5 volt DC single rail operation and rollover protection make this an absolute must for the MPU constructor! Supplied complete with connection diagram and edge connector, at a secondhand

"no time to test" price of only **£20.00 + P.P. £1.60**

SUPER CASED VERSION Same as above spec. but housed in attractive two tone moulded, free standing case. Unit also includes an all TTL parallel to serial converter (no details) etc.

£27.50 + P.P. £1.85

TOROIDAL TRANSFORMERS

PR 240v pri sec 15 0 15 @ 2 amps dimensions 2 1/2" x 2 1/2" £4.95 + p.p. 99p.
TM 240v/110v pri sec 15 0 15 8vA dimensions 2 1/2" x 1" £1.95 + p.p. 30p.
All voltages measured off load

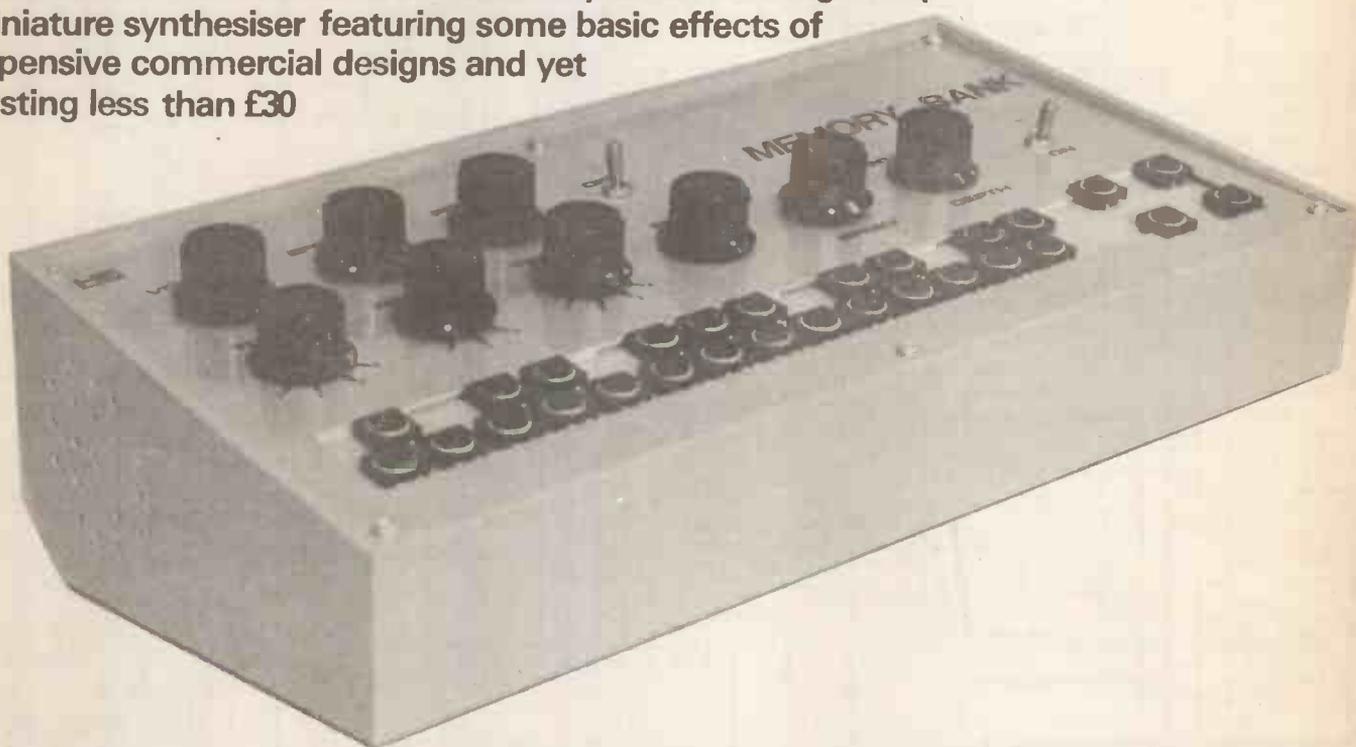
Plugs, Sockets & Connectors Cannon 'D' Range

Ways	Plug	Socket
9	£1.03	£1.26
15	£1.17	£2.01
25	£1.72	£2.58
37	£2.35	£4.14
50	£2.90	£5.46

25 way ex-equip. plug or socket **£1.25**
Edge connectors, gold plated
0.1" DS 40 way **£2.45**
0.1" DS 85 way **£3.99**
0.16" DS 56 way **£3.25**
0.156DS 36 way **£2.00**
All connectors easily cut to size
1000's of other connectors ex stock

Mini Synth With Memory

Ideal for the music enthusiast, Memory Bank is a single chip miniature synthesiser featuring some basic effects of expensive commercial designs and yet costing less than £30



WELL, WE'VE GOT to admit it! When we first set about producing this project for £30 we didn't think it was going to be possible. We immediately had visions of banks of circuits each producing a different effect and hundreds of ICs — just how were we going to break this £30 price barrier? Not to be deterred, we sent out feelers to our many contacts in the electronics market. Finally, word began filtering through of a new IC which would do; not only most of the job itself, but it also had an accessible memory from which to record and recall notes in a sequential fashion. The name Memory Bank stems from this function — the chip stores a 32 beat-length sequence of notes and spaces and, upon recall, replays the sequences at one of four switched tempos.

The IC in question is of the same family as the doorbell chip — you know, the one which produces

4000603½ tunes simply by pressing one button! But — and this is important — *not exactly the same one*. They are all known under the family number of TMS 1000N and are produced by Texas Instruments. Officially, they are 'dedicated micro-processors' which means that they are, in essence, small computers designed and programmed for one purpose.

Many of the features of Memory Bank stem directly from the chip, as it is so versatile but one or two features are additional, hence the use of a number of components around the IC.

Effective Effects

The main oscillator provides two squarewave output signals an octave apart. Effects pot RV4 allows a controlled variable mix of these two frequencies so that the overall output is not necessarily a pure square wave and consequently more pleasant to the

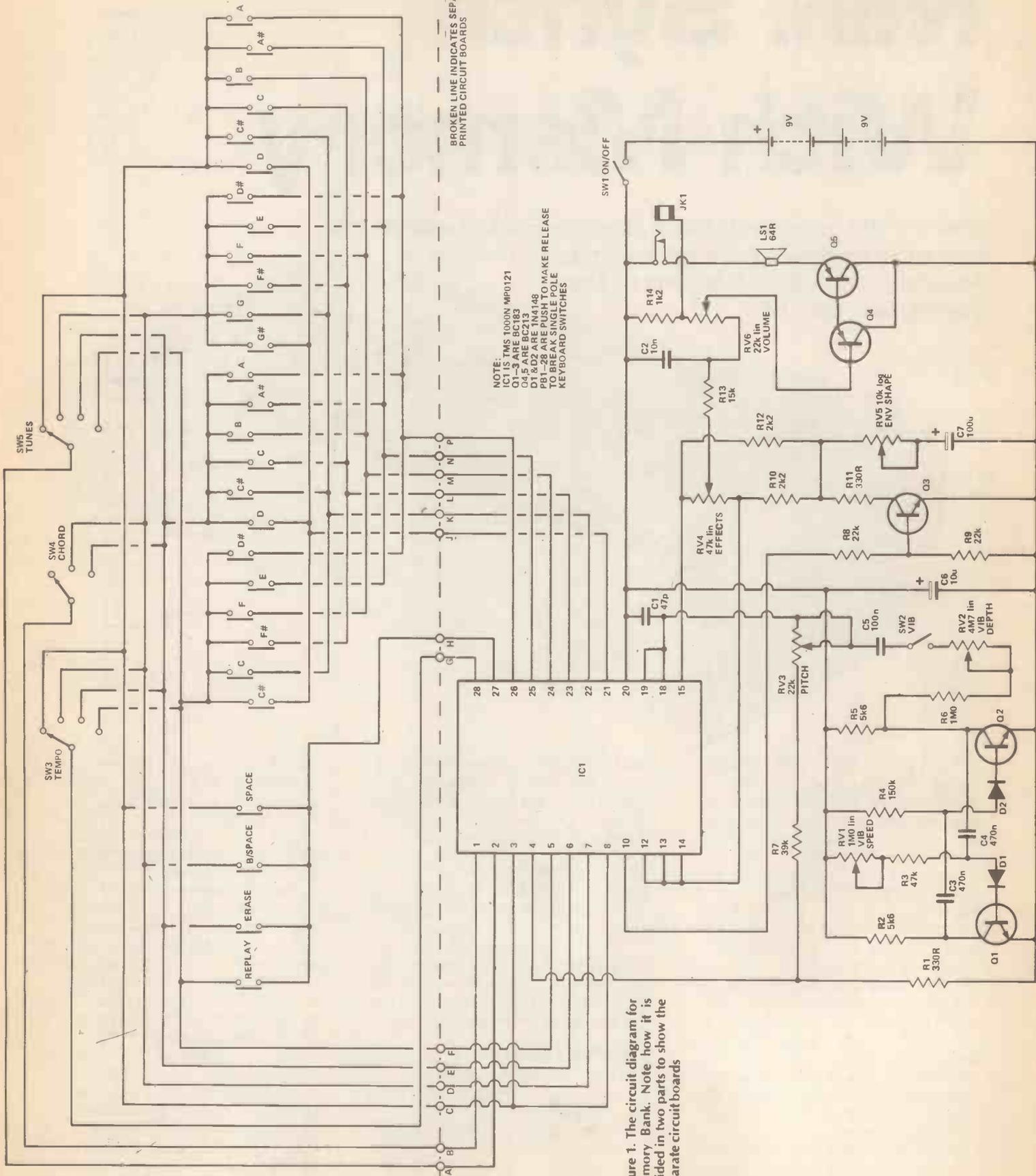
ear. The frequency of the oscillator can be varied by RV3, the pitch control. Incidentally, a control voltage can be fed to the wiper of this potentiometer to give a VCO (voltage controlled oscillator) function seen in expensive commercial synthesisers.

The envelope control gives a variable attack and decay to each individual note — from a quick staccato effect to a long slow increase and decrease in volume. For instance, set at the longest attack and decay, Memory Bank produces a sound akin to a phased echo. This is perhaps one of the most interesting effects.

Vibrato is a standard effect where by the pitch of the main oscillator is frequency-modulated; that is, the centre frequency of the oscillator is raised and lowered slightly at a variable depth at a variable rate between about 1 to 10 Hz.

Other switched controls allow a





BROKEN LINE INDICATES SEPARATE PRINTED CIRCUIT BOARDS

NOTE:
 IC1 IS TMS 1000N MP0121
 Q1-Q3 ARE BC213
 Q4-Q5 ARE BC213
 D1, D2, D7 ARE 1N4148
 PB1-28 ARE PUSH-TO-MAKE RELEASE
 TO BREAK SINGLE POLE
 KEYBOARD SWITCHES

Figure 1. The circuit diagram for Memory Bank. Note how it is divided in two parts to show the separate circuit boards

How it Works

Whenever a key is pressed, a NOTE output is connected to a corresponding RETURN input. In this way, one of 24 (that is, 6 x 4) different connections can be made, by pressing one keyswitch. A two-octave capability is possible with 24 notes, and we have arranged the keys from note A to G sharp, two octaves up.

The RETURN inputs are also used via PB1 to 4 and SW3 to 5 as returns for the memory (pin 27), tempo (pin 28), chord (pin 1) and tunes (pin 2) outputs of the integrated circuit, in the same manner as detailed above.

Capacitor C1, which charges up through R7 and RV3, determines the main oscillator frequency. Altering the position of RV3 thus alters the charge rate and the output frequency changes accordingly. The output of the main oscillator is divided down inside the IC to one of 24 output note frequencies. Pressing one of the note keyswitches will produce the corresponding note at pin 14. A frequency of half the pin-14 frequency is obtained at pin 15, providing the basis of a useful effect. The

IC1 is the heart of the project. Being a dedicated device it does much of the donkey work, acting simply as a control device between the switched keyboard inputs and the audio circuit outputs. Pressing a key on the keyboard indicates to the TMS 1000N what is required; it then generates the correct response or set of responses. A more detailed description of the circuit follows.

About half way up the circuit diagram is a broken line indicating the two separate PCBs of the project and the 14 connections which are needed between them. The upper board contains the keyboard with 28 push-button switches — 24 notes and four controls — and three rotary switches. The connections, although looking complex, are actually straightforward. Pins 21 to 26 of IC1 are the 'NOTE' outputs which feed directly, via inter-board connections J, K, L, M, N, P to the note keypad. The keys are arranged in six groups of four.

The 'RETURN' inputs of IC1 (pins 5 to 8) are taken via inter-board connections C, D, E, F to the other side of the keys in four groups of six.

two outputs are connected directly across RV4 and so the wiper of this pot gives a straight mix dependent on position, which is amplified by Q4 and Q5 then fed to the miniature loudspeaker.

A pulsed output is given from pin 10 of the IC every time a note is played. We have used this facility to trigger a variable envelope shaper built around Q3 and its associated components. The charge and discharge rate of C7 defines the slope on the envelope of output sound, and so varying RV5 to alter this rate controls the attack and decay of each note. This pin 10 output could also be used to trigger voltage controlled amplifiers (VCAs) filters (VCFs), etc. in a more complex synthesiser circuit.

Finally, Q1 and Q2 are connected as an astable multivibrator with a variable frequency of between about 1 Hz and 10 Hz. Potentiometer RV1 controls frequency. The output of the astable is taken via RV2 (depth) to the main oscillator pot (RV3 - pitch), thus modulating the frequency of the main oscillator in a vibrato manner.

Parts List

RV3,6	22k lin	Q4,5	BC213 PNP transistor
RV4	47k lin	D1,2	1N4148 diode
RV5	10k log	MISCELLANEOUS	
CAPACITORS		PB1 to 28	push-to-make, release-to-break, single-pole, single-throw toggle switches
C1	47p polystyrene	SW1,2	4-way rotary switches
C2	10n polyester	SW3,5	3-way rotary switches
C3,4	470n polyester	SW4	Stereo 1/4 in. jack socket
C5	100n polyester	JK1	2 x PP3 type batteries and clips
C6	10u 25V electrolytic	Case to suit	
C7	100u 16V electrolytic	9 x knobs	
SEMICONDUCTORS		64R miniature loudspeaker	
IC1	TMS1000N MP0121		
Q1,2,3	BC183 NPN transistor		
RESISTORS (All 1/4 W, 5%)			
R1,11	330R		
R2,5	5k6		
R3	47k		
R4	150k		
R6	1M		
R7	39k		
R8,9	22k		
R10,12	2k2		
R13	15k		
R14	1k2		
POTENTIOMETERS			
RV1	1M lin		
RV2	4M7 lin		

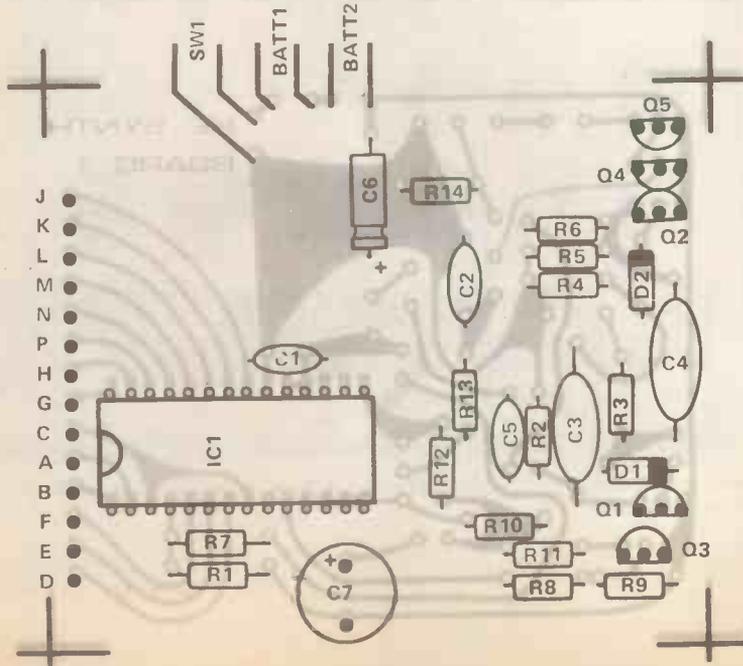
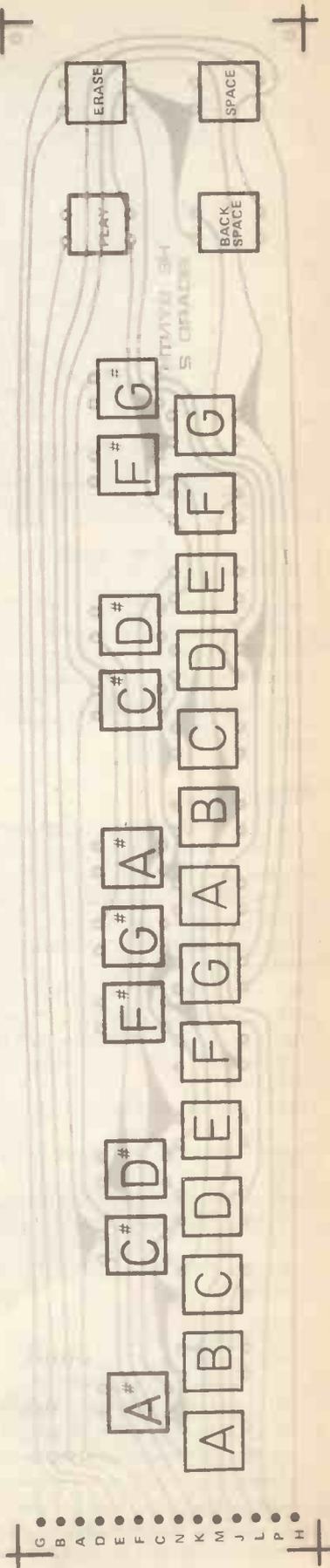


Figure 2. Overlay of the main circuit board. Make sure you insert all polarised components the correct way round

Figure 3. Below, is the overlay of the keyboard PCB. It is shown at about 65% reduction



Mini Synth With Memory

On the main board all resistors and capacitors are best inserted first, being careful to polarise C6 and C7 correctly. An IC socket is advisable for IC1 and this should be put in next. Don't insert the IC yet, however, leave it till last. Semiconductors D1, D2 and Q1 to Q5 can be soldered into position now. Note that there are two varieties of transistor — take care not to mix them up. To insert the transistors, align their flat side to correspond to the flat on the overlay diagram: the transistor will then fit neatly into its correct position on the board. Finally, IC1 should be carefully inserted into its socket. This is quite an expensive device so take your time to prevent possible damage through breaking off any pins.

Construction of the keyboard is simply a matter of inserting the 28 push-button switches. Make sure they are all perfectly flush to the board — this makes no difference to electrical connections, it simply looks better if they are visually lined up.

The second and final part of this article next month continues with constructional details of Memory Bank and includes full interconnection procedures along with case details.

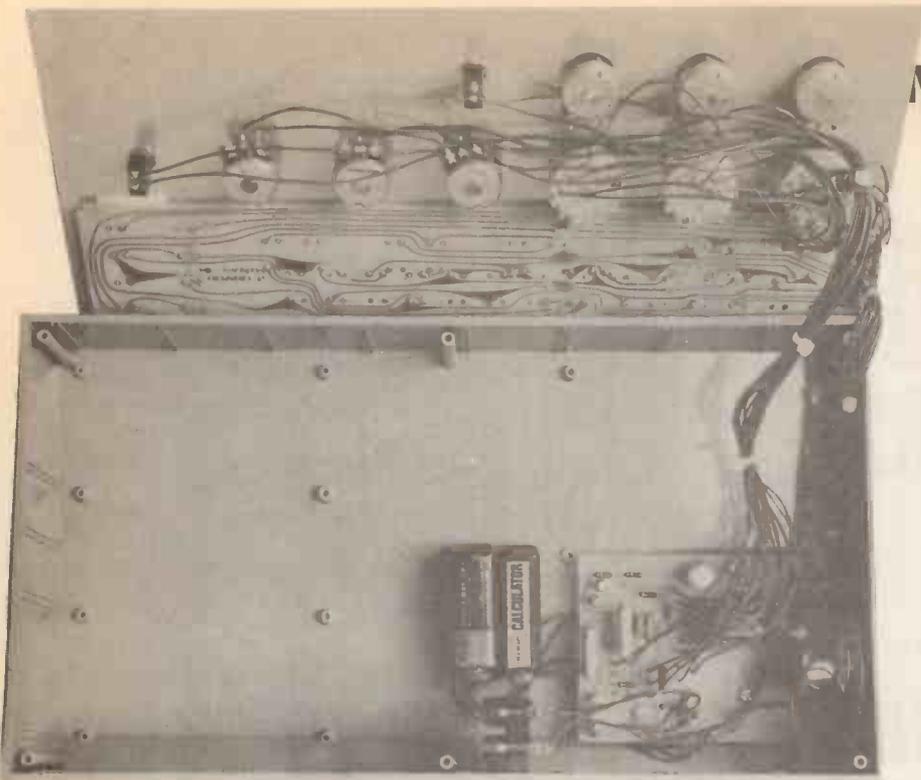


Figure 4. Lots and lots of interwiring, isn't there? Wait till next month before you commence wiring and we'll tell you the best way to do it

variety of extra facilities such as an echo where every note played is automatically repeated three times, or a chorded sequence where the played note produces the three harmonic notes of a basic chord in rapid succession.

All Keyed Up

Obviously we couldn't produce the project with a standard piano-type keyboard — that alone would cost more than the price limit of £30 — hence the use of push-button switches. But a musical-style layout with 24 buttons from A to G sharp two octaves above was maintained with all tones and semitones in between. An extra four switches to the right of this keypad control the 'record into memory' functions:

Erase — erases the present contents of memory

Space — records a single note-length space

Backspace — cancels the previous note recorded (useful if a mistake has been made)

Replay — recalls and plays the whole recorded sequence.

Upon switch-on, one of four switched tunes stored in the chip's permanent internal memory is automatically recorded into the accessible memory, after which it can be replayed or erased if desired. These tunes are: Oranges and lemons; When the Saints go marching in; Yankee doodle; and Holahi. Jack socket JK1 allows you to play through an external amplifier for extra volume. Insertion of

a ¼ inch jack plug will cut off the internal speaker and provide a low level signal to the external amplifier.

Now what else can Memory Bank do? Oh yes, we almost forgot! After a few minutes of not being used — if it hasn't been switched off — the IC produces a warning tone for a few seconds to tell you that you haven't turned off the power. This helps prolong battery life.

Memory Bank Construction

Construction procedure this month consists of making up the two PCBs from the overlay diagrams shown. Neither board should cause much difficulty, but there are one or two points to note.

Buylines

A full kit of parts for HE Memory Bank has been produced by Magenta Electronics, who advertise with us, on page 38 this month. All parts (excluding as usual the case, but including the PCBs and IC socket) will cost you only £28.50 including p&p and VAT.

If you wish to house your Memory Bank in the same case as we did, Magenta can supply one (when ordered with the kit) for an extra £5.80 including p&p and VAT.



Figure 5. Showing front panel layout and lettering. Note the hole which needs to be cut out for the keyboard push buttons

HE

Conquer the chip.



Be it career, hobby or interest, like it or not the Silicon Chip will revolutionise every human activity over the next ten years.

Knowledge of its operation and its use is vital. Knowledge you can attain, through us, in simple, easy to understand stages.

Learn the technology of the future today in your own home.

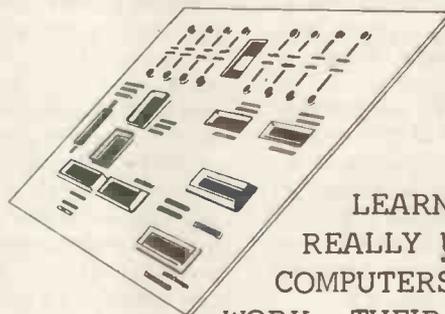
MASTER ELECTRONICS



LEARN THE
PRACTICAL WAY BY
SEEING AND DOING

- Building an oscilloscope.
- Recognition of components.
- Understanding circuit diagrams.
- Handling all types Solid State 'Chips'.
- Carry out over 40 experiments on basic circuits and on digital electronics.
- Testing and servicing of Radio, T.V., Hi-Fi and all types of modern computerised equipment.

MASTER COMPUTERS



LEARN HOW TO
REALLY UNDERSTAND
COMPUTERS, HOW THEY
WORK – THEIR 'LANGUAGE'
AND HOW TO DO PROGRAMS.

- Complete Home Study library.
- Special educational Mini-Computer supplied ready for use.
- Self Test program exercise.
- Services of skilled tutor available.

MASTER THE REST

- Radio Amateurs Licence.
- Logic/Digital techniques.
- Examination courses (City & Guilds etc.) in electronics.
- Semi-conductor technology.
- Kits for Signal Generators – Digital Meters etc.

FREE

Please send your **FREE** brochure without obligation to:-

Name

Address

BLOCK CAPS PLEASE

I am interested in :-

PRACTICAL ELECTRONICS

COMPUTER TECHNOLOGY

OTHER SUBJECTS
(please state your interest)

BRITISH NATIONAL RADIO & ELECTRONICS SCHOOL

4 CLEVELAND ROAD, JERSEY, CHANNEL ISLANDS.

HE/11/811

Story Behind Stereo

We have become complacent over the past few years. Technological developments come so quickly that we rarely pause to consider how they were developed. Ian Sinclair looks into the (surprisingly) long history of stereo and where future research may lead

NOW THAT we have the technical ability to process almost anything with electronics, it's interesting to note how many ideas which have been around for a long time are now being used at last. Stereo sound was one of the first of these ideas to be picked up, particularly when transistors became cheap enough to allow two amplifiers to be built for a price which previously bought only one. In this article, we'll try to trace the shaky beginnings of today's stereo.

Musicians have, of course, played with different arrangements of choirs and orchestras for centuries, and in many cathedrals, carefully chosen seating arrangements for the choristers were found by trial and error to give much clearer sound over a large space. By contrast, many composers preferred to write for small groups of players, deliberately avoiding the large spread of sound of the full orchestra.

The effect of the arrangement and spacing of sound sources which was well known to musicians was not lost on the physicists either, though it took some time before their knowledge of sound waves was sufficient to match up to the needs of analysing something so complex. Much of our knowledge of sound waves was laid down by the great physicist Helmholtz, and carried on by Lord Rayleigh of Terling, Essex. Rayleigh's Theory of Sound, published in 1896, is still the sourcebook for anyone investigating sound waves, and his work is the real starting point of the stereo systems which were developed after that time.

Rayleigh conducted a large number of experiments to find what factors determined how the human hearing system could 'localise' sound; that is, discover where the source of a sound

appeared to be. One of his classic experiments involved fitting a listener with a pair of tubes, one to each ear, and sounding identical tuning forks at the end of each tube. He used this scheme for tuning forks with a wide variety of pitches, and found that the listener, who was blindfolded, imagined that the sound was directly in front of him when the higher-frequency tuning forks were used. This illusion did not persist when low frequencies were used, and could be restored only when a single fork was used and its sound taken through tubes of equal lengths to both ears.

Phased Forks

Rayleigh's conclusions were that the information on sound direction which we obtain arises in different ways at different frequencies. At low frequencies, it is phase differences between waves which carry the sensations of direction. Since he could not ensure that two tuning forks stayed in phase, the listener was unable to locate the source of low notes from two separate forks. At high frequencies, phase differences seemed less important, and the most important factor was the intensity of the sound; the direction of the sound always seemed to be towards the louder sound.

Rayleigh's experiments and theory weren't at all ahead of technology. Some fourteen years *earlier*, a telephone engineer in Paris had patented a system for enabling late-comers to a theatre to hear a realistic performance. His idea was to use two microphones, one on each side of the stage. Each listener had also two earphones, left and right, so that the effect was that of headphone stereo. Since no amplification was needed, the system

was quite practicable, and was, in fact, exhibited in action in 1881.

The lack of amplification in all early sound systems forced inventors to concentrate on headphone systems. Now, though headphones produce interesting effects, there is a vast difference between the sound heard on headphones, with its artificial separation, and the sound you hear live, or through loudspeakers. A good description of the difference is that headphone sound always makes your ears feel fifty feet apart, and this must be caused by the complete separation of signals which doesn't happen under normal listening conditions.

Early attempts at providing some form of loudspeaker stereo had to use the horn gramophone, and some of these were actually made. There is a photograph in the Science Museum of the 'Columbia Multiplex Grand', a cylinder gramophone with three pickups and horns, playing a cylinder with three separate tracks. Unfortunately, we can't tell now whether these were three tracks in the sense we would use now; ie, if they were simply three tracks of different instruments, using the horns as a form of mixer. These attempts came to nothing.

Two Channel Radio

World War I turned inventor's minds to less harmless pastimes, and at the end of the conflict, the new possibilities which were opened up by radio broadcasting began to excite considerable interest. One scheme which was tried in 1925 was the separate broadcasting of two channels on different wavelengths. The medium-wave bands were not so crowded then as they are now — you

didn't get the call-sign of Radio Bohemia continually coming over the station you wanted in those days!

In Berlin, stereo experiments were carried out using 430 and 505 metre transmitters, and at New Haven, Connecticut, station WPAJ won a place in history as a stereo transmitter using 270 metres and 227 metres. Details of the Berlin system are lost, but the New Haven system is quite well documented. At the studio, the microphones were seven inches apart, a distance which had been picked by trial and error.

Station WPAJ had to bow to its listeners, though. Most listeners, still using headphones, didn't like the effect, which in any case was available only to listeners with two receivers. For the less well off, the reception of only one of two stereo channels was not a particularly good deal, and the scheme was abandoned.

For The Record

Curiously enough, disc stereo was not in such an advanced state. It's curious because all the information that was needed was already present. The early cylinder recordings had used what was known as 'hill and dale' recording (Fig.1) — the sound waves were recorded as a pattern of vertical bumps on the cylinder. Emil Berliner's flat discs of 1888 used lateral recording, the familiar groove which waves from side to side. It must surely have occurred to many inventors that it should be possible to record one programme on a vertical recording and another on a lateral recording in the same groove — and yet there's no trace of it.

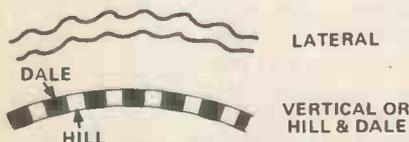


Figure 1. In the early years of this century, both lateral (side-to-side) and vertical (hill and dale) recordings could be bought. No one seems to have seen that both types of cut could be made on a single track.

Stereo as we know it has its roots in the work of one man — Alan Blumlein of EMI. Blumlein was probably the ultimate virtuoso of electronics; his patents cover all aspects ranging from stereo sound through most of television to radar. What he might have eventually accomplished is something we can only guess at, because he was killed in an air crash, during radar tests, in the early days of World War II.

His work at EMI started in 1929, and by 1931 he had taken out the patent

which forms the foundations for most of today's stereo systems. This patent, number 394325 if you want to look it up, outlines all the requirements that we use today, and suggests in particular, the use of sum and difference rather than straightforward L and R sound channels. The important point about a sum-and-difference system (Fig.2) is that the sum signal is a normal mono signal, which can be used by mono equipment, and the difference signal is of comparatively small amplitude, easier to transmit. The sum-and-difference system has survived in FM stereo, though it was not used for either tape or disc stereo systems after World War II. The principles were revived, however, for most of the so-called 'quad' systems.

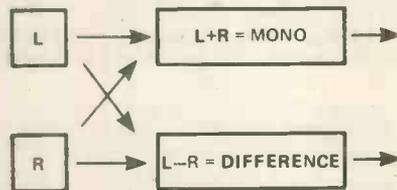


Figure 2. Blumlein's sum-and-difference method. The important point is that the sum signal is the normal mono signal, and the difference signal is at a much lower amplitude.

By 1932, Blumlein had turned his attention to the problem of coding two separate signals onto discs. The obvious method, stemming from gramophone history was to use both lateral and hill and dale recording on the same groove. This isn't entirely satisfactory, because one of the reasons for abandoning hill

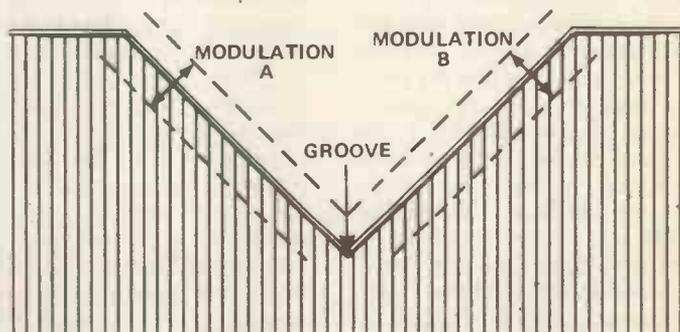


Figure 3. Groove cross-section — the walls are at 90° to each other, 45° to the horizontal. Each wall is separately recorded on by a hill-and-dale method.

and dale recording was that the pickup could not follow the dales at high frequencies; it simply slipped from one hill to the next. Blumlein suggested that the two walls of the disc, set at 90° to each other (and at 45° to the vertical) could be separately modulated, and this is the scheme which was eventually used.

Degrees Of Stereo

Now earnest students of 'O' level physics will have realised what the significance of 90° is in all this, but

everyone else deserves some sort of explanation. Without going into a lot of detail, any motion in a straight line can be imagined as being caused by two movements at right angles to each other.

For example, if you pull on the two strings illustrated in Fig.4, then the block moves in the straight line which is shown. These two motions at right angles to each other are quite independent — changing one does not affect the other. Translating this into something closer to our applications now, imagine a device which consists of a miniature railway track with a plunger touching the surface of a plate between the rails (Fig.5). If the plate is shaped like a wave, the plunger will be forced to move up and down as the 'truck' is moved along. The up-and-down movement, however, does not cause the truck to move from side to side. Similarly, if the plate is flat, but the 'railway track' is a set of Z bends, the truck and the plunger with it will zig-zag without causing the plunger to move up or down. The two separate motions do not interfere with each other, provided that their directions are always at 90° to each other. We can now imagine that both sets of motions exist, with a wave shaped plate and Z-bends in the track, causing the end of the plunger to move in both directions simultaneously — this is as close as we can come to showing what takes place on a stereo recording. Imagine now that the whole caboodle is tilted through 45° — and you're there!

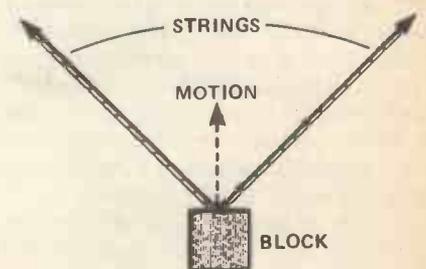


Figure 4. How forces at 90° to each other can produce movement at 45° to each force.

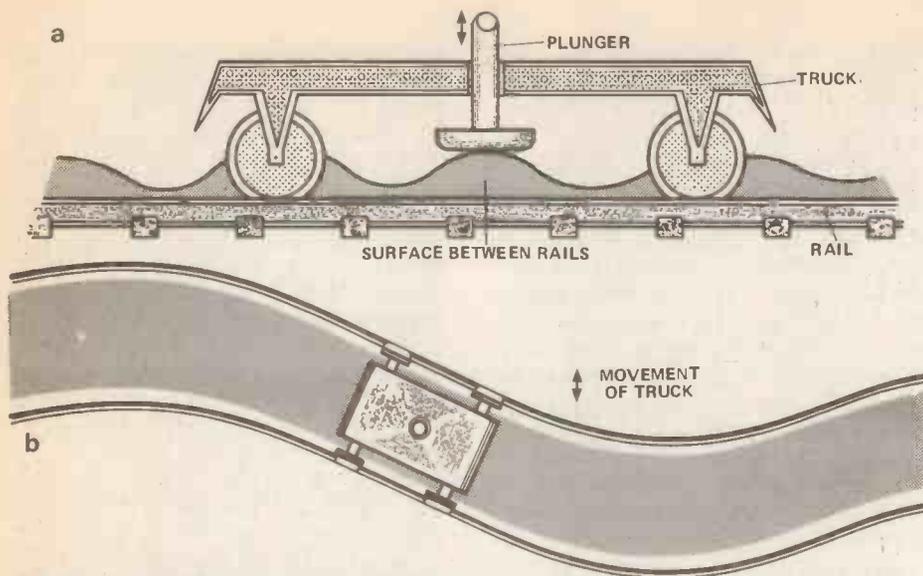


Figure 5. Independent movements which do not affect each other. The vertical motion in (a) is quite separate from the horizontal motion of (b), but if the two are combined, the plunger will have both types of motion simultaneously.

Fantasy Sounds

By the early thirties, all of the methods for obtaining and transmitting stereo had been worked out. The sum-and-difference coding for radio had been contributed by Blumlein, the 45°/45° disc was his work as well, and the third system, separate channels on tape was still waiting for further development of tape recorders.

There, for some reason, it rested. It was as if people couldn't take any more novelties, or perhaps that everyone sensed a coming war. Whatever happened, stereo sound didn't change, at least as far as the home user was concerned. Where it all started to happen was where there was money to play with, in the film world. The historic date was 1935, when the Bell Telephone Laboratories demonstrated before the Society of Motion Picture Engineers (SMPTE now, the T standing for Television) a stereo sound system for films, using twin tracks of the conventional type. It made some impression, but only on a few dedicated engineers. The big breakthrough came only in 1941 when Walt Disney Studios made *Fantasia*, a film of such remarkable originality that it still goes the rounds today. The theme of *Fantasia* is the fitting of cartoons to music, and Disney's engineers, who had heard the demonstrations in 1935, were convinced that a very large step forward in cinema sound was desirable. They certainly achieved it, after umpteenth experiments and as many as ten full scale attempts, they ended up with an eight channel recording system. Their idea, later expressed in an article, was that if this improvement in sound was to catch the attention of the public

it must be a dramatic improvement — there was no point in spending a million dollars in making something just slightly better. It's a principle that a lot of inventors ought to remember!

Fantasia certainly made its mark in the USA. No cinema carried the equipment necessary to reproduce the sound tracks, so the Disney Studios devised travelling sound systems, which had to be carted to each cinema and set up where a copy of the film was playing.

Coils And Cutters

By the mid '50s everyone was waiting for stereo to happen, and there were countless proposals, ranging from the well-researched to the simply silly, lined up. As usual someone had to break the ice and take the first step into the water. The someone in this case was that champion of all the innovating companies in electronics, RCA. At that time, virtually all the disc cutting heads were made by one company, Westrex, a branch of Westinghouse. In 1957 RCA instructed Westrex to make them a 45°/45° stereo cutting head — with the option that if they didn't, RCA would start manufacturing the heads themselves. It was an offer Westrex couldn't refuse, because several other companies were already in the business of developing such cutters, notably Telefunken in Germany, Decca in Britain and Orotofon in Denmark. Westrex went ahead to develop a type of cutting head which, with later refinements, is still in use today.

The Westrex head uses two separate moving coil assemblies. The moving-coil principle is an old and well known one in the history of disc cutting and

reproduction, and is illustrated in Fig. 6. A coil is driven with signals, and its magnetic field, which increases and decreases in step with the signal current, causes variable forces on an iron core. If the coil is suspended on springs, it will move in sympathy with the variations in magnetism, so producing a mechanical movement which keeps in step with the waveform of the signal. This is the motion which is used to operate the cutting stylus, and the Westrex arrangement consisted of two moving coil drives (or motors, as they are called) set at 90° (Fig. 6).

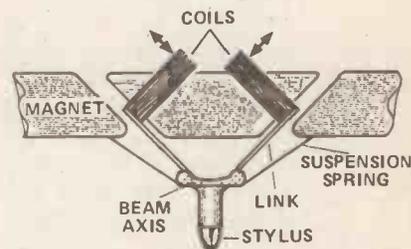


Figure 6. Front view (simplified) of a classic type of stereo cutter. The two coils are driven in directions at 90° to each other, so producing a 90° cut by the stylus.

Once the Westrex stereo cutter went into production, the manufacturing of stereo discs became possible. By that time, the microgroove long-play disc had been developed also, and the modern stereo disc became a reality.

Through The Air

Stereo radio, as we've seen earlier, actually started much earlier than stereo discs, though the systems which used separate channels broadcast on separate wavelengths were not compatible. Compatibility is always a problem which tends to prevent new systems from being developed for any established process. The argument is that the customer already has equipment which mustn't be made out of date. The fact that advertising is continually trying to tell the same customer that his equipment is out of date is conveniently ignored. The compatibility problem has affected two systems in particular — stereo radio and colour TV. The argument in each case was that the existing owner of radio or TV should continue to be able to receive the same transmissions. This was a reasonable argument in the USA, where millions of customers had mono radio and black/white TV, but it looked a bit less plausible in Britain where few people had FM radio, and the colour TV was to be broadcast on UHF, on a new standard which required new receivers anyway!

The two-transmitter method of

transmitting stereo is therefore a dead-duck as far as compatibility is concerned, and any scheme for transmitting what should be high quality signals on medium wave is a lost cause anyway. It's ironic that the only music on BBC medium-wave, which needs a reasonable bandwidth and quiet background, has just been shifted to the most unsuitable of all the wavelengths, 247 metres. Perhaps they don't really care any more!

As it happened, the first FM transmitter had been built by the beginning of World War II, by Edwin Armstrong, inventor of frequency modulation, and in the post-war years, FM transmitters multiplied rapidly in the USA. The users of FM tended to be listeners who were interested in higher quality reproduction of music, so the FM transmitters were seen as the natural medium for stereo transmissions. The bandwidth of an FM broadcast is much greater than that of medium wave, however, and this, along with the compatibility problem, rules out the use of transmitting each channel on a separate frequency.

Transmission Systems

Once again, the field was open to inventors to devise methods of modulating the two channels onto one single carrier in such a way that an existing one million radios would continue to receive an acceptable signal, but a specially adapted stereo radio would be able to separate the two channels. A large number of proposals were put forward mostly hinging on the use of a sub-carrier. A subcarrier is a sinewave which can be modulated by a signal, and which is then, in turn, modulated on to a main carrier along with other signals. This time, the systems had to pass the

scrutiny of the Federal Communications Commission, the body which controls broadcasting technical standards, and it showed! The FCC had previously insisted (1953) that any colour system should be compatible, and it certainly wasn't going to make its rules any easier for half-baked schemes to provide FM stereo.

The system which was eventually chosen was the Zenith Radio, General-Electric joint submission. This is the stereo system which, unlike the NTSC colour system, is used world-wide with only minor modifications, and a brief reminder of its principles might be useful.

The Zenith GE system (Fig.7) relies on Blumlein's principle of sum and difference signals, $L + R$ and $L - R$. The sum signal, $L + R$ is frequency modulated onto the main carrier in the usual way, so that the user of mono equipment has the same signal input to his receiver as he had before. The carrier is also modulated with two other signals. One of them starts as a subcarrier at 38 kHz, which is amplitude modulated by the difference signal, $L - R$. The subcarrier is then removed, leaving only the modulated sidebands, mainly low amplitude, to be modulated onto the main carrier. The third signal which is modulated onto the main carrier is a low amplitude sinewave at 19 kHz, which is obtained at the transmitter by dividing down the 38 kHz subcarrier frequency.

At the receiver, these signals can be separated without much difficulty (Fig.8). A mono receiver detects only the sum signal, with its normal de-emphasis circuits (low pass filter) removing the 19 kHz sinewave (the 'pilot tone') and the sidebands of the sub-carrier. A stereo receiver uses no filtering im-

mediately after the demodulator, so that the pilot tone can be detected, amplified and frequency doubled to 38 kHz again. This newly regenerated carrier frequency can now be used to demodulate the subcarrier sidebands (a method called synchronous demodulation is used) to recover the $L - R$ signals. The $L + R$ and $L - R$ signals can be combined to provide the L and R signals which are the stereo channel signals.

On Tape

Tape recorders? Oddly enough, though stereo on tape was used comparatively early by the manufacturers of discs, stereo tape for the home user came a lot later. The use of tape was only ever a minority interest in any case, apart from the brief craze for tape-recording in the early sixties, until tape became capable of providing better quality sound at reasonable prices. Though stereo tape recorders eventually became available, with such excellent machines as the Revox providing considerable competition to the best of discs, tape stereo still remained a minority pursuit. Things stayed this way until the cassette developed four channels and efforts were made to sort out the miserably poor signal-to-noise ratio.

Because commercially-made stereo cassettes could be bought, unlike stereo tapes, stereo on cassette flourished despite its technical shortcomings. Rapid development ensured that whatever stereo equipment you bought one year would be out of date by the next year, so keeping manufacturers keenly interested in research. In some cases, the research simply resulted in more shiny cases with less inside them, but some very important advances were made in tape material, in circuit techniques (such as Dolby and dbx), and in convenience (such as being able to set up the recorder easily for different types of tape). Because cassette stereo was the most recently developed stereo system, it's still developing, trying to reach nearer perfection before the next big breakthrough.

The next one? There are digital tapes, laser-read discs, and presumably, laser-read tapes all being developed, all with the promise of high packing density (lots of music in a small space) and very low noise levels. That doesn't mean that manufacturers have learned from early mistakes — there are as many systems competing now as ever were, some with such obvious flaws that it's difficult to imagine they were being seriously put forward except as a way of keeping a place in a queue. All we can do is wait and hear!

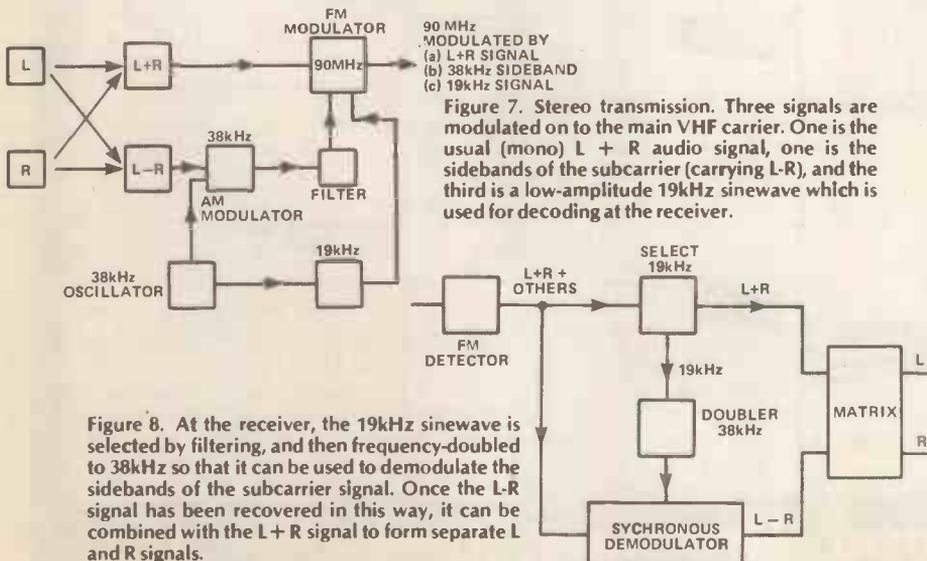


Figure 8. At the receiver, the 19kHz sinewave is selected by filtering, and then frequency-doubled to 38kHz so that it can be used to demodulate the sidebands of the subcarrier signal. Once the $L - R$ signal has been recovered in this way, it can be combined with the $L + R$ signal to form separate L and R signals.

HE MICROBE R/C

Basic Kit £19.90
(2 PCB's and all PCB components)

C.B - C.B - C.B

AERIALS AND ACCESSORIES

Cutter mount	£15.95
Boot/Roof/Wing mount	£19.95
Traditional Fibreglass Whip	£14.95
AM/FM/CB Retractable	£25.95
CB Electric Retractable	£29.95
AM/FM/CB Electric Ret	£39.90
Roof mount 20" Glass Whip	£19.95
SWR/Power/F.S. Meter	£24.95
SWR/Power Meter	£12.95
Pre-Amp 20db gain	£19.95
Splitter Box	£9.95
Linear Amps from	£59.95
27 MHz Monitor + AM/FM	£18.65

These are a few of the items available

ELECTRONIC GAMES

Star Chess T/V game	£63.35
Database Prog T/V game	£89.95
Chess Challenger 7	£99.00
Chess Challenger 10	£160.00
Voice Challenger	£230.00
Chessmate 8 level	£59.95
Zodiac Astrology Computer	£29.95
Electronic Mastermind	£14.90
Supersonic Mastermind. New	£21.00
Mattel Subchase. New	£17.90
Mattel Armor Battle. New	£17.90
Enterprise 4 in 1	£22.90
Galaxy Invaders. New	£22.95
Radio Control Models—Various	

Ball Clock as H.E. offer. Kit £24.95, or ready-built £29.95.

S.a.e. enquiries. Please allow up to 21 days for delivery. ALL PRICES INCLUSIVE



N.I.C.

61 BROAD LANE, LONDON N.15 4DJ
Day 01-808 0377; Eve 01-889 9736



The latest from the U.S.A.

PINBALL WIZARD

★Still available★

Featured in Nov. issue of E.T.I.
Home TV Game - B/W Kit

Basic Kit £28.90

Contains everything except box and controls

Box & Controls £6.50, P.S.U. £3.90

CEH Car Alarm Kit £18.90

Chroma Chime 24 tune door chimes kit £10.75. Built £15.95

SINCLAIR SC110 10MHz scope £145.25

PFM 200 Digital Frequency Meter £52.00

3" 5 MHz Oscilloscope £113.85

4" 5 MHz Oscilloscope £139.90

5" 10 MHz Oscilloscope £169.90

ATARI £138

COMPUTERS—HOME BUSINESS, ETC

Pet 8k	£458.85
Pet 16K	£573.85
Pet 32K	£790.00
Superboard 11 4K	£172.45
UK101 kit 4K	£228.85
UK 101 Built 4K	£286.35
Superboard/UK101 case	£33.80
Nascom 2 kit	£339.25
TRS80 16K Level II	£409.40
H14 line printer kit	£410.00
5 1/4" disc drive for TRS80	£271.40
Computer Books	S.a.e.
Software - Pet/TRS80/Superboard, etc.	
Exody Sorcerer 16/32/48K from	£860.00
ReNUMBER prog. 101	£4.00

Free - Advice/Demonstrations/Coffee

Free - Advice/Demonstrations/Coffee

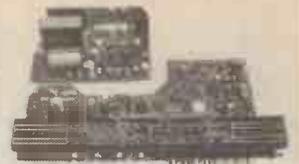
Free - Advice/Demonstrations/Coffee

GEC AM/FM STEREO TUNER AMPLIFIER CHASSIS

Originally designed for installation into a music centre

Supplied as two separate built and tested units which are easily wired together.

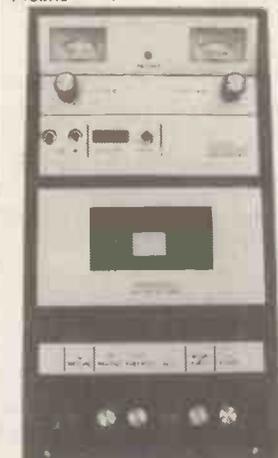
Note: Circuit diagram and interconnecting wiring diagrams supplied. Rotary Controls: Tuning, on/off volume, balance, treble, bass. Push-button controls: Mono, Tape, Disc, AFC, FM (VHF), LW, MW, SW. Power Output: 7 watts RMS per channel, at better than 2% THD into 8 ohms. 10 watts speech and music. Frequency Response: 60Hz-20kHz within ±3dB. Tape Sensitivity: Output — typically 150 mV. Input — 300 mV for rated output. Disc Sensitivity: 100mV (ceramic cartridge). Radio: FM (VHF), 87.5MHz — 108MHz. Long wave 145kHz — 108kHz. Medium wave,



520kHz — 1620kHz. Short wave. 5.8MHz — 16MHz. Size: Tuner — 2 1/4in. x 15in. x 7 1/2in. approx. Power amplifier — 2in. x 7 1/2in. x 4 1/2in. approx. 240V AC operation. Supplied complete with fuses, knobs and pushbuttons, and LED stereo beacon indicator. Price £21.50 plus £2.50 postage and packing.

STEREO CASSETTE TAPE DECK ASSEMBLY

Comprising of a top panel assembly and tape mechanism coupled to a record/play back printed board assembly. For horizontal installation into cabinet or console of own choice. Brand new, ready built and tested. Features: Pause control, auto stop, 3 digit tape counter, illuminated twin VU meters with individual level controls, twin mic, input sockets, AC erase system, LED record indicator. (Separate power amplifier required). Input Sensitivity: 6 mV (with level control set at max.). Input Impedance: 47kOhms. Output Level: To both left and right-hand channels 150 mV. Output Impedance: < 10k. Signal to noise ratio: 45 dB nominal. Power Supply Requirements: 12V AC at 300mA. Connections: All connections to the unit are via a wander lead terminated with nine-pin plug (socket provided). Dimensions: Top panel — 11 1/2in. x 6 1/2in. Mechanism fits through a cut out 5 1/4in. x 10 1/2in. Clearance required under top panel 2 1/4in. Supplied complete with circuit diagram etc. Price £30.50 plus £2.50 postage and packing. Suitable 12V mains transformer £3.00.



B.K. ELECTRONICS

37 Whitehouse Meadows, Eastwood, Leigh-on-Sea, Essex SS9 5TY

BARCLAYCARD



* SAE for current lists * Official orders welcome * All prices include VAT * Mail order only * All items packed where applicable in special energy absorbing PU foam. Callers welcome by prior appointment please telephone 0702 527572.



STEVENSON

REGULATORS

7805	85p	7805	70p
7812	85p	7812	70p
7815	85p	7815	70p
TIC246 16A 400V Triac	115p		
C106D 4A 400V SCR	45p		

SPEAKERS

64mm 8Ω	110p
64mm 64Ω	110p
70mm 8Ω	140p
70mm 80Ω	170p
56mm 8Ω	100p
Pair of ultrasonic transducers	380p
Magnetic earphone + 3.5mm plug	17p
Crystal earphone + 3.5mm plug	48p

POTENTIOMETERS

Rotary 5K-1M Log or Lin	8p
Rotary 5K-1M stereo	33p
Slide 50mm travel 5K-500K log or Lin, single	110p
Suitable knobs for above with coloured caps in red, blue, green, grey, yellow and black. Rotary 16p. Slide 12p each.	65p

CONNECTORS

DIN	Plug	Socket	Line Socket
2 pin	9p	8p	12p
3 pin	12p	10p	12p
5 pin 180	13p	11p	16p
JACK	Plug	Scr. plug	Socket
2.5mm	10p	16p	9p
3.5mm	11p	18p	9p
std.	17p	30p	22p
Stereo	25p	39p	25p

SPECIAL OFFERS

2708 EPROM	490p	10 x J1081 op. amps	350p
AY5-1013 UART	290p	100 x IN4148	180p
TDA 1022 Delay line	550p	20 x 1N4001 diodes	70p
MM57160 STAC timer	500p	20 x 0.125 red LED's	150p
SN76477 Sound generator	180p	20 x 0.125 yellow LED's	260p
NE567 Tone decoder	100p	4 x HP7 rechargeable cells	500p
LM318 Op. amp.	70p	3 x LM339 Quad comp.	140p
5 x C106D SCR	200p	10 x 2N3707 transistors	50p
4 x FND500 displays	350p	10 x BC157 transistors	60p
3 x 7905 or 7912	150p	10 x Miniature slide switches	150p
2 x CA3046 arrays	100p	20 x 8 pin DIL sockets	160p
		3 x 4P3V rotary switch	100p
		10 x T05 heatsinks	100p

Send 50p for your copy of our catalogue, containing 100 illustrated pages detailing over 3000 line items. You will receive: * A mail order form to facilitate rapid despatch * A 50p discount voucher. All prices include VAT. Please add 50p carriage on all orders below £15. Minimum order £5.



Access & Barclaycard welcome
Sales office: 01-464 5770.



TRANSISTORS

AC127	25p	8C547	8p	TIP30C	70p
AC128	25p	8C771	18p	TIP2955	65p
AD161	40p	8D131	35p	TIP3055	60p
AD162	40p	8D132	35p	ZTX107	12p
BC107	10p	8D139	35p	ZTX108	12p
BC108	10p	8D140	35p	ZTX109	12p
BC109C	12p	8F29	25p	ZTX300	14p
BC147	9p	8F34	26p	ZTX500	15p
BC178	16p	8F50	23p	2N3053	25p
BC182	10p	8F51	23p	2N3055	55p
BC182L	10p	MJ2955	98p	2N3072	9p
BC184	10p	TIP29C	60p	2N3703	9p
BC184L	10p			2N3704	9p
BC212	10p			2N3709	9p
BC212L	10p			2N3819	22p
BC214	10p			2N3905	10p
BC214L	10p			2N5777	50p

LINEAR

741	18p	LM324	52p	MM57160	650p
747	70p	LM339	55p	NE531	140p
748	40p	LM348	100p	NE555	23p
7106	850p	LM377	170p	NE556	60p
CA3046	70p	LM378	230p	NE567	120p
CA3080	75p	LM380	85p	RC4136	100p
CA3140	60p	LM382	120p	SN76477	230p
LF347	170p	LM386	90p	T8A800	80p
LF351	45p	LM387	120p	T8A810	110p
LF353	90p	LM1458	40p	TDA1022	630p
LF356	95p	LM1830	180p	TLO81	45p
LM301A	30p	LM3900	60p	TLO82	85p
LM318	85p	LM3909	72p	TLO84	125p
		LM3911	120p	XR2206	390p
		LM3914	320p	ZN414	80p
		LM3915	320p	ZN425E	475p

PACKS

Specially designed packs intended for development work at a considerable saving.
1/4w resistors. 10 of each value 4.7ohm to 1 Mohm, a total of 650 resistors. 530p each.
1/2w resistors. 10 of each value 4.7ohm to 1 Mohm, a total of 650 resistors. 875p each.
Presets. Pack of 5 of each value from 100ohms to 1 Megohm, a total of 65 presets. 390p each.
LED's. Pack containing 10 of each colour LED 0.2 size. Total of 30 Led's + clips. 450p each.
Zeners. Pack of 5 of each value from 2V7 to 33V a total of 130 zeners 780p each.

CMOS

4001	25p	4025	25p	4072	25p
4002	25p	4026	150p	4081	30p
4006	95p	4027	50p	4082	30p
4007	25p	4028	90p	4085	85p
4011	30p	4029	110p	4093	80p
4013	50p	4040	110p	4095	110p
4015	85p	4042	85p	4510	90p
4016	48p	4046	110p	4511	100p
4017	90p	4047	95p	4518	90p
4018	90p	4049	50p	4520	110p
4020	110p	4050	50p	4527	165p
4021	100p	4052	80p	4528	100p
4022	100p	4060	120p	4532	125p
4023	25p	4066	63p	4543	170p
4024	80p	4068	25p	4583	80p
		4069	25p	4585	115p
		4070	25p		
		4071	25p		

SKTS

Low Profile Texas	
8 pin	9p
14pin	11p
16pin	12p
18pin	16p
20pin	18p
22pin	20p
24pin	22p
28pin	26p
40pin	38p

OPTO

Red	0.125in.	0.2in.
Green	TIL209	TIL220 10p
Yellow	TIL211	TIL221 16p
Clips	TIL213	TIL223 16p
		3p
DL704	0.3in	CC 130p
FD707	0.3in	CA 130p
FND500	0.5in	CC 100p

CAPACITORS

TANTALUM BEAD	
0.1, 0.15, 0.22, 0.33, 0.47, 0.68, 1 and 2.2uF @ 35V	12p
4.7, 6.8, 10uF @ 25V	20p
22 @ 16V, 47 @ 6V, 100 @ 3V	26p
POLYESTER (Mullard C280 series)	
0.01, 0.015, 0.022, 0.033, 0.047, 0.1	6p
0.15, 0.22	8p
0.33, 0.47	12p
RADIAL LEAD ELECTROLYTICS	
63V 0.47 1.0 2.2 4.7 10 7p	
	22 33 47 9p
25V 10 22 33 47 7p	
	100 9p
	470 20p
1000	32p

Mail orders to STEVENSON (Dept HE)

76 College Road, Bromley, Kent BR1 1DE.

CAMBRIDGE LEARNING

SELF-INSTRUCTION COURSES

It's faster and more thorough than classroom learning: you pace yourself and answer questions on each new aspect as you go. This gives rare satisfaction - you know that you are really learning and without mindless drudgery. With a good self-instruction course you become your own best teacher.

Understand Digital Electronics

In the years ahead digital electronics will play an increasing part in your life. Calculators and digital watches mushroomed in the 1970's - soon we will have digital car instrumentation, cash cards, TV messages from friends and electronic mail. After completing these books you will have broadened your career prospects and increased your knowledge of the fast-changing world around you.

DIGITAL COMPUTER LOGIC AND ELECTRONICS £7.00

This course is designed as an introduction to digital electronics and is written at a pace that suits the raw beginner. No mathematical knowledge is assumed other than the use of simple arithmetic and decimals and no electronic knowledge is expected at all. The course moves painstakingly through all the basic concepts of digital electronics in a simple and concise fashion: questions and answers on every page make sure that the points are understood.

Everyone can learn from it - students, engineers, hobbyists, housewives, scientists. Its four A4 volumes consist of:

Book 1 Binary, octal and decimal number systems; conversion between number systems; conversion of fractions; octal-decimal conversion tables.

Book 2 AND, OR gates; inverters; NOR and NAND gates; truth tables; introduction to Boolean algebra.

Book 3 Positive ECL; De Morgans Laws; designing logic circuits using NOR gates; dual-input gates.

Book 4 Introduction to pulse driven circuits; R-S and J-K flip flops; binary counters; shift registers; half-adders.



DESIGN OF DIGITAL SYSTEMS £12.50

This course takes the reader to real proficiency. Written in a similar question and answer style to Digital Computer Logic and Electronics, this course moves at a much faster pace and goes into the subject in greater depth. Ideally suited for scientists or engineers wanting to know more about digital electronics, its six A4 volumes lead step by step through number systems and Boolean algebra to memories, counters and arithmetic circuits and finally to an understanding of calculator and computer design.

Book 1 Octal, hexadecimal and binary number systems; conversion between number systems; representation of negative numbers; complementary systems; binary multiplication and division.

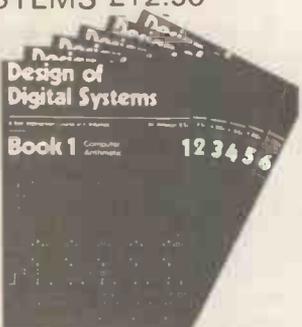
Book 2 OR and AND functions; logic gates; NOT, exclusive-OR, NAND, NOR and exclusive-NOR functions; multiple input gates; truth tables; De Morgans Laws; canonical forms; logic conventions; karnaugh mapping; three state and wired logic.

Book 3 Half adders and full adders; subtractors; serial and parallel adders; processors and arithmetic logic units (ALUs); multiplication and division systems.

Book 4 Flip flops; shift registers; asynchronous and synchronous counters; ring, Johnson and exclusive-OR feedback counters; random access memories (RAMs) and read only memories (ROMs).

Book 5 Structure of calculators; keyboard encoding; decoding display data; register systems; control unit; program ROM; address decoding; instruction sets; instruction decoding; control programme structure.

Book 6 Central processing unit (CPU); memory organization; character representation; program storage; address modes; input/output systems; program interrupts; interrupt priorities; programming; assemblers; computers; executive programs; operating systems and time sharing.



Flow Charts and Algorithms

are the essential logical procedures used in all computer programming and mastering them is the key to success here as well as being a priceless tool in all administrative areas - presenting safety regulations, government legislation, office procedures etc.

THE ALGORITHM WRITER'S GUIDE £4.00

explains how to define questions, put them in the best order and draw the flow chart, with numerous examples.

GUARANTEE No risk to you.

If you are not completely satisfied, your money will be refunded upon return of the books in good condition.

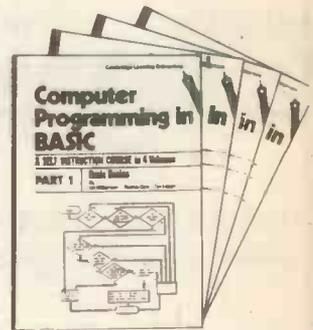
**CAMBRIDGE LEARNING LIMITED, UNIT 86
RIVERMILL SITE, FREEPOST, ST. IVES, HUNTINGDON,
CAMBS., PE17 4BR, ENGLAND.
TELEPHONE: ST. IVES (0480) 67446**

All prices include worldwide postage (airmail is extra - please ask for prepayment invoice).

Please allow 28 days for delivery in U.K.

Microcomputers are coming - ride the wave! Learn to program.

Millions of jobs are threatened but millions more will be created. Learn BASIC - the language of the small computer and the most easy-to-learn computer language in widespread use. Teach yourself with a course which takes you from complete ignorance step-by-step to real proficiency with a unique style of graded hints. In 60 straightforward lessons you will learn the five essentials of programming: problem definition, flowcharting, coding the program, debugging, clear documentation. Harder problems are provided with a series of hints so you never sit glassy-eyed with your mind a blank. You soon learn to tackle really tough tasks such as programs for graphs, cost estimates, compound interest and computer games.



COMPUTER PROGRAMMING IN BASIC

£9.00

Book 1 Computers and what they do well; READ, DATA, PRINT, powers, brackets, variable names; LET; errors; coding simple programs.

Book 2 High and low level languages; flowcharting; functions; REM and documentation; INPUT, IF...THEN, GO TO; limitations of computers, problem definition.

Book 3 Compilers and Interpreters; loops, FOR...NEXT, RESTORE; debugging; arrays; bubble sorting; TAB.

Book 4 Advanced BASIC; subroutines; string variables; files; complex programming; examples; glossary.

THE BASIC HANDBOOK £11.50

This best-selling American title usefully supplements our BASIC course with an alphabetical guide to the many variations that occur in BASIC terminology. The dozens of BASIC 'dialects' in use today mean programmers often need to translate instructions so that they can be RUN on their system. The BASIC Handbook is clear, easy to use and should save hours of your time and computer time. A must for all users of BASIC throughout the world.

A.N.S. COBOL £4.40

The indispensable guide to the world's No. 1 business language. After 25 hours with this course, one beginner took a consulting job, documenting oil company programs and did invaluable work from the first day. Need we say more?

ORDER FORM

Please send me the following books:-

- Digital Computer Logic & Electronics @ £7.00
- Design of Digital Systems @ £12.50
- Algorithm Writer's Guide @ £4.00
- Computer Programming in BASIC @ £9.00
- BASIC Handbook @ £11.50
- ANS COBOL @ £4.40
- Your Booklist (Free)

I enclose a *cheque/PO payable to Cambridge Learning Ltd. for £..... (*delete where applicable)

Please charge my:

*Access/American Express/Barclaycard/Diners Club/Eurocard/Visa/
Mastercharge/Trustcard

Credit Card No.....

Signature.....

Telephone orders from credit card holders accepted on 0480 67446 (Ansafone).

Overseas customers (incl. Eire) should send a bank draft in sterling drawn on a London bank, or quote credit card number.

Name.....

Address.....

Cambridge Learning Limited, Unit 86, Rivermill Site
FREEPOST, St. Ives, Huntingdon, Cambs PE17 4BR, England.
(Registered in England, No. 1328762)

Battery Eliminator



Don't let the soaring price of batteries worry you. Save your hard earned pocket money with the help of this simple project

IF YOU HAVE battery-powered equipment or projects and seem to be constantly buying cells, then the HE Battery Eliminator is just the job for you. The project gives a variety of switched output voltages — 5, 9 and 12 V, on our prototype — with a maximum output current of over 1 A, from mains 240 V AC. A single IC gives exceptionally good regulation to the required voltage and makes the project short-circuit proof — it virtually cannot be damaged, provided all components are inserted correctly. The use of this IC, the LM317T, makes the circuit extremely simple to build and operate. Output voltage is set by the value of only two resistors, so a wider range of voltages can be obtained, if you wish, simply by substituting different resistor values in their place. Connection to your battery-powered equipment is made with a suitable length of two-core flex with the correct plug on the end. If, like us, you intend to use the Battery Eliminator with a variety of equipment then a 4-way power plug, which gives a choice of different connections, is an advantage.

Construction

The HE Battery Eliminator is built on Veroboard, so you should take the usual steps when constructing the circuit. Follow the overlay diagram carefully, making all links before you insert any components.

Mark and drill the case for all switches, grommets etc., and be careful when wiring up the project because of the 240 VAC mains connection. Although the low voltage, secondary side of the circuit is isolated by the transformer, the primary side is potentially dangerous. Cover all connections with heat-shrink sleeving to give protection.

Follow the connection diagram

carefully and use grommets and cable ties, thus preventing the mains cable from being pulled out or shorted to the case. Remember to fasten the mains earth to the transformer mounting bolt using a solder tag so that the whole metal case of the project is at earth potential. Note how IC1 is fastened to the case. A mica insulating washer must

be used to provide electrical isolation with good heat conduction. A spot of heat sink compound wouldn't go amiss here, if you have any — but it's not essential.

Finally, once you have finished wiring up and have thoroughly checked the project through you can switch on and test it.

How it Works

The secondary output of T1 provides an AC voltage of approximately 12 V. This is full-wave rectified by BR1, a bridge rectifier, to DC and capacitor C1 smooths the voltage to a fairly constant level of about 16 VDC.

IC1 is a device known as a voltage regulator, which provides a very constant output voltage, regardless of its input voltage (bearing in mind that the input voltage should always be higher than the required output). The IC develops a reference voltage of 1.25 V between its output and adjustment terminals, ie across resistor R1. The value of R1 is 270R, hence from Ohm's Law:

$$I = \frac{1.25}{270} = 4.6 \text{ mA}$$

This current also flows through one of the three switched resistors R2, 3 or 4, depending on the position of switch SW2. Again from Ohm's Law the voltage across, for example, the resistor R2 is given by:

$$V_{R2} = 4.6 \text{ mA} \times 820 = 3.77 \text{ V}$$

Therefore, the total voltage from the 0V line to the +V line (the output voltage) is:

$$3.77 + 1.25 = 5.022 \text{ V}$$

The calculations for the other two resistors are similar.

Any other voltage within the range 1.25 to 14 VDC can be supplied by IC1 (given that its input voltage is always more than its output) with the appropriate resistors in circuit.

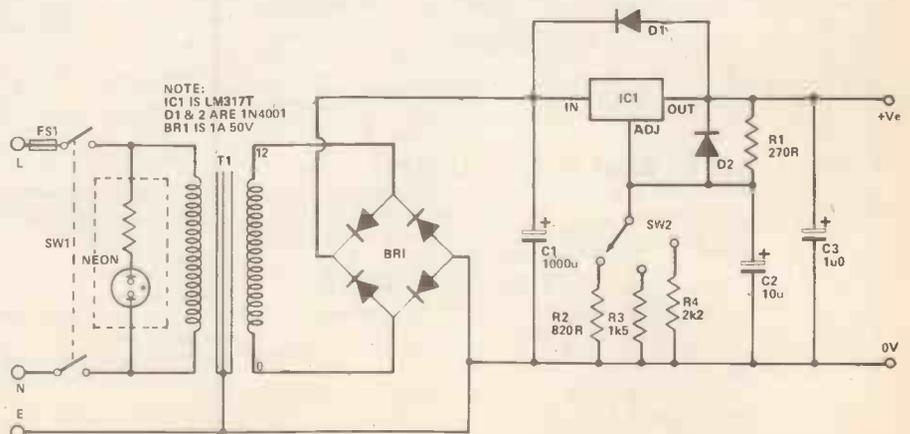


Figure 1. The Battery Eliminator circuit diagram. IC1 keeps the circuit simple yet gives good regulation

Buylines

IC1 is the only component which you may have problems finding from your local supplier. Mail order companies who advertise with us should be able to help. The total cost of components (excluding case) will be approximately £8.

The case we used is one of a range obtainable from Tandy. The stock number is 270-251 and the range is well worth a look, being very good value for money.

Parts List

RESISTORS (All 1/4 W, 5%)

R1 270R
R2 820R
R3 1k5
R4 2k2

CAPACITORS

C1 1000u 25V printed circuit mounting electrolytic
C2 10u 16V tantalum
C3 1u 16V tantalum

SEMICONDUCTORS

IC1 LM317T
BR1 1A 50V bridge rectifier
D1,2 1N4001 1A diode

MISCELLANEOUS

FS1 1A fuse + holder
SW1 double-pole, double-throw toggle switch
SW2 1-pole, 3-way rotary switch
T1 240/12V, 6VA transformer case to suit (see Buylines)
mains neon
grommets, cable ties, insulating washer
knob to suit
10 strip x 24 hole Veroboard

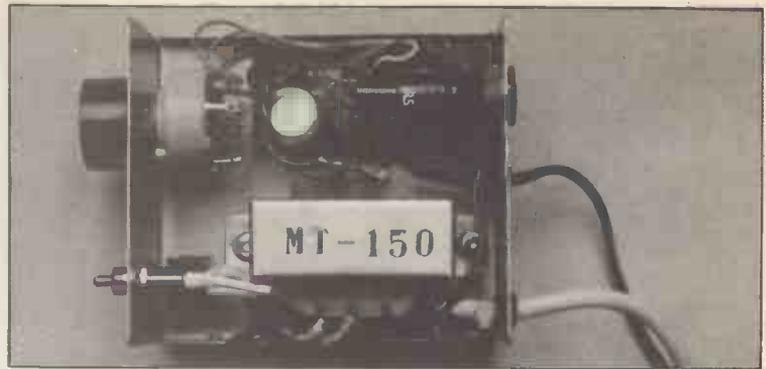


Figure 2. You can see how tightly packed the project is

Figure 3. Veroboard layout of the HE Battery Eliminator. The diagram of the underside shows where the breaks in track should be

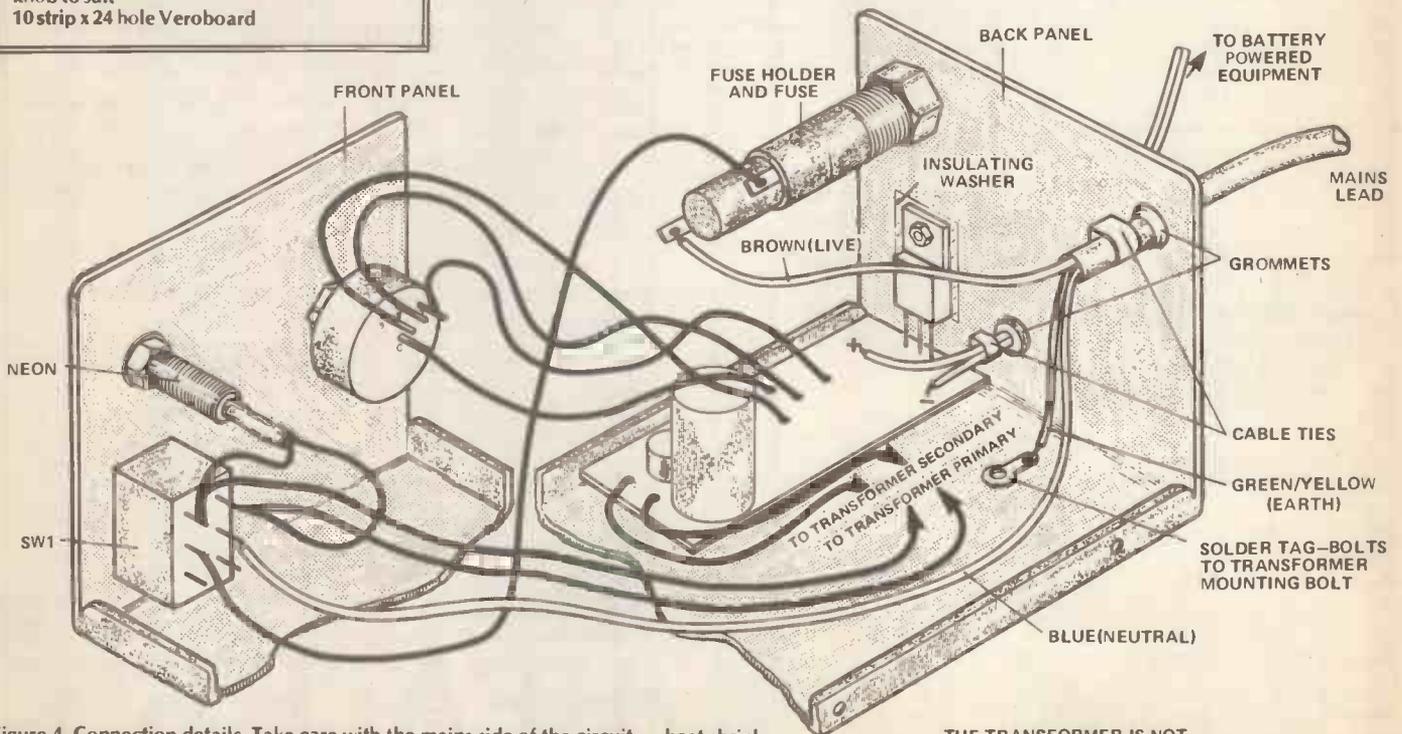
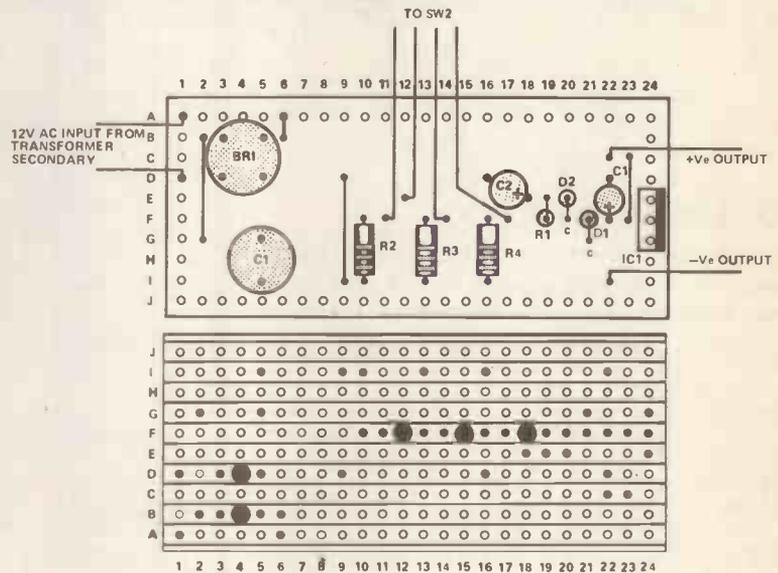


Figure 4. Connection details. Take care with the mains side of the circuit — heat-shrink sleeving is a good idea

THE TRANSFORMER IS NOT SHOWN FOR REASONS OF CLARITY

HE



C300/ES200

high performance electronic ignition, to add power, economy, reliability, sustained smooth peak performance, instant all weather starting, to your car.

Surefire has sold in its thousands in ready made form from big name accessory firms, but it is now available in quality kit form to fit all vehicles with coil ignition up to 8 cylinders.

ES200. A high performance inductive discharge ignition incorporating a power integrated circuit (special selection): electronic variable dwell circuit (maximises spark energy at all speeds): pulse processor (overcomes contact breaker problems). Coil governor (protects coil). Long burn output. Negative earth only. Compatible with all rev. counters.

C300. In it's ready built form (C3000) it came top of all systems tested by an independent national authority July '79. A high energy capacitive discharge ignition incorporating a high output short circuit proof inverter, top grade Swedish output capacitor, pulse processor circuit, transient overload protection. Fast rise bidirectional output ideal for fuel injection, sports carburation, oily engines. Compatible with most rev. counters. (Low cost adaptors available for rare cases. Application list enclosed with each kit. Note: Vehicles with Smiths/Jaeger rev. counters code RVI on dial will require adaptor type TCI).

What's in the kits. Surefire's own precision anodised aluminium extruded case. P.C. mounted security changeover switch, static timing light. Special selection Motorola semi-conductors. Capacitors, resistors etc. selected after 5 years experience. Glass fibre pcb, solder, complete down to last washer.

Fully illustrated comprehensive instructions and full technical back up service.

SUREFIRE

ELECTRONIC IGNITION

Suretron Systems (UK) Ltd.
Bayer Buildings, Lower Bristol Road, Bath, BA2 3EF. Tel: Bath (0225) 332317

Dept. HE8

Name _____

Address _____

Phone order with Access/Barclaycard
VAT and P & P inc

Quantity
required

ES200: Neg	£13.95	£11.95	I enclose chq/PO's £ Chq No.
C300: Pos	£17.95	£15.95	
C300: Neg	£17.95	£15.95	
Tacho Adapt. TCI		£3.90	

Make sure of your Heathkit catalogue... write now.



Keep up to date
with the world's finest
electronic kits—with the Heathkit catalogue.

48 product packed pages contain
photographs and specifications of the widest
possible range of kits. Everything from doorbells
to digital clocks, multimeters to microcomputers.

Heathkit make it easy to build, easy on your
pocket, and as with 13 million Heathkit builders
over 34 years, your success is guaranteed.

Make sure of your copy of the Heathkit
catalogue. Send the coupon today, plus 25p in
stamps and beat the demand.

To: Heath Electronics (U.K.) Limited, Dept (HE11),
Bristol Road, Gloucester, GL2 6EE.

Please send me a copy of the Heathkit catalogue.
I enclose 25p in stamps.

Name _____

Address _____

Soldering
iron offer
FREE

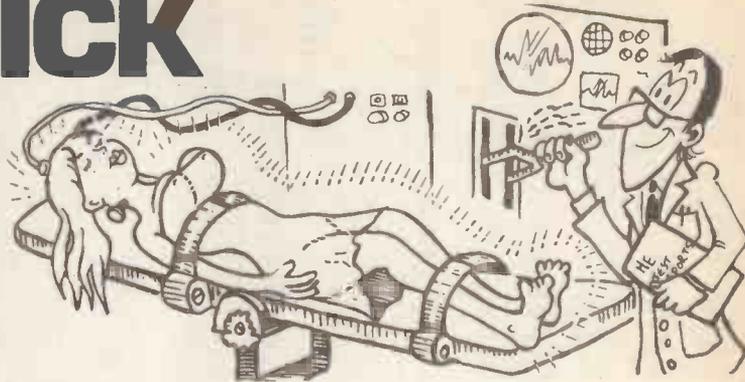
N.B. If you are already on the Heathkit mailing list you will
automatically receive a copy of the Heathkit catalogue; without
having to use this coupon. When you receive your
catalogue you will get details of this free offer.

HEATHKIT

HEATH
KIT

Clever Dick

Do you know why ICs are usually black? Clever Dick thinks he does. Find out the answer to this and many other really burning questions



I GET ASKED some very silly questions each month: 'where can I buy a PP3?' or 'what does an IC do?'. So you can imagine what we thought when M Turner innocently asked 'why is an IC black?'. It was I who felt silly when I tried to find the answer.

Dear CD,

Has it not occurred to you that Integrated Circuits would be a lot easier to identify if the plastic with which they are covered were made in different colours. CMOS for instance would for instance be a different colour to TTL, linear different to digital and so on. Apart from anything else it would make the boards a lot more colourful, why do they have to be black?

PS. How about a binder for this super fantastic idea?

M Turner
Bristol

I started by asking all the incredibly intelligent people that work in the office (the HE staff don't actually work but the cleaners were most helpful). After a decent amount of head scratching, no-one seemed to have any realistic (or printable) ideas. The next step was to phone up some IC manufacturers, and so we chose the big three: Mullard, Texas and National. As you might have expected we got three different reasons,

- it aids heat dissipation
- it keeps out the light which can upset the operation of the circuit
- the epoxy resin that is used for IC encapsulation is cheaper to produce in black.

If anyone else has any ideas then please let us know: a binder to M Turner for a very tricky question.

We seem to have gained a reputation for finding addresses for manufacturers of obscure and foreign equipment, and here is this months plea.

Dear Clever Dick,

I have recently acquired a desk type calculator, made in Sweden by a company called FACIT. I wonder if you could give me an address for the company so that I can obtain some spare parts and possibly a circuit diagram. I would be very grateful if you could help me.

G Acreman
Somerset

This was a relatively easy one to track down. A quick call to the Swedish Embassy's trade commission produced two addresses. In this country you can call: Facit Addo Ltd., Maidstone Road, Rochester, Kent. Or if they cannot help you the Swedish Head Office is at: Facit AB Ltd., S-59700, Atvidaberg, Sweden.

Now for something a little closer to home.

Dear CD,

Just two questions: Concerning the Auto Probe in September '80, my wife's pill comes in a bubble pack, would something like an Aspirin container do instead?

Secondly, in your sister magazine ETI in the June issue they featured a project that could send audio signals down the mains. There was also a feature concerning house wiring that mentioned that the mains could also be used for transmitting control signals. How about a similar circuit (especially the remote control) sometime in HE for lazy people like myself?

Finally, thanks for a great mag, I've bought every one since you started in November '78 (isn't that loyal of me?). Now all I need is a binder to put them all in...

PS. I think you are the tea boy (or girl).
Dave Hart
Ongar, Essex.

You would need the Aspirin for your headache if you tried to get the circuit into the little hole that most Aspirin bottles have. Perhaps we'll have a project in a bubble-pack soon, you'll just have to 'control' yourself and wait to see!

What on earth is the point of printing a super difficult circuit like that when our sister mag ETI does it all the time? By the way, the circuit for a mains control system will be appearing in ETI in the next month or three — watch out for it. Now about that binder. They are available from our offices for the paltry sum of £3.95 all inclusive. Keep guessing about my identity, you're getting warmer.

Time now for some quick ones.

... Is it against the law to operate a radio control jamming transmitter? I want to stop someone who flies his models over my house at six o'clock in the morning.

MTF
London

Yes it is and don't do it, you'll kill someone.

... Can the frequency of a radio receiver be changed by altering the channel selector assembly?

J McEvoy
Merseyside

Sorry, not unless you really know what you're doing and even then it's doubtful

And finally...

Where can I buy PCBs for Hobby Electronics projects?

Richard Long
Norfolk

No problem, just look at some of the advertising in this issue. Most of the companies who supply kits for our projects will be happy to oblige. See you next month, and please keep those letters short.

HE

Into Digital Electronics

Dust off your Eurobreadboard, we have some practical circuits for you to try out using the theory we covered last month

USEFUL THINGS, gate circuits. In case you've forgotten last month's work, we can make any sort of gate circuit which has a 1 at the output for whatever pattern of 1s we want at the inputs. Even if these were the only kind of digital circuits we could make, they would still be useful, but NAND gates can be used to make an even *more useful* type of circuit, called a sequential circuit or flip-flop.

Practice before theory, this time. Build the circuit which is shown in Fig.3.1. The Eurobreadboard switches and LEDs are in their usual places, and the quad NAND gate 74132 has been inserted with its pin 1 in line 19A and its pin 14 in line 19B. The connections are as shown on the diagram. Looks familiar? Yes, if you've built multi-vibrators with transistors you should recognise this as one of the great multi-vibrator family. There are no capacitors, though, so this is a form of bistable; and all the resistors are inside the ICs. What makes this important is that it is a simple example of a circuit which, although it's made out of gates, doesn't behave like any of the gate circuits you've built so far.

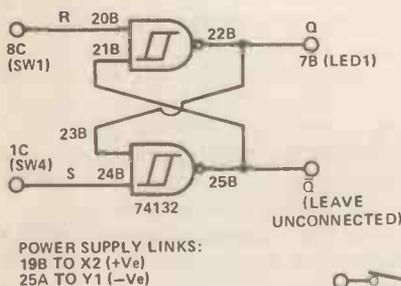


Fig.3.1 The circuit for the R-S flip-flop, showing the Eurobreadboard link numbers.

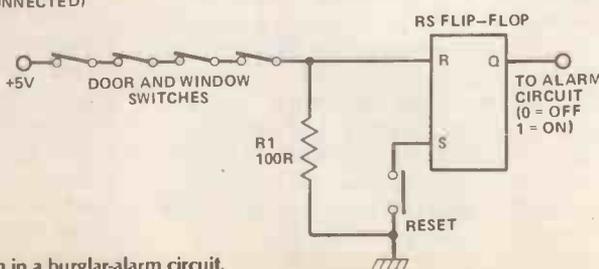
Fig.3.3 Using an R-S latch in a burglar-alarm circuit.

Figure 3.2 is a blank truth table for this circuit. Make sure you go through this table in the order which is given, otherwise you may miss the important feature of this circuit. There's nothing accidental about the fact that we have two lines in the truth table for which the inputs, R and S, are both at logic 1.

R (SW1)	S (SW2)	Q
1	0	
1	1	
0	1	
1	1	

Fig.3.2 Blank truth table for the R-S flip-flop. Make sure that you go through the truth table in the order which is shown.

See the difference? With $R=1, S=1$, the output which is monitored by the LED can be 1 or 0. What does it depend on? Look at the table again. What decides the value of the output Q is the value it had *before* the inputs changed to $R=1, S=1$. Now this is quite different from the circuit which we used in Part Two. In these 'combinational' circuits, the output from the gate circuit was decided completely by the combination of inputs: If we had a gate circuit with two inputs and one output, the output would always be the same when the inputs were both 1s. The circuit we're looking at now doesn't do this. What counts here is the *sequence* of signals at the inputs, and the output for $R=1, S=1$ depends on this sequence — the signals which were there



at the inputs just before this state. If we had $R=1, S=0$ before $R=1, S=1$, then Q is 0. If we had $R=0, S=1$ before $R=1, S=1$, then Q is 1. Sequence, not combination, is what matters, so that circuits of this type are called *sequential* logic circuits.

The R-S Flip Flop

This particular one is called the R-S flip-flop, with R and S meaning Reset (putting Q to 0) and Set (putting Q to 1). It's the simplest type of sequential circuit, but it's not used very much because of two problems. Problem 1 is that we have to leave out $R=0, S=0$ on the truth table. Why? Well, with that input, the Q output is 1, and the other output, marked Q is also 1. Now if we used only Q, this might not be too serious, although it's still a nuisance, having another state which causes $Q=1$. For a lot of flip-flop applications, however, we use Q to provide the inverse of Q (so if $Q=1, \bar{Q}=0$ and if $Q=0, \bar{Q}=1$), saving another inverter. With $R=0, S=0, \bar{Q}$ is not the inverse of Q, so our logic goes bananas. Problem number 2 is that the output changes almost instantly when either input is taken to logic 0. For a number of reasons which we'll look at later, we'd like some control over this.

When the R-S flip-flop is used, it's used as a latch. A latch is our name for a circuit which will hold a bit (binary digit) unchanged for a time, a sort of temporary memory. We can set the R-S latch by making $R=0, S=1$ and reset it by making $R=1, S=0$, and we can store the result by keeping both R and S at logic 1. The outputs Q and \bar{Q} will stay as they are as long as power is applied and $R=1, S=1$; this is the latching condition.

How about an example? Imagine the R-S latch is connected to operate a burglar alarm (Fig.3.3). The reset button

has been pressed, making $S = 0$, $R = 1$ momentarily, so that the output Q is at logic 0. When the button is released, $R = 1$, $S = 1$ for as long as the door and window switches remain intact. Breaking contact on any one of these switches, even momentarily, will cause the input $R = 0$ because of the 'pull-down' resistor $R1$. This makes $Q = 1$, and this condition will remain latched even when $R = 1$, causing the alarm to sound until the switches are all closed and the reset button pressed. The 'pull-down' resistor is needed because without it a TTL input will remain at logic 1 if the connections to it are broken. Another way in which the R - S flip-flop is used is to control a gate in a counting circuit — the gate can be 'opened' by a push button which sets the output of the flip-flop, and closed by an 'end-of-count' pulse. The important point is that the R - S flip-flop can be changed over by a very brief pulse at one input, and the output can then be held in its new state.

D-lightful D-difference

So much for the R - S flip-flop. Incidentally, there seems to be no particular rhyme or reason about how the inputs are labelled. Some texts show the R input to the gate whose output is Q (the scheme we've used here), others show the R input to the gate whose output is \bar{Q} . It doesn't really matter which way round it is, so long as you know the action — a zero at one input will cause a change at the output, and when the inputs are both at logic 1, the output is held latched. An R - S made from NOR gates, by the way, has just the opposite action, latching when $R = 0$, $S = 0$ and changing when either input goes to logic 1. Just as well we don't make much use of them!

We make a lot more use of the next chip, a D-type flip-flop. The example we have is a 7474, and it involves us in a lot of new ideas, one of which is clocking. Start by setting up the circuit in Fig.3.4.

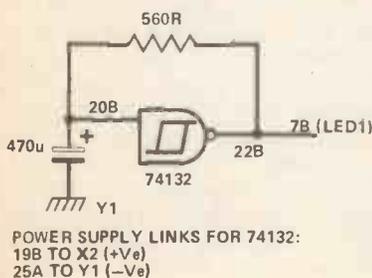


Fig.3.4 A pulse generator which makes use of the 74LS132 IC. Don't be tempted to use larger resistance values.

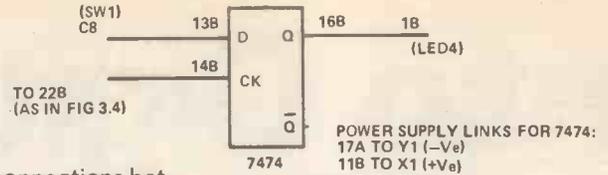


Fig.3.5 Using the D-type flip-flop 74LS74. The 74LS132 which is already on the board provides the clock pulses.

We have removed the connections between the 74132 and the switches, and substituted the 560R feedback resistor, and 470uF capacitor. Please note, you can't use this circuit with just any old gates. Only the 74132 NAND gate, the 7413 (also NAND) and the 7414 (hex inverter) can be used this way, because they are all of a type called Schmitt gates — more of that later.

Now switch on, and see what LED 1 is doing. If you are so lucky as to get a quick flash at intervals, that's it! The output of this circuit is a pulse, a change from logic 0 — to 1 — to 0 which recurs at regular intervals. Because it ticks away so regularly, we call it a clock pulse.

For any sort of sequential circuit beyond the simple R - S type, a clock pulse is essential. The reason is that the clock pulse can be made to control each step in the sequence, so that any changes which take place will always take place at some particular part of the clock pulse, either the leading edge (the start of the pulse) or the trailing edge (the end of the pulse). This avoids a lot of problems which can arise because of time delays in gate circuits. A single NAND gate will usually manage to respond to an input in about 30 nanoseconds (that's 0.03uS). That's fast, but suppose you have a circuit which uses two signals, one of which has come from one single NAND gate and the other of which has passed through about ten NAND gates. No prizes for guessing which signal gets to the circuit first, but suppose we need to wait until both of them are present? A circuit which operates from clock pulses (a clocked circuit) has a built-in time delay, the time between the clock pulses. We could arrange the circuit so that the signals were held in latches until both were present, and then gate them into our circuit by a clock pulse. The next clock pulse then resets the latches, ready for the next lot of signals. Circuits which make use of clock pulses avoid all the problems which time delays can cause in simple gate circuits, and also give us an automatic method of resetting latches. Clock pulses put the sequence into sequential circuits, and allow us to carry out very complicated actions in a surprisingly simple way, because we do only one step at a time. This idea is the germ from which the microprocessor has grown.

Going back to the board, you now have a clock pulse generator ticking away merrily at a nice slow pace. This pace isn't typical, most clock pulses go a lot faster, 100 kHz or more, but by slowing it down we can see what is going on by watching the LEDs. Switch off now, keep the clock pulse generator in place and put a 7475 on the board, with its pin 1 on line 11A and its pin 14 on line 11B. The power supply connections are shown in Fig.3.5 with line 17A connected to line Y1 and line 11B connected to line X1. This also shows the symbol for a D-type flip-flop; there are two such flip-flops in the 7475.

Now for your actual flip-flop. Connect up as shown in Fig.3.5. The clock input of one D-type flip-flop is connected to the output of our clock pulse generator. The clock pulse generator circuit hasn't been shown here, only the connections. The D-type input (D for datum — one bit is datum, two or more is data) is obtained from one switch, SW1, and the Q output is connected to LED 1. We can now use SW1 to switch the D input to 0 or 1, and watch the output LED change — but when does it change? Does it change at the exact instant when you change over the switch?

That's the action. It might not seem very spectacular, but watch this space. What happens is that whatever logic level (0 or 1) is present at the D input when the leading edge of the clock pulse occurs is latched into the output (Fig.3.6). Notice that it's *latched* — if you stop the clock pulses, the Q output will remain as it is, no matter how the voltage at the D input changes. The other important point is that the leading edge of the clock pulse starts the latching — and this leading edge takes very little time, a few nanoseconds. The \bar{Q} output is, as its symbol suggests, always the inverse of the Q output.

Now the interesting point about the D-type is that we can actually make use of the time delay between the leading edge of the clock and the appearance of the output. The clock pulse has its effect only while the voltage is rising, not at 0 nor at 1, and the output reaches its final state some time *after* the clock pulse voltage has reached 1. We can

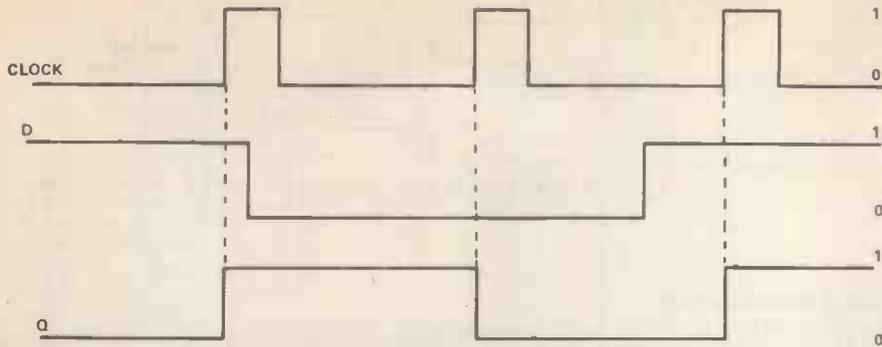
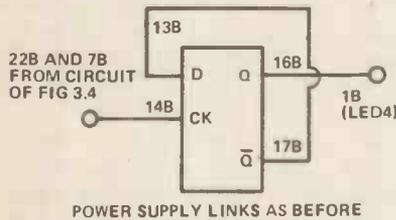


Fig.3.6 D-type action. The Q-output switches over at the leading edge of each clock pulses to a value equal to the logic level at the D-input.

therefore connect up the crazy-looking circuit of Fig.3.7. Try it, and watch the two LEDs. Led 4 is operated by the Q output of the 7474, and LED 1 is operated by the clock pulse. Notice anything about the flashing rate of LED 4?



POWER SUPPLY LINKS AS BEFORE

Fig.3.7 Toggling a D-type flip-flop. This connection makes the D-type give one output pulse for each two in, but only if the clock pulses have very fast rising leading edges.

It is indeed half of the flashing rate of LED 1, so that the output is a set of pulses at half the frequency of the clock pulses. The circuit is variously known as a toggle circuit, divide-by-two, scale-of-two, binary divider or bistable. The sixty-four thousand dollar question is, how does it work? The key to it is this business of time delays.

Imagine that the output of Q is logic 1, so that the output at \bar{Q} is logic 0. Because \bar{Q} is connected to D, the D input is also at logic 0, but this doesn't have any effect until a clock pulse comes along. When the clock pulse appears, its leading edge starts the changeover action, but the clock voltage has reached logic 1 before Q has had time to change from 1 to 0. That's the important point, because when the change takes place, it's too late to have any effect on D until the next clock pulse arrives. A timing diagram will make this a bit clearer. Fig.3.8 shows the times, not to scale. You can see that by the time Q and \bar{Q} change, the D input is 'locked out' — because the leading edge of the clock pulse has passed, the voltage at the D input has no effect on the output.

The result is the toggling action, with the voltage at Q changing at each clock pulse leading edge, causing an output

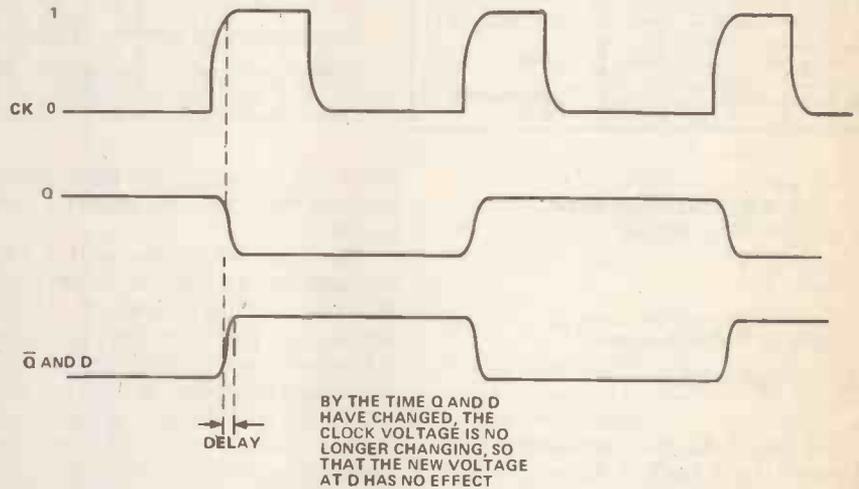


Fig.3.8 The time delays which cause the toggling action of the D-type.

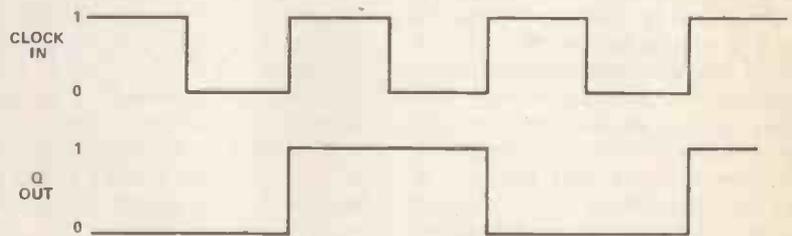


Fig.3.9 The divide-by-two action of a toggling circuit.

pulse at half the rate of the input (Fig.3.9). This toggling action is important because it is the method that a lot of counting circuits use — more of that later.

All Right, J-K?

D-type flip-flops have their uses, but the toggling action is reliable only if the rise-time of the clock pulse is very short. A much more versatile flip-flop has been evolved over the years, one which doesn't rely on this rise time or on the delay in the circuit. Its full name is Master-slave J-K flip-flop; just to keep your tongue from rattling too much we'll call it the J-K. It's not the sort of circuit you'd want to make up from separate transistors; even if you made it from IC NAND gates you'd need eight of them, but it can be made reasonably

easily and cheaply in IC form. The one we'll use has the type number 7476, and this particular IC has two J-Ks in its 16-pin package.

The symbol for a J-K is shown in Fig.3.10. It looks a lot more complicated than the flip-flop we've used so far, and it is. The reason is that the J-K can replace any other type, and ever since J-Ks have been made at reasonable prices, other types have not been needed to anything like the same amount.

Going over the connections to a single J-K in detail, the outputs are the

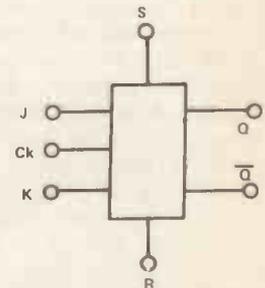


Fig.3.10 J-K flip-flop symbol.

familiar Q and \bar{Q} which we're used to by now. Three of the inputs are also familiar — the clock and the R and S inputs. A clock pulse is taken to the clock input of the J-K, and the action of the J-K very much depends on this clock pulse. The R and S inputs are used to set ($Q = 1$) or reset ($Q = 0$) the output at

any time — there's no need to wait for a clock pulse. These inputs are called the asynchronous inputs — they are not synchronised to the clock.

The other two inputs are labelled J and K, and they are used to 'program' the flip-flop. The voltages we set at these inputs will decide what the J-K does at each clock pulse. **Table 1** summarises what happens.

J	K	Q BEFORE CLOCK PULSE	Q AFTER CLOCK PULSE	
0	0	0	0] NO EFFECT
0	0	1	1	
1	0	0	1] FORCES Q = 1
1	0	1	1	
0	1	0	0] FORCES Q = 0
0	1	1	0	
1	1	0	1] CHANGES Q OVER
1	1	1	0	

S AND R
(CHANGES TAKE PLACE WHEN
S OR R TAKEN TO LOGIC 0)

S = 0, Q = 1
R = 0, Q = 0

S AND R MUST NOT BE TAKEN TO
LOGIC 0 AT THE SAME TIME

Table 1. J-K flip-flop action

The important thing now is to try it for yourself and **Fig.3.11** shows a circuit diagram. We've kept the clock generator in place, but the 7476 plugged in, with its pin 1 on line 10A and its pin 16 on line 10B. Remember that this one is a 16-pin IC! We also need to make some changes to one switch. Switch 4 is altered as shown, so that there are connections to the R and S inputs, with the switch selecting which of the two is taken low. Taking the R input to logic 0 will reset the J-K (Q = 0), and taking the S input to logic 0 will set the J-K (Q = 1). With the wiring shown, the J-K will be reset with SW4 down and set with SW4 up. SW3 is used to control the voltage used for R and S, so that we can leave them both isolated (switch 3 up) or have one of these inputs operated (switch 3 down). **Table 2** summarises the action of switches 3 and 4 in this circuit.

Switches 1 and 2 are used to control the J and K inputs. These switches are wired in the same way as they were when we started, up for logic 1, down for logic 0. Switch 1 controls J, and switch 2 controls K. LED 4 indicates the state of Q.

Start with J = 0, K = 0 (SW1 and SW2 both down) and reset the J-K by having switch 3 down and switch 4 down. With these settings, the clock pulse (watch LED 1) should have no effect on Q (watch LED 4). If you now push SW3 up just after a clock pulse,

Fig.3.11 Connecting the J-K flip-flop into the board. Note that the connections to switches 3 and 4 have been changed.

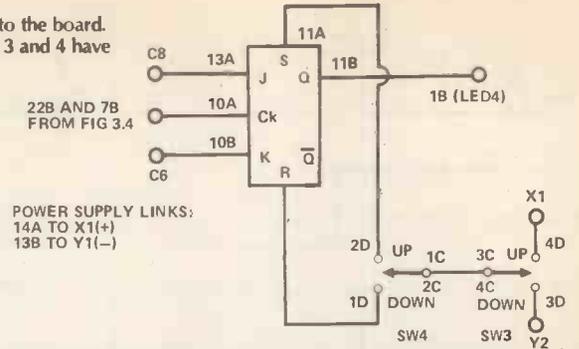


Table 2. Action of switches SW3 and SW4 in Fig.3.11.

	UP	DOWN
SW3	NO ACTION	ACTIVATES S OR R
SW4	SET SELECTED	RESET SELECTED

NOTE: SOME SAMPLES OF 74LS76 MAY NEED 'PULLUP' RESISTORS. IF YOU ENCOUNTER INCONSISTENT RESULTS, CONNECT 10K RESISTORS BETWEEN 2D & X1 AND BETWEEN 1D & X1.

the R and S inputs are released, and whatever happens is caused by J = 0, K = 0.

Nothing? Don't panic — that's what is supposed to happen. With J = 0, K = 0, the J-K is isolated. It saves having to add a gate if we can cut off the J-K like this. Just to confirm the action, try again, but this time set switch 4 up, so that Q is set (LED 4 glows) before isolating with SW3 (up). This time the Q output remains set; the clock pulses have no effect.

What we're doing is to hold the output set or reset by using the R or S inputs, and then releasing these inputs by pushing SW3 to give logic 1. Since the set/reset inputs need a logic 0 to operate, this prevents them from acting, so that the J-K is then programmed by its J-K inputs only. With J = 0, K = 0, the state of the Q output is unaffected by the clock pulse.

Now set the switches so that J = 0, K = 1 (switch 1 down, switch 2 up). Go through the same routine again, with switches 3 and 4 down so that Q is reset, then flick switch 3 up. Is there any effect on LED 4? Try again, starting with switch 4 up this time so that Q is set. Does the clock pulse cause any change after SW2 has been pushed up?

When J = 0, K = 1, the next clock pulse will cause the output to go to logic 0. If the output was already at 0, of course, the change will not be noticeable, but if the output was at 1, then the changeover occurs at the clock pulse.

Now try again, with J = 1, K = 0 (SW1 up, SW2 down). This time you'll find that the clock pulse has the effect of setting the output to 1 after the R,S inputs have been released.

Finally, try J = 1, K = 1, and leave SW3 up. What effect do the clock

pulses have on the output now? J = 1, K = 1 is the toggling connection for the J-K flip-flop. No external feedback links are needed to accomplish this (compare the D-type) and the action does not depend on having a clock pulse with a very fast rise time.

The reason for this advantage is the master-slave principle. The J-K consists of two sets of flip-flops, the master, which is affected by the J, K inputs and the slave which is driven by the master and which in turn provides the outputs. Both of these flip-flops are operated by the same clock pulse, but the master operates on the leading edge of the clock, and the slave operates on the trailing edge. This guarantees a time difference between inputs and outputs, a time difference equal to the time of the clock pulse. At the leading edge of the clock pulse, the master flip-flop is set or reset by the J, K inputs, and its outputs are connected to the inputs of the slave. The slave does not operate, however, until the trailing edge of the clock pulse comes along, and that's when the outputs of the J-K change. By that time, no changes in the inputs can have any effect.

The J-K is such a versatile flip-flop, with so many useful operating conditions that it's seldom worthwhile using any other type. The usual TTL operating conditions apply — any unconnected input will 'float' to logic 1, and it's important not to have both set and reset inputs low at the same time, which is the reason for the connections to switches 3 and 4 in **Fig.3.11**. These inputs are also known by the names of preset (for set) and clear (for reset).

Quick Flips And Slow Bounces

And now for something entirely different — just to tidy up a few odd points. You'll remember the clock pulse oscillator circuit of **Fig.3.4** which needed to use a form of NAND gate called a Schmitt gate — here's why. Most NAND/NOR gates are simply based on inverting amplifiers with a very high gain.

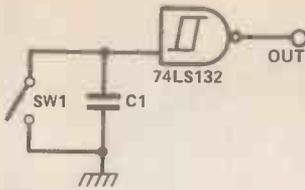


Fig.3.12 Debouncing a switch, using the 74LS132.

Like any other high gain amplifier, these will oscillate if they are suitably biased, and in the course of changing between logic 0 and logic 1 (or 1 to 0) they pass through a suitable bias voltage. Now if the input pulses are so fast that the gates don't have time to oscillate, that's fine. You can't always guarantee this, though, especially when the input comes from other circuits, particularly operational amplifiers (slow little devils, these). A Schmitt trigger input to a gate has a snap-over action which never allows the gate circuit to oscillate. No matter how slowly the input voltage of a Schmitt gate changes, the output will snap over at a really high speed, and there's a fair difference in the voltage which is needed at the input to switch the output high and the voltage which is needed to switch low. This quantity is

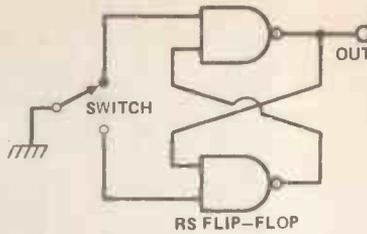


Fig.3.13 Using the R-S flip-flop to debounce a switch.

called the voltage hysteresis. Whenever a signal has to be fed into a digital circuit from circuits which are not digital circuits, Schmitt trigger gates should be used. The symbol which is used to distinguish these gates is a miniature version of the shape of the V_{out}/V_{in} graph.

How does a gate like this oscillate? Imagine that the output in Fig.3.4 is at logic 1, and the input is at 0. The current flowing through R charges up capacitor C, and when the voltage at the input reaches about 2.4 V, the output switches to logic 0. Capacitor C now discharges through R, until the input voltage reaches its other switching voltage at 0.8 V. At this voltage, the out-

put goes high again and the action starts all over again.

We can use the Schmitt trigger gate also for 'debouncing' a switch. Whenever a switch is closed, the contacts will bounce, so that the switch closes and opens a few times before finally closing. If you're trying to generate one single pulse, this isn't very good, and some method of 'debouncing' the switch is needed. Fig.3.12 shows one circuit, making use of the Schmitt trigger NAND gate 74132. The idea is that if the switch bounces open, the voltage at the input of the gate will not change fast enough to allow the voltage to get high enough to operate the gate — the capacitor C1 ensures that. When the switch is closed, C1 is discharged.

Another method of debouncing a switch is the use of the R - S flip-flop (Fig.3.13). If the switch has touched its contact, the flip-flop will switch-over, and any bounce simply leaves the R and S inputs both at logic 1. As you know by now, having both inputs of the R - S at logic 1 leaves the output unaffected, so the switch bounce has no effect on the output. We'll have a look at these debounced switches when we start on binary counters next time. **HE**

video TODAY
OCTOBER 1980 60p

Philips' V2020 - European Video Takes On Japan

Video Discs LP Records With Pictures

Vision Mixing At Home For £70

The Best Hi-Fi Amplifier Yet

NEW PRE-RECORDED REVIEWS AND DETAILS OF EVERY MAJOR VIDEOCASSETTE AVAILABLE

NEW With Unique 22 Page Video Check List!

AT YOUR LOCAL NEWSAGENTS

NOW!

or direct from us, add 25 pence p&p

For a mere 60p you can sample the delights of our new Modmags publication VIDEO TODAY.

If your interests include hi-fi, films and video equipment of all descriptions, this magazine can fill the void in your life.

Finding yourself with nothing to do with your leisure hours? VIDEO TODAY can supply loads of new ideas.

Features include film reviews as well as video machines, vision mixing and hi-fi amplifiers.

THE entertainment magazine for the home!

MODMAGS LTD
Publishers of:
ELECTRONICS TODAY INTERNATIONAL
HOBBY ELECTRONICS
COMPUTING TODAY
VIDEO TODAY

SUPER OFFER

to
HOBBY ELECTRONICS
Readers

mini 20 multimeter only £19.50



INCLUSIVE OF POST & PACKAGE AND V.A.T.

The Mini 20 Multimeter is an ideal instrument for the constructor.

This Special Offer is a wonderful opportunity to acquire an essential piece of test gear with a saving of nearly £10 on the normal retail price.

The 21 ranges cover all likely requirements. Operation is straight-forward, just turn the 22-position selection switch to the required range.

Sensitivity 20k Ω /V d.c. 4k Ω V a.c.
Ranges extend from
100mV to 6000V d.c. 15V to 1500V a.c.
50 μ A to 600mA d.c. 30mA to 3A a.c.
0 to 2k Ω 0 to 2M Ω

Movement protected by internal diode and fuse.

The instrument is supplied complete with case, leads and instructions.

Offer closes December 31st. 1980. Please allow 28 days for delivery.

Please complete both parts of the coupon in block capitals

Name

Address

From: Alcon Instruments Ltd. (HE Offer)

19 Mulberry Walk, London, SW3 6DZ

To: Alcon Instruments Ltd. (HE Offer)
19 Mulberry Walk, London SW3 6DZ
Mail order only

Please send me meter/s at £19.50 each

I enclose P.O./Cheque No. Value

Name

Address

Guitar Pre-amp

Got a guitar? Here's a way of improving its frequency response and cutting down noise and interference. This may seem too good to be true, but the HE Guitar Preamp can do all these things and a few more

WHY SHOULD YOU need to build a circuit like the HE Guitar Preamp into your guitar? I mean, who wants to take hacksaw, mallet, chisel and Black-and-Decker to their favourite Les Paul, simply to stick in some classy tone controls? Well, (believe it or not) there is a good reason why: you see, the trouble is that guitar pickups produce only a very low-level signal, usually just a few millivolts. And it's amazing just exactly what this signal has to put up with before it comes blasting out of the speaker at 4000 MW audio power.

First this feeble little signal has to fight its way through the passive tone networks and volume control on the guitar. After this, it reaches the outside world through the jack socket on the guitar body. But here it finds itself confronted with a long tunnel — about 20 feet (6 metres) of screened cable. Exhausted, it arrives at its destination, the amplifier. Up to this point the signal receives no amplification at all. Instead it relies on the high-gain preamplifier in the main amp to do all the work.

This arrangement, although popular for decades, has some serious pitfalls:

- passive tone controls — they do the job but don't allow for a great deal of tonal change in the sound. Active controls are much better

- a low-level signal in a long lead — very susceptible to noise and interference pickup. This can be understood more easily as a ratio of signal-to-noise. For instance, consider a noise or interference pulse, with an amplitude of 10 mV introduced along the lead. Your guitar produces a signal of, say 100 mV, so the signal-to-noise ratio is 10 to 1. The result will be an audible click. If, however, the guitar signal is amplified at source to say 5 V,

then the ratio becomes 500 to 1. Because the noise amplitude remains the same it will be totally masked by the signal. Remember, once the noise or interference has been introduced it becomes extremely difficult to eliminate — amplifying the signal at the end of the lead only amplifies the noise too!

- A high-gain preamp is prone to interference itself — and unfortunately a power amplifier is a very good producer of interference (because of the high currents roaming around inside it). It is better to keep the preamp and power amplifier as far apart as possible.

Inserting the preamplifier inside the body of the guitar immediately reduces all these effects and gives an improvement in guitar sound. This is the method we have adopted for the HE Guitar Preamp. The preamp is as close to the signal source as possible and the resultant quality just has to be heard to be believed.

Construction

Although the circuit is rather compact, using Veroboard, its construction is still remarkably easy. Remember to break the copper strips of the board in the correct places before inserting components. Either the correct tool or an $\frac{1}{8}$ in. drill bit — carefully hand-held — can be used for this job. Press lightly down on the correct hole and gently twist the tool or drill bit clockwise until the track is broken. Make sure no bridges have been formed between adjacent tracks by loose copper swarf.

The components can now be inserted following the overlay diagram of the circuit. An IC socket is advised for IC1 but not essential. Make sure that



all polarised components, C4, C7 and IC1, are the right way round.

After checking that you have no solder bridges across copper tracks, you can commence wiring up the board to pots, battery and jack socket — and final housing.

As you can see in the photographs we housed our circuit inside the body of the guitar, directly underneath the pickup. This is the most advantageous position. However, if you don't want to carve up the inside of your Gibson, Guild or Gretsch, build it in a small box outside the guitar: the improvement in performance will still be worth the effort.

You will find it easier to mount all three pots and the jack socket on the front panel before commencing wiring. Solder longer-than-necessary leads on the pots (screened lead need only be used on the volume pot). Mark them and loosely mount the panel, taking the leads along inside the body of the guitar to wherever the circuit board and battery are mounted. The connection diagram shows where all connections from the pots to the board go. Remember C10 (we ran out of room on the board!) mounts on the volume pot. Cut the leads to the required length before soldering, and when all connections have been made, the group of leads, nine in all, can be held together with cable ties to form a neat cable. Finally, earth all pot bodies with one length of wire. You may have to lightly file the body of each pot to clean up the surface before it will solder.



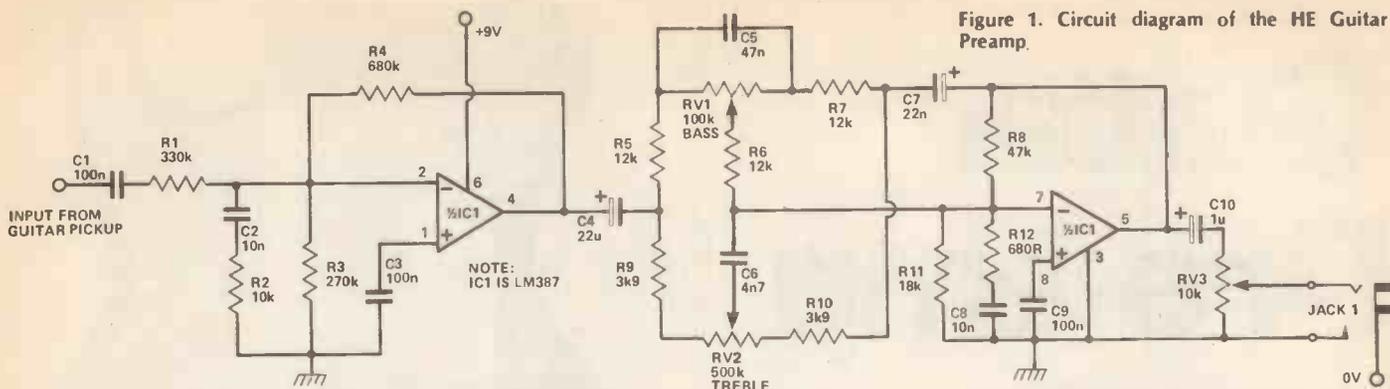


Figure 1. Circuit diagram of the HE Guitar Preamp.

How it Works

The main component, IC1 consists of two separate preamplifiers housed in the same 8-pin DIL body connected only by a common power supply of between 8 and 30 VDC. Both preamps are identical and are ideally suited for single 9V-battery operation — current consumption is low, meaning that a PP3-sized cell can be used and has a reasonable life.

The first preamplifier (pins 1, 2 and 4) acts as a fixed gain, flat response circuit, meaning that all frequencies within the audio band are amplified equally. The gain factor of this stage is determined by the ratio of R4 to R1. If further gain is required, R1 should be reduced in value. Conversely, if gain has to be reduced, R1's value should be increased. This facility need only be used if the output from your guitar pickup is either less than, or larger than, average. We used a medium-output amplitude pickup and so our value for R1 provides a good starting point.

The input impedance of this preamplifier is such that the guitar pickup will not be loaded at all.

The second stage is designed around the second half of IC1 (pins 7, 8 and 5) and forms an active two-band tone control block. Bass and treble potentiometers are inserted in the feedback loop of this preamplifier, and provide very good control over the desired frequency response.

Potentiometer RV3 can be adjusted for volume. Because the output signal amplitude of the whole circuit is in the region of 2 volts it should be more than adequate for most requirements. A stereo jack socket is used for the output connections — this provides a useful means of on/off switch for power. When a normal mono jack plug is inserted into the stereo socket, the first two connections are shorted by the jack. Thus, if the battery 0V connection is taken to the circuit via these two connections, power will only be supplied when a plug is in. You must, however, remember to take out the lead, when not using the guitar, to switch off the circuit and save your batteries.

Parts List

RESISTORS (All 1/4W, 5%)

R1	330k
R2	10k
R3	270k
R4	680k
R5,6,7	12k
R8	47k
R9,10	3k9
R11	18k
R12	680R

POTENTIOMETERS

RV1	100k lin
RV2	500k lin
RV3	10k log

CAPACITORS

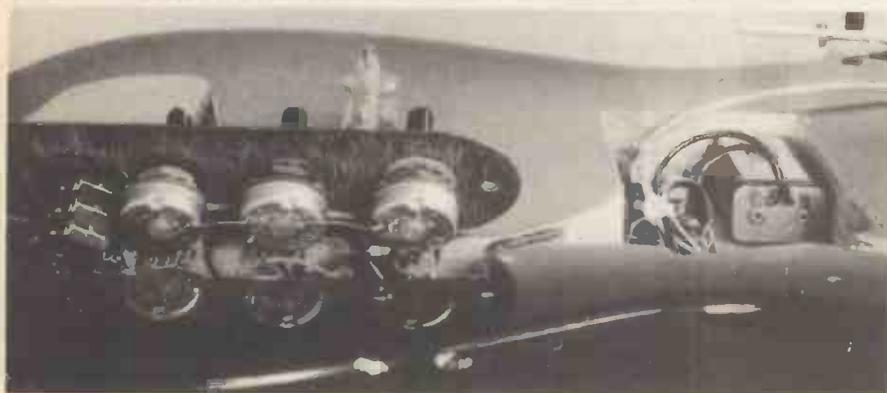
C1,3,9	100n polyester or ceramic
C2,8	10n polyester or ceramic
C4,7	22u 10V tantalum
C5	47n polyester or ceramic
C6	4n7 polyester or ceramic
C10	1u 10V electrolytic

SEMICONDUCTORS

IC1	LM387 dual preamp
-----	-------------------

MISCELLANEOUS

10 strip x 24 hole Veroboard
stereo jack socket, battery and clip,
knobs to suit



Buylines

The approximate cost of all components for this project should be in the region of £6. No case or PCB is involved. All components should be freely available from most of the larger mail-order companies.

And that's it! You can check the whole thing before putting the guitar back together by plugging the unit into an amplifier — remember the guitar will now work with an amplifier without a pre-amplifier — and set all controls at about mid-position. Dangle anything metallic, — a bunch of keys will do — close to the pickup. The result will be a raucous noise from the speaker, proving that everything is OK. Check that all controls function correctly and if so you can now replace all guitar panels and play to your heart's content — with hifi sound.

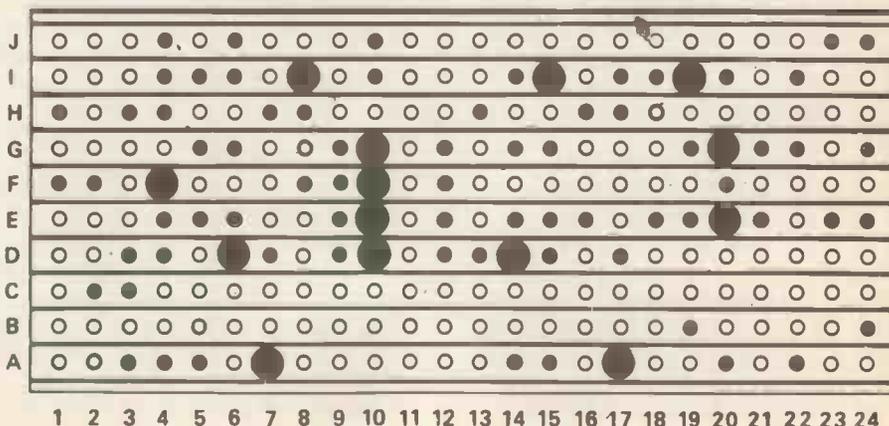


Figure 2. Veroboard component position and track cutting diagram

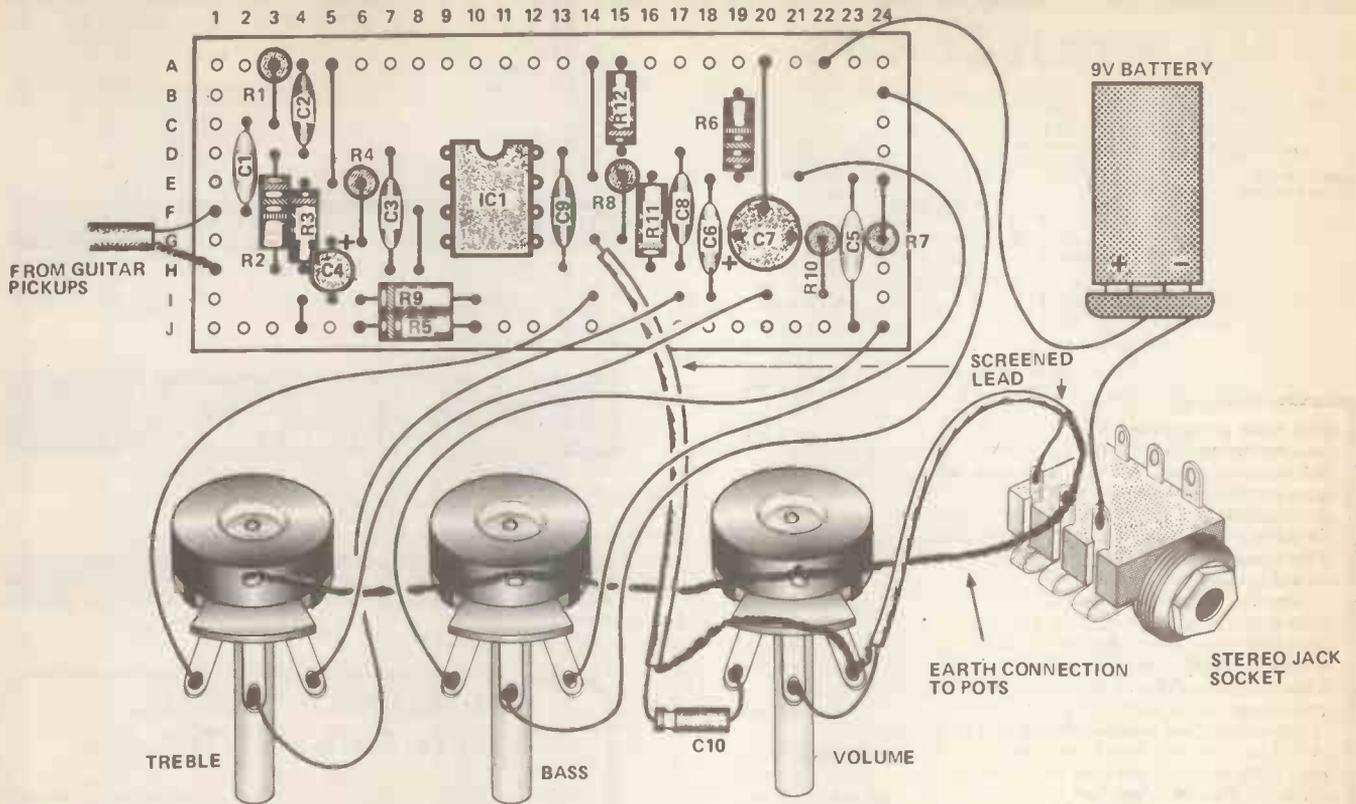


Figure 3. Interwiring and overlay diagram for the HE Guitar preamp

HE

Conquer the chip.

Be it a career, hobby or interest, like it or not the Silicon Chip will revolutionise every human activity over the next ten years.

Knowledge of its operation and its use is vital. Knowledge you can attain, through us, in simple, easy to understand stages.

Learn the technology of the future today in your own home.

MASTER ELECTRONICS LEARN THE PRACTICAL WAY BY SEEING AND DOING

- Building an oscilloscope. ● Recognition of components.
- Understanding circuit diagrams. ● Handling all types Solid State 'Chips'.
- Carry out over 40 experiments on basic circuits and on digital electronics.
- Testing and servicing of Radio, T.V., Hi-Fi and all types of modern computerised equipment.

MASTER COMPUTERS

LEARN HOW TO REALLY UNDERSTAND COMPUTERS, HOW THEY WORK - THEIR 'LANGUAGE' AND HOW TO DO PROGRAMS.

- Complete Home Study library. ● Special educational Mini-Computer supplied ready for use. ● Self Test program exercise.
- Services of skilled tutor available.

MASTER THE REST

- Radio Amateurs Licence. ● Logic/Digital techniques.
- Examination courses (City & Guilds etc.) in electronics.
- Semi-conductor technology.
- Kits for Signal Generators - Digital Meters etc.



FREE	Please send your FREE brochure without obligation to -	I am interested in -
	Name	PRACTICAL ELECTRONICS
	Address	COMPUTER TECHNOLOGY
	OTHER SUBJECTS
BLOCK CAPS PLEASE		(Please state your interest)
BRITISH NATIONAL RADIO & ELECTRONICS SCHOOL		
4 CLEVELAND ROAD, JERSEY, CHANNEL ISLANDS. HE/11/813		

MAGENTA ELECTRONICS LTD.

H.E. PROJECT KITS

Make us your No. 1 SUPPLIER OF KITS and COMPONENTS for H.E. Projects. We supply carefully selected sets of parts to enable you to construct H.E. projects. Kits include ALL THE ELECTRONICS AND HARDWARE NEEDED. Printed circuit boards or veroboard are, of course, included as specified in the original article, we even include nuts, screws and I.C. sockets. PRICES INCLUDE CASES unless otherwise stated. BATTERIES ARE NOT INCLUDED. COMPONENT SHEET INCLUDED. If you do not have the issue of H.E. which includes the project — you will need to order the Instruction reprint as an extra 45p each.

NOBELL DOORBELL, Oct. '80	£11.98
INTRUDER ALARM, Oct. '80	£17.83
FREEZER ALARM, Oct. '80 with probe	£9.42
TUG O' WAR, Oct. '80	£16.98
KITCHEN TIMER, Oct. '80 (2% resistors)	£7.34
MICROMIX, Sept. '80	£7.82
AUTO PROBE, Sept. '80	£3.67 less case
TOUCH SWITCH, Sept. '80	£2.34 less case & contacts
GUITAR PHASER, Sept. '80	£13.84
DEVELOPMENT TIMER, Sept. '80	£11.93
BENCH PSU, Sept. '80	£28.50
EQUITONE CAR EQUALISER, Aug. '80	£14.98
GAZTEC GAS DETECTOR, Aug. '80	£24.98
OP AMP CHECKER, Aug. '80	£4.55
MOVEMENT ALARM, Aug. '80	£5.68
RADIO TIMER, Aug. '80	£6.98
PASS THE LOOP GAME, Aug. '80	£13.98
SOUND OPERATED FLASH TRIGGER, July '80, no skt.	£4.59
18W+18W CAR STEREO BOOSTER, July '80	£29.98 (stereo)
FOG HORN, June '80	£5.65
EGG TIMER, June '80	£8.99 less case
5080 PRE-AMP, May '80	£39.98
SPEED CONTROLLER FOR R/C, April '80	£14.92 less case
DIGITAL FREQUENCY METER, April '80	£35.78
HOBBYCOM: TWO WIRE INTERCOM, April '80	£33.95 (Master)
Sub Station	£3.38 each
ELECTRONIC IGNITION (CD), April '80	£20.87
25-WATT MODULE (5080), Mar. '80	£17.98
PSU MODULE (5080), Mar. '80	£33.75
WIN INDICATOR, Feb. '80 (with switches)	£13.92
DIGI-DICE, Jan. '80	£9.98
BARGRAPH CAR VOLTMETER, Dec. '79	£7.33 less case
RING MODULATOR, Dec. '79	£12.95
GUITAR TUNER, Nov. '79	£10.98
TANTRUM STEREO AMPLIFIER, Oct. '79	£79.50
HOBBYTUNE, Oct. '79	£26.98
ANALOGUE FREQUENCY METER, Oct. '79	£15.52
MULTI-OPTION SIREN, Oct. '79	£15.98
STARBURST, Sept. '79	£19.98 less case
ULTRASONIC SWITCH, Sept. '79	£28.85 less 3 pin mains socket
HOME SECURITY UNIT, Aug. '79	£28.56 less siren
SIREN	£5.09 less case
LED TACHOMETER, Aug. '79	£17.98
INJECTOR TRACER, Aug. '79	£4.34
CONSTANT VOLUME AMPLIFIER, Aug. '79	£15.60
LINEAR SCALE OHMMETER, July '79	£15.98
SHARK, July '79	£25.98
GSR MONITOR, June '79	£9.63
ENVELOPE GENERATOR, June '79	£14.98
PARKING METER TIMER, May '79	£8.79
WHITE NOISE EFFECTS UNIT, May '79	£17.74
TRANSISTOR GAIN TESTER, April '79	£9.98
PHOTOGRAPHIC TIMER, Mar. '79	£16.45
CAR ALARM, Feb. '79	£10.98
SCRATCH/RUMBLE FILTER, Feb. '79	£25.48 Mono
	£29.98 Stereo
SINE/SQUARE WAVE GENERATOR, Feb. '79	£25.78
GRAPHIC EQUALISER, Jan. '79	£28.68
PUSH BUTTON DICE, Dec. '78	£6.98
AUDIO MIXER, Dec. '78	£25.98
BEDSIDE RADIO, Nov. '78	£16.99
STEREO AMPLIFIER (HOBIT), Nov. '78	£59.50

LATEST KITS: S.E.A. OR 'PHONE FOR PRICES

ELECTRONICS CATALOGUE

Magenta's Catalogue has been carefully designed for Electronics Constructors. Product data and illustrations make the Magenta Catalogue an indispensable guide for the constructor. Catalogue includes ELECTRONIC COMPONENTS, HARDWARE, TOOLS, CASES, TEST EQUIPMENT. Details of advertised items and CIRCUIT IDEAS for you to build.

No minimum order — all products are stock lines. FIRST-CLASS delivery of FIRST-CLASS components. Send for your copy and see how easy our catalogue is to use. WRITE TODAY enclosing 6 x 10p stamps.

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 and the components for the projects. Adventures With Electronics £1.75. Component pack £16.72 less battery.

ADVENTURES WITH MICROELECTRONICS

Same style as above book. 11 projects based on integrated circuits — includes dice, two-tone doorbell, electronic organ, MW/LW radio, reaction timer, etc. Component pack includes Bimboard 1 plug-in breadboard and the components for the projects. Adventures with Microelectronics £2.35. Component pack £29.95 less battery.

MICROPROCESSORS FOR BEGINNERS

We have 2 practical microprocessor courses. Both are ideal for learning about this exciting technology. Educational and interesting with practical work. Details in our catalogue or s.a.e. for sheet.

H.E. MEMORY BANK — SYNTHESISER NOV. '80

Complete kit for this exciting project, includes i.c. with socket, 2 pcbs, case etc. The custom designed i.c. at the heart of this project generates musical sounds which can be stored in its own memory. Features include memory erase, vibrato, speed and depth controls, variable pitch, chord and tremolo etc. 'Synthesiser' Nov. '80 — £33.95

INTO DIGITAL ELECTRONICS

Current H.E. series. Part 1 in Sept. '80. Covers digital electronics from the basics. Circuits are built on a plug-in Eurobreadboard. Reprints of back issues available 45p each. Eurobreadboard and components for series £18.95 less battery. Components only £12.75.

INTO ELECTRONICS CONSTRUCTION

H E 6-part Series: Feb. '80 to July '80. COVERS THE BASICS OF ELECTRONICS — LOTS OF PRACTICAL WORK. Circuits are built on a plug-in Eurobreadboard. REPRINTS AVAILABLE, 45p each part. Eurobreadboard and Components for Series £15.63. Components only £9.43.

TOWERS INTERNATIONAL TRANSISTOR SELECTOR £10.50.
 ANTEX SOLDERING IRON 25W £4.98.
 SOLDERING IRON STAND £2.03.
 SPARE BITS: Small, standard, large 65p each.
 SOLDER. Handy size 98p.
 EUROBREADBOARD £6.20.
 LOW COST LONG NOSE PLIERS £1.97.
 LOW COST CUTTERS £1.98.
 P.C.B. ASSEMBLY JIG £11.98.
 P.C.B. ETCHING KIT £4.98.
 AM-FM AIRCRAFT BAND PORTABLE RADIO £8.98.
 WIRE STRIPPERS AND CUTTERS £2.48.
 MULTIMETER TYPE 1. 1,000 o.p.v. with probes 2" x 3/4" x 1" £8.68.
 MULTIMETER TYPE 2. 20,000 o.p.v. with probes 5" x 3/4" x 1 1/4" £11.52.
 F.M. INDOOR AERIAL 57p.
 TELEPHONE PICK-UP COIL 72p.
 CRYSTAL MICROPHONE INSERT 58p.
 SPEAKERS MINIATURE, 8 ohm 87p, 64 ohm 98p, 89 ohm £1.56.
 PILLOW SPEAKER, 8 ohm 98p.
 6" ROUND SPEAKER, 8 ohm 5W £2.28.
 EARPIECES. Crystal 55p, Magnetic 18p.
 STETHOSCOPE ATTACHMENT. Fits our ear-piece 69p.
 RING HEADPHONES. 2K Padded. Superior sensitive £3.28.
 HOW TO SOLDER BOOKLET 12p.

HEAT SINK TWEEZERS 15p.
 SOLDER BOBBIN 30p.
 DESOLDER PUMP £5.98.

3 BAND S.W. RADIO

Simple T.R.F. Design. Covering most Amateur Bands and Short Wave Broadcast Bands. Five controls. Bandsel. Bandspread. Reaction. Wavechange and Attenuator. Coil section is by Wavechange Switch. Use with Headphones or a Crystal earpiece. Kit contains all the components required, including the P.C. Board and Case. Instructions are included with this kit. KIT: £18.97. Headphone extra £3.28.

CROC CLIP TEST LEAD SET. 10 leads with 20 clips £1.15.
 CONNECTING WIRE PACK. 5 x 5 yd coils 55p.
 VERO SPOT FACE CUTTER £1.21.
 VERO PIN INSERTION TOOL. 0.1" £1.66. 0.15" £1.67.
 RESISTOR COLOUR CODE CALCULATOR 21p.
 STEREO HEADPHONES. 6 ohm Padded £4.35.
 DESOLDERING BRAID 69p.

MAGENTA ELECTRONICS LTD.

HC 3, 98 CALAIS ROAD, BURTON-ON-TRENT, STAFFS, DE13 0UL. 0283-65435. 9-12, 2-5 MON.-FRI. MAIL ORDER ONLY

ADD 35p P & P TO ALL ORDERS ALL PRICES INCLUDE 15% V.A.T. OFFICIAL ORDERS FROM SCHOOLS ETC WELCOME ENQUIRIES MUST INCLUDE S A E OVERSEAS. SEND ORDER WITH 3 INTERNATIONAL POSTAL COUPONS WE WILL QUOTE EXACT PRICE BY AIR MAIL. EIRE & BFPO ORDERS U.K. PRICES — LESS 10% (COVERS V A T REFUND & EXPORT DOCUMENTS). PAYMENT STERLING U.K. BANK DRAFT U.K. POSTAL ORDERS or U.K. CHEQUE. ENQUIRIES: ENCLOSE 2 INTERNATIONAL POSTAL COUPONS.



What's In A Name

The transistor was the mainstay of modern electronics for three decades. Only during the past couple of years has it become clear that it too will follow the thermionic valve into history. Rick Maybury looks at the history of the transistor

REMEMBER VALVES? They were those glass tubes filled with high voltages and glowing filaments. Way back in 1948, just after World War II a lot of research was being carried out by the Bell Telephone Laboratories in the USA to produce an amplifier that didn't use valves. Research during the early 1900s suggested that materials called semiconductors (see September What's In A Name) could be worth investigating. A team of three men, John Bardeen, Walter H Brattain and William Shockley were looking at the possibility of semiconductor materials changing their resistance when subjected to an electric field. Most of their experiments resulted in dismal failure. (They were actually doing the groundwork for the Field Effect Transistor which didn't appear until 1963.) Their failure to observe the predicted changes in resistance led the team to carry out further experiments on the surface characteristics of certain semiconductor crystals. This involved placing two fine tungsten wires onto the surface of a slice of Germanium crystal.

Current Affairs

They found that a current change in one of the wires caused a current change approximately five times larger in one of the other wires, the transfer resistor or as we call it now, the Transistor was born!

The first devices became known as the 'point contact transistors' and led to the first practical, commercial device becoming available in 1950. The limitations of the point contact device soon became apparent, the first transistors were largely hand-made. High noise levels generated within the device and difficulty with quantity production led to further research which culminated in 1951 with the filing of a patent by William Shockley for the Junction transistor.

The Junction Transistor

In the point contact transistor the NPN or PNP structure was formed by using a single P or N type base, each of the other two junctions were formed at the point of contact by the fine tungsten wires. Apart from the noise problem the structure limited the power handling capability to a fraction of a watt. The almost microscopic junction was replaced by a slab of either P or N type semiconductor material fused to the base. By making the central base region thinner than the collector or emitter, the power handling, gain and noise figures improved dramatically, it also enabled the growing number of companies manufacturing semiconductor devices to produce transistors in their millions.

The next advance came during the early fifties with the Alloyed Junction Transistors. They used two pellets of Indium placed on either side of a slice of N-type semiconductor germanium. This was put into an oven and heated to 500°C. The two pellets partially dissolved into the germanium. After connecting the three leadout wires the assembly was then encapsulated into a glass or metal envelope. The famous OC71 was its name, ask your grandad about it sometime.

The Silicon Story

Developments followed thick and fast and the late fifties saw the introduction of silicon as a semiconductor material. Silicon offered several important advantages over germanium as it could withstand higher temperatures and had far lower leakage currents as well as having lower noise characteristics.

The Planar process revolutionised transistor manufacture. For the first time the semiconductor manufacturers could design their product to a given specification. The Planar process is essentially a photographic one. The thicknesses of the semiconductor layers

can be finely controlled. The principle of the process relies on the diffusion of impurities into areas of the substrate defined by exposure of the silicon to a photographic mask. This process is the basis of modern IC manufacture.

In 1962 a further refinement to the Planar process was introduced, this was known as the Planar Epitaxial Transistor process. This involved the use of highly refined silicon designed to have all its component crystals in one plane.

By now the earlier research carried out by the Bell team was beginning to bear fruit. Advances in manufacturing techniques led to the Field Effect Transistor (FET) which made its debut in 1963.

This was the first real departure from conventional semiconductor operation for over a decade. Conventional transistors are commonly known as current amplifiers. You put a small current into the base and it will control a much larger current flowing through the collector and emitter. The FET is basically voltage-operated, similar in many respects to the thermionic valve. (There was even a suggestion some years ago that valves could be directly replaced with FETs with little or no modification to the circuit.)

The FET has become the basic building block for most of the ICs we use today. Their excellent switching characteristics and inherent simplicity make them ideal for logic gates.

As with many scientific developments the wheel turns full circle. The original research work that led to the transistor was in fact looking at FETs which are themselves similar to the valve for which the scientists were trying to find a replacement. The FET didn't appear until 1963, some 15 years after the original research was abandoned, and now it looks as though the FET (in its many guises) will replace the conventional transistor. What next we ask? **HE**

SEMICONDUCTORS SEND YOUR ORDERS TO
DEPT. H.E.11, P.O. BOX 6, WARE, HERTS.
VISIT OUR SHOP AT: 3 BALDOCK ST., WARE, HERTS.
TEL: 0920 3182. TELEX: 817861

TRANSISTORS

AC126	£0.23	BC149	£0.08	BC550	£0.16	BU105	£1.84	ZTX108	£0.12
AC127	£0.23	BC157	£0.12	BC556	£0.16	BU105/02	£2.24	ZTX109	£0.12
AC128	£0.22	BC158	£0.12	BC557	£0.15	BU204	£1.61	ZTX300	£0.14
AC128K	£0.32	BC159	£0.12	BC558	£0.14	BU205	£1.61	ZTX500	£0.15
AC132	£0.23	BC167	£0.14	BC559	£0.16	BU208/02		2N1613	£0.23
AC134	£0.23	BC168	£0.14	BD115	£0.58	BD115	£0.58	2N1711	£0.23
AC137	£0.23	BC169	£0.10	BD116	£0.52	MJE2955	£1.04	2N1889	£0.52
AC141	£0.25	BC169C	£0.12	BD121	£0.75	MJE3055	£0.69	2N1890	£0.52
AC141K	£0.35	BC170	£0.10	BD124	£0.81	MJE3440	£0.60	2N1893	£0.35
AC142	£0.23	BC171	£0.10	BD131	£0.40	MPP102	£0.64	2N1894	£0.86
AC176	£0.21	BC172	£0.10	BD132	£0.40	MPP104	£0.40	2N2148	£0.86
AC176K	£0.30	BC173	£0.10	BD133	£0.46	MPP105	£0.40	2N2192	£0.44
AC178	£0.29	BC177	£0.18	BD135	£0.44	MPSA05	£0.23	2N2193	£0.44
AC179	£0.29	BC178	£0.18	BD136	£0.40	MPSA06	£0.23	2N2194	£0.44
AC180	£0.23	BC179	£0.18	BD137	£0.40	MPSA55	£0.23	2N2217	£0.25
AC180K	£0.32	BC180	£0.29	BD138	£0.41	MPSA56	£0.23	2N2218	£0.25
AC181	£0.23	BC181	£0.10	BD138	£0.41	OC22	£1.73	2N2218A	£0.23
AC181K	£0.32	BC182L	£0.10	BD140	£0.41	OC23	£1.73	2N2219	£0.23
AC187	£0.23	BC183	£0.10	BD155	£0.92	OC24	£1.55	2N2219A	£0.28
AC187K	£0.32	BC183L	£0.10	BD175	£0.69	OC25	£1.15	2N2904	£0.21
AC188	£0.23	BC184	£0.10	BD176	£0.69	OC26	£1.15	2N2904A	£0.24
AC188K	£0.32	BC207	£0.10	BD177	£0.78	OC28	£0.92	2N2905	£0.21
AD140	£0.59	BC208	£0.13	BD178	£0.78	OC29	£1.09	2N2905A	£0.23
AD142	£0.88	BC209	£0.14	BD179	£0.86	OC35	£1.03	2N2906	£0.19
AD143	£0.86	BC212	£0.10	BD203	£0.92	OC36	£1.03	2N2906A	£0.23
AD149	£0.89	BC212L	£0.10	BD204	£0.92	OC70	£0.28	2N2907	£0.21
AD161	£0.40	BC213	£0.10	BDY20	£0.92	OC71	£0.17	2N2907A	£0.25
AD161K	£0.40	BC213L	£0.10	BF457	£0.43	TIC44	£0.33	2N2926G	£0.11
AD161	£0.40	BC214	£0.10	BF458	£0.43	TIC45	£0.40	2N2926H	£0.09
162MP	£0.81	BC214L	£0.10	BF459	£0.43	TIP29A	£0.46	2N2926J	£0.09
AF124	£0.35	BC227	£0.18	BF594	£0.35	TIP29B	£0.46	2N2926K	£0.09
AF125	£0.35	BC238	£0.18	BF596	£0.32	TIP29C	£0.51	2N2926L	£0.09
AF126	£0.35	BC251	£0.17	BF939	£0.28	TIP30A	£0.46	2N3053	£0.20
AF127	£0.37	BC251A	£0.18	BF940	£0.29	TIP30B	£0.48	2N3054	£0.46
AF139	£0.40	BC337	£0.32	BR779	£0.32	TIP30C	£0.51	2N3055	£0.46
AF186	£0.58	BC342	£0.32	BR780	£0.32	TIP31A	£0.46	2N3614	£1.15
AF239	£0.44	BC303	£0.32	BFX29	£0.25	TIP31B	£0.46	2N3615	£1.21
AL102	£1.38	BC304	£0.44	BFX30	£0.25	TIP31C	£0.51	2N3616	£1.21
AL103	£1.38	BC327	£0.18	BFX84	£0.25	TIP32A	£0.46	2N3646	£0.10
AU104	£1.61	BC328	£0.17	BFX85	£0.28	TIP32B	£0.48	2N3703	£0.08
AU110	£1.61	BC333	£0.17	BFX86	£0.29	TIP32C	£0.51	2N3704	£0.08
AU113	£1.61	BC338	£0.17	BFX87	£0.25	TIP41A	£0.51	2N3705	£0.08
BC107A	£0.09	BC440	£0.35	BFX88	£0.25	TIP41B	£0.52	2N3706	£0.09
BC107B	£0.10	BC441	£0.35	BFY50	£0.20	TIP42A	£0.51	2N3707	£0.09
BC107C	£0.12	BC460	£0.44	BFY51	£0.20	TIP42B	£0.53	2N3708	£0.08
BC108A	£0.10	BC461	£0.44	BFY52	£0.20	TIP42C	£0.55	2N3710	£0.08
BC108B	£0.11	BF477	£0.23	BFY90	£0.95	TIP2955	£0.69	2N3711	£0.08
BC108C	£0.12	BC478	£0.23	BF937	£0.25	TIS4	£0.25	2N3819	£0.21
BC109A	£0.09	BC479	£0.23	BF938	£0.25	TIS9	£0.21	UT46	£0.23
BC109B	£0.10	BC546	£0.12	BF939	£0.25	20MP	£0.92	ZTX107	£0.12
BC109C	£0.12	BC547	£0.12	20MP	£0.92				
BC147	£0.18	BC548	£0.12	20MP	£0.92				
BC148	£0.08	BC549	£0.12	20MP	£0.92				

74 SERIES TTL

Type	Price	Type	Price	Type	Price	Type	Price	Type	Price
7400	£0.10	7427	£0.28	7473	£0.29	74110	£0.41	74165	£0.78
7401	£0.13	7428	£0.30	7474	£0.29	74111	£0.67	74166	£0.90
7402	£0.13	7430	£0.30	7475	£0.33	74118	£0.92	74174	£0.75
7403	£0.13	7432	£0.25	7476	£0.28	74119	£1.36	74175	£0.75
7404	£0.13	7433	£0.35	7477	£0.51	74121	£0.76	74176	£0.87
7405	£0.13	7437	£0.24	7481	£0.98	74122	£0.45	74177	£0.67
7406	£0.25	7438	£0.24	7482	£0.78	74123	£0.48	74180	£1.73
7407	£0.25	7440	£0.14	7483	£0.67	74136	£0.60	74181	£0.67
7408	£0.24	7441	£0.58	7484	£1.01	74141	£0.83	74182	£0.81
7409	£0.15	7442	£0.46	7485	£0.78	74145	£0.63	74184	£0.91
7410	£0.13	7443	£0.81	7486	£0.30	74146	£0.78	74190	£0.78
7411	£0.20	7444	£0.81	7489	£1.96	74151	£0.55	74191	£0.71
7412	£0.17	7445	£0.75	7490	£0.37	74153	£0.55	74192	£0.67
7413	£0.28	7446	£0.69	7491	£0.74	74154	£0.94	74193	£0.69
7414	£0.51	7447	£0.64	7492	£0.40	74155	£0.58	74194	£0.71
7416	£0.26	7448	£0.55	7493	£0.35	74156	£0.58	74195	£0.69
7417	£0.26	7450	£0.13	7494	£0.86	74157	£0.58	74196	£1.21
7420	£0.13	7451	£0.13	7495	£0.58	74160	£0.67	74197	£1.21
7421	£0.23	7453	£0.13	7496	£0.58	74161	£0.71	74198	£2.13
7422	£0.26	7454	£0.13	74100	£0.98	74162	£0.71	74199	£2.13
7423	£0.23	7455	£0.13	74104	£0.45	74163	£0.71		
7425	£0.22	7470	£0.25	74105	£0.44	74164	£0.71		
7426	£0.26	7472	£0.23	74107	£0.28	74164	£0.78		

CMOS ICs

Type	Price								
CD4000	£0.16	CD4012	£0.22	CD4022	£0.94	CD4031	£2.30	CD4046	£1.50
CD4001	£0.22	CD4013	£0.48	CD4023	£0.22	CD4035	£1.38	CD4047	£1.00
CD4002	£0.18	CD4015	£0.94	CD4024	£0.75	CD4037	£1.09	CD4049	£0.55
CD4006	£1.06	CD4016	£0.49	CD4025	£0.22	CD4040	£1.01	CD4050	£0.55
CD4007	£0.20	CD4017	£0.94	CD4026	£1.70	CD4041	£0.87	CD4054	£1.27
CD4008	£1.06	CD4018	£0.98	CD4027	£0.58	CD4042	£0.83	CD4014	£0.92
CD4009	£0.52	CD4019	£0.48	CD4028	£0.78	CD4043	£1.01	CD4055	£1.15
CD4010	£0.55	CD4020	£1.04	CD4029	£0.98	CD4044	£0.94	CD4056	£1.25
CD4011	£0.22	CD4021	£0.94	CD4030	£0.55	CD4045	£1.61	CD4069	£2.50

LINEAR

Type	Price	Type	Price	Type	Price	Type	Price	Type	Price
CA3011	£1.13	CA3130	£1.07	MC1496	£1.04	UA723C	£0.52	TA6550B	£0.40
CA3014	£1.55	CA3140	£0.81	NE536	£3.06	72723	£0.52	TA6521A	£2.28
CA3018	£0.75	LM301	£0.33	NE550	£1.09	UA741C	£0.28	TA6521B	£2.88
CA3020	£0.82	LM304	£1.84	NE555	£0.28	72741	£0.28	TA661	£1.70
CA3028	£0.82	LM308	£1.73	NE586	£0.69	741P	£0.23	TA6100	£1.50
CA3035	£1.15	LM309	£1.15	NE586	£1.38	UA747C	£0.69	TA8450	£2.42
CA3036	£1.15	LM380	£0.98	NE586	£1.38	72747	£0.69	TB8105	£0.86
CA3042	£1.73	LM381	£1.67	NE586	£1.96	UA748	£0.69	TB8110	£1.19
CA3043	£2.13	LM3900	£0.67	UA702C	£0.53	748P	£0.40	TB820	£0.81
CA3046	£0.81	LM3914	£2.45	72702	£0.53	SN76013N		TB8200	£2.88
CA3052	£0.84	LM3915	£2.19	72703	£0.29	SN76023N	£2.01	TB8205	£2.30
CA3054	£1.27	LM304	£2.45	UA710C	£0.46			TB8206	£2.30
CA3075	£1.73	MC1310	£1.09	72710	£0.35	SN76110	£1.73	TB8210	£0.60
CA3081	£1.73	MC1312	£2.18	72711	£0.35	SN76115	£2.19	TB841A	£1.94
CA3089	£2.30	MC1350	£1.39	UA711C	£0.37	SN76115	£2.19	ZN514	£1.18
CA3090	£4.14	MC1352	£1.61	Z2211	£0.37	SN78660	£0.86		
CA3123	£2.19	MC1469	£3.39						

THYRISTORS

Volts	Price	Volts	Price
10 THY600ma/10v	£0.17	50 THY1A/50	£0.30
20 THY600ma/20v	£0.18	100 THY1A/100	£0.30
30 THY600ma/30v	£0.23	200 THY1A/200	£0.37
50 THY600ma/50v	£0.25	400 THY1A/400	£0.44
100 THY600ma/100v	£0.29	600 THY1A/600	£0.52
200 THY600ma/200v	£0.44	800 THY1A/800	£0.67
400 THY600ma/400v	£0.51		
50 THY10A/50	£0.58		
100 THY10A/100	£0.65		
200 THY10A/200	£0.71		
400 THY10A/400	£0.80		
600 THY10A/600	£0.89		
800 THY10A/800	£0.95		

LEDs

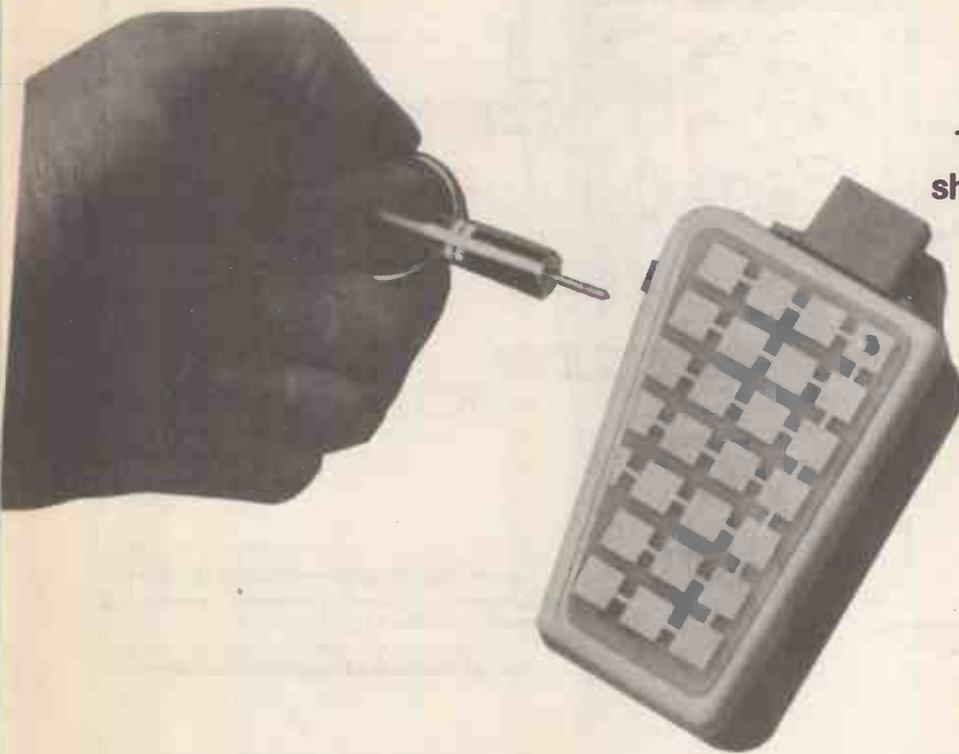
O/no	Size	Colour	Price
1501	125	RED	£0.10
1502	125	GREEN	£0.16
1503	125	YELLOW	£0.16
1504	2	RED	£0.10
1505	2	GREEN	£0.16
1506	2	YELLOW	£0.16
1509	2	CLEAR	£0.12

SUPER 'Hi'Brite' Type

1521	125	RED	£0.11
1522	2	RED	£0.11
1523	2	GREEN	£0.11
1520	2	ORP 12 Light dependent resistor	£0.70
1520	2	OC71 Photo transistor	£0.40

CLIPS

Party Grenade



This Christmas, we think that you should give your kids (and yourself) a treat and build something with no useful purpose — something just for fun. Designed by Jonathon Scott

IF YOU HAVE kids (or can borrow some), they make a great excuse for building this project! Don't think that it's purely for children, though — judging from the reactions we saw from adults (especially our staff!), the game is just as good for anyone young at heart.

The basic idea started from the old 'hot potato' game in which an object — the hot potato — is passed from person to person until some cue occurs, such as the music stopping, as in musical chairs. The holder of the object is then out of the game and it proceeds with one person less. Eventually, all but one person is excluded and he or she wins the game.

In this new version (which the office wag dubbed 'Irish Roulette') the tossed object is a grenade. Once the 'pin' (a shorted 2.5 mm jack plug) is removed, the grenade becomes active. After that, making touch contact between the two PCB plates on the outside of the box causes a capacitor to charge. When it has charged to a preset level, which is the same as saying that the grenade has been handled by the people in the game for the required time, the buzzer goes off — with no damage to life or limb!

The grenade will go off while a particular person is holding it. It is highly

unlikely to go off in mid-air (though very wet hands can leave enough moisture to set it off). The faster your reaction and the quicker you get rid of the grenade the less likely you are to get 'blown up'. The grenade times at a rate independent of damp hands or strength of grip, and is reset by putting the pin back in.

Construction

The first job to undertake is the construction of the PCB. Take care that the diode, capacitor, transistor and the IC are inserted the right way round. As usual we recommend the use of an IC socket.

Mark and drill whatever case you are using to allow for the jack socket, buzzer and two touch contact-plates. The touch contacts are made from shaped pieces of PCB, etched in the pattern shown in the photographs, to imitate the visual appearance of a grenade and are simply glued to the side of the case.

Drill holes in the box underneath the places where the PCB touch contact board wires are to run. It is best to drill the small holes in the boards first to enable you to mark the positions of the

holes to be made in the box. One touch contact can be glued on the outside of the case now, but the one which must cover the screws will obviously need to be left till last.

You can mount your PCB on the inside of the case using nuts and bolts if you wish but we preferred to hold ours down using one of the proprietary brands of double sided, adhesive pads available.

Interconnect the board, buzzer, battery and jack socket as in the diagram, mount the battery using double sided pads or jam it in place with some foam rubber and screw on the lid. Finally, the second touch contact is glued on the remaining side of the case. We found that a few small drops of cyanoacrylate adhesive was best, as it maintains good adhesion during normal use, but the board can be prised sharply off when the time comes to change the battery. Remember to follow the manufacturers' instructions when using the adhesive, it can be dangerous.

The pin is made by simply shorting the two connections together. Then if you drill a small hole through the cover of the plug a key ring can be used as a finger pull.



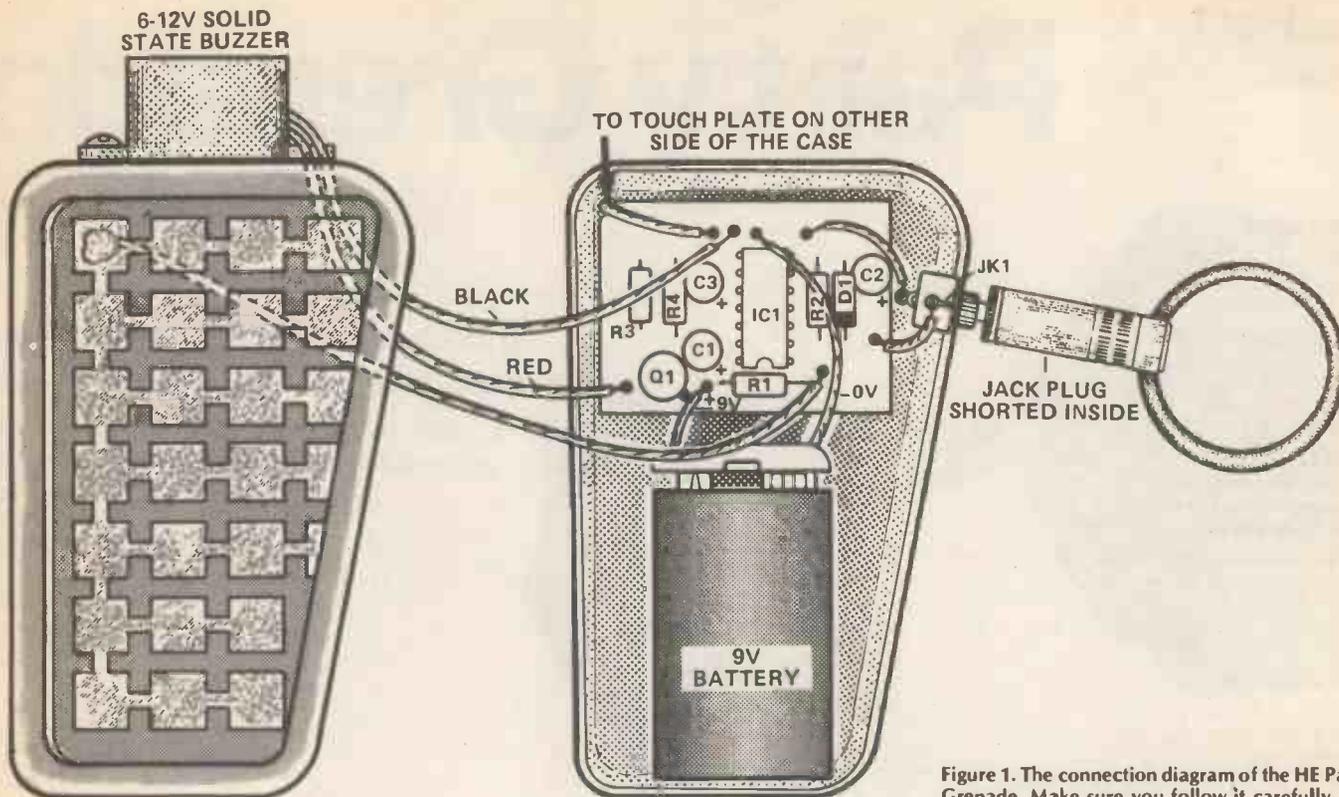


Figure 1. The connection diagram of the HE Party Grenade. Make sure you follow it carefully and your project should go like a bomb!

Figure 2. The circuit diagram is shown below

How it Works

The circuit counts the period of time that the grenade is held after the 'pin' has been pulled and operates the buzzer when this period reaches several seconds.

Initially, a shorted plug (the 'pin') is inserted in JK1, shorting C2. Resistor R1 holds the inputs of IC1a high. Its output is therefore low, so no current flows through R2/D1 (No relation to R2-D2!)

The output of IC1d is high, so that Q1 is biased off and the output of IC1c is held low. Quiescent current flowing in this state is negligible — less than 0.5 uA.

If the device is picked up and the skin resistance of a hand placed across the touch

contacts, the output of IC1a goes high and a small current flows through R2, but C2 remains shorted out by the pin.

When the pin has been removed, however, holding the device causes C2 to charge. D1 prevents rapid discharging when the touch is removed by preventing current flowing back through R2.

When C2 charges to the threshold of IC1b, its output goes low and a monostable formed by IC1c and IC1d turns Q1, and thus the buzzer, on for about a second.

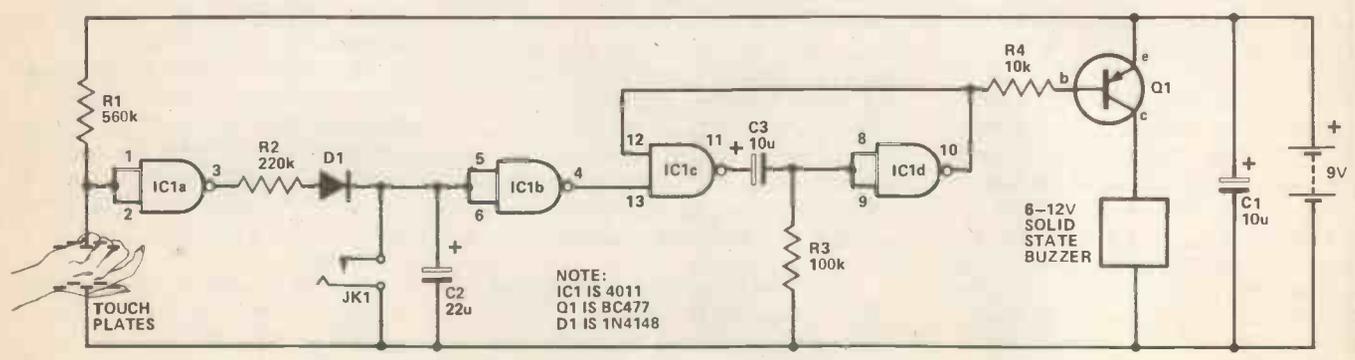
The pin is then replaced to reset the circuit, ready for another attack.

Buylines

The solid state buzzer is about the only component which may be difficult to find. Any of the usual mail order companies should be able to help.

The box is made by Vero and their code number for it is 202-21026G.

Approximate price for the HE Grenade should only be about £3. As usual this does not include case or PCB.



Parts List

RESISTORS (All 1/4 W, 5%)

R1 560k
R2 220k
R3 100k
R4 10k

CAPACITORS

C1,3 10u 16 V tantalum
C2 22u 16 V tantalum

SEMICONDUCTORS

D1 1N4148
Q1 BC477
IC1 4011

MISCELLANEOUS

6 to 12 V solid state buzzer
2.5 mm jack plug and socket
case to suit (see Buylines)

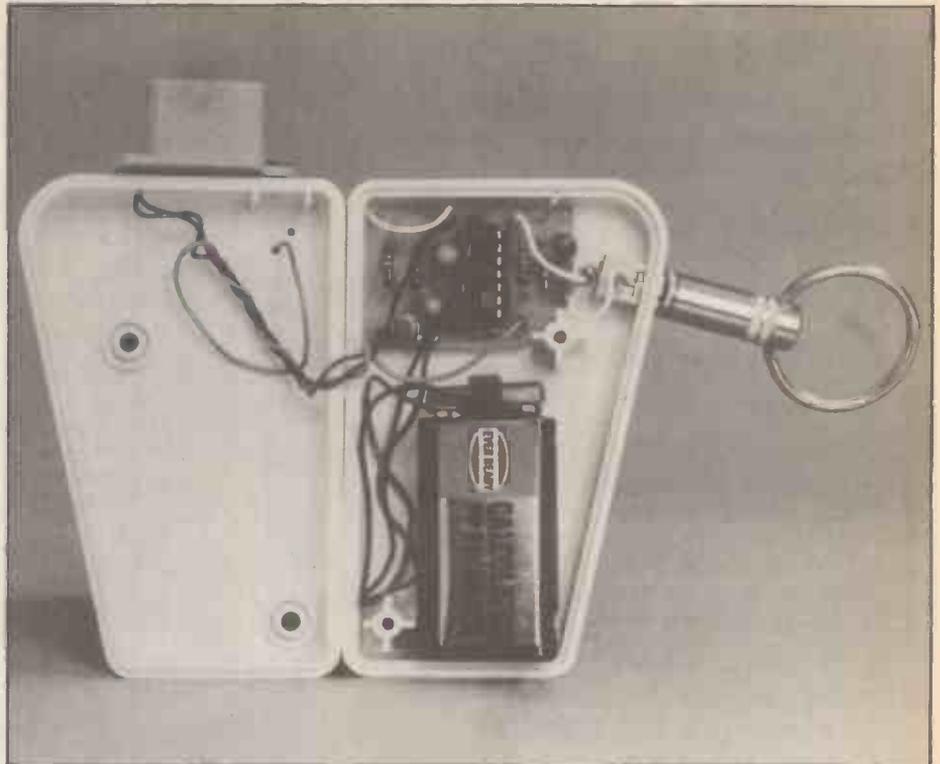


Figure 4. The inside of the case. There's not a lot of room left, is there?

HE

Marshall's

A. Marshall (London) Ltd., Kingsgate House,
Kingsgate Place, London NW6 4TA
Industrial Sales: 01-328 1009
Mail Order: 01-624 8582 24hr. service
Also retail shops: 325 Edgware Road, London W2
40 Cricklewood Broadway, London NW2 85 West Regent St. Glasgow
108A Stokes Croft, Bristol

We now supply the extremely reliable and cost conscious LEADER range of testgear.

SINGLE TRACE OSCILLOSCOPES

LBO 510A 5" 4MHz 20mV	£125.00
LBO 512A 5" 10MHz 10mV	£170.00
LBO 513A 5" 10MHz 10mV	£215.00
LBO 507A 5" 20MHz 10mV	£239.00

DUAL TRACE OSCILLOSCOPES

LBO 308S 3" 20MHz 2mV	£419.00
LBO 508A 5" 20MHz 10mV	£229.00
LBO 520A 5" 35MHz 5mV	£475.00
LNO 514 5" 10MHz 5mV	£255.00

T.V. RADIO TEST GEAR

LSG 16 Signal Generator	£ 49.00
LSG 231 FM Stereo Signal Generator	£169.00
LCG 392U PAL B Pattern Generator	£189.00

AUDIO TEST GEAR

LAG 26 Audio Generator	£ 60.00
LAG 120A Audio Generator	£119.00
LDM 170 Distortion Meter	£225.00
LFM 39A Wow/Flutter Meter (Dual)	£249.00
LFM 39A Wow/Flutter Meter (Dual)	£299.00
LAV 191 Audio Tester	£249.00
LAG 125 Low Distortion Audio Generator	£229.00

GENERAL TEST GEAR

LCH 740 LCR Bridge	£135.00
LTC 906A Transistor Checker	£ 90.00
LVT 72 Fet Transistor Checker	£119.00
LTC 907 Transistor Checker	£139.00
LAT 47 Attenuator	£135.00
LAT 45 Attenuator	£ 75.00
LFG 1300 Sweep Function Generator	£299.00

AMATEUR RADIO

LOM 815 DIP Meter	£ 43.00
LIM 870A Antenna Impedance Meter	£ 41.00
LPM 880 RF Power Meter	£ 69.00
LPM 885 SWR/Watt Meter	£ 44.00
LAC 895 Antenna Coupler	£ 85.00
LAC 896 Antenna Coupler	£ 41.00
LAC 897 Antenna Coupler	£ 41.00

Please send large SAE for special catalogue. All prices exclusive VAT/carriage.

The new Marshall's 80/81 catalogue is now available. A veritable treasure house of components, test gear, tools, etc.



Lots of old friends, but also many new products including leader test gear, Crimson Hi Fi Modules, Rechargeable Ni Cad batteries and chargers (very competitive). More components including SN74ALS series, new tools etc. Available by post, UK 75p post paid: Europe 95p post paid: Rest of world £1.35 post paid.

SINCLAIR INSTRUMENTS

Digital Multimeter

" " PDM35	£ 34.50
" " DM235	£ 52.50
" " DM350	£ 72.50
" " DM450	£ 99.00

Digital Frequency Meter

PFM200	£ 49.80
--------	---------

Low Power Oscilloscope

SC110	£139.00
-------	---------

NEW

TF200	Frequency Meter	£145.00
TGF105	Pulse Generator	£ 85.00

CRIMSON ELEKTRIK HI FI MODULES

CE608	Power Amp	£20.09
CE1004	" "	£23.43
CE1008	" "	£26.30
CE1704	" "	£33.48
CE1708	" "	£33.48
CPS1	Power Unit	£19.52
CPS3	" "	£23.52
CPS6	" "	£30.00
CPR1	Pre Amp	£32.17
CPR1S	Pre Amp	£42.52

All Prices + VAT + postage/packaging

Don't forget! We also carry an impressive range of semi-conductors, passive components, electro mechanical components, tools etc.

MITRAD

The premier mail order house specialising in quality products and superior after-sales care.

SEIKO QUARTZ

LCD MEMORY-BANK CALENDAR WATCH

SPECIAL PRICE **ONLY £49.95**

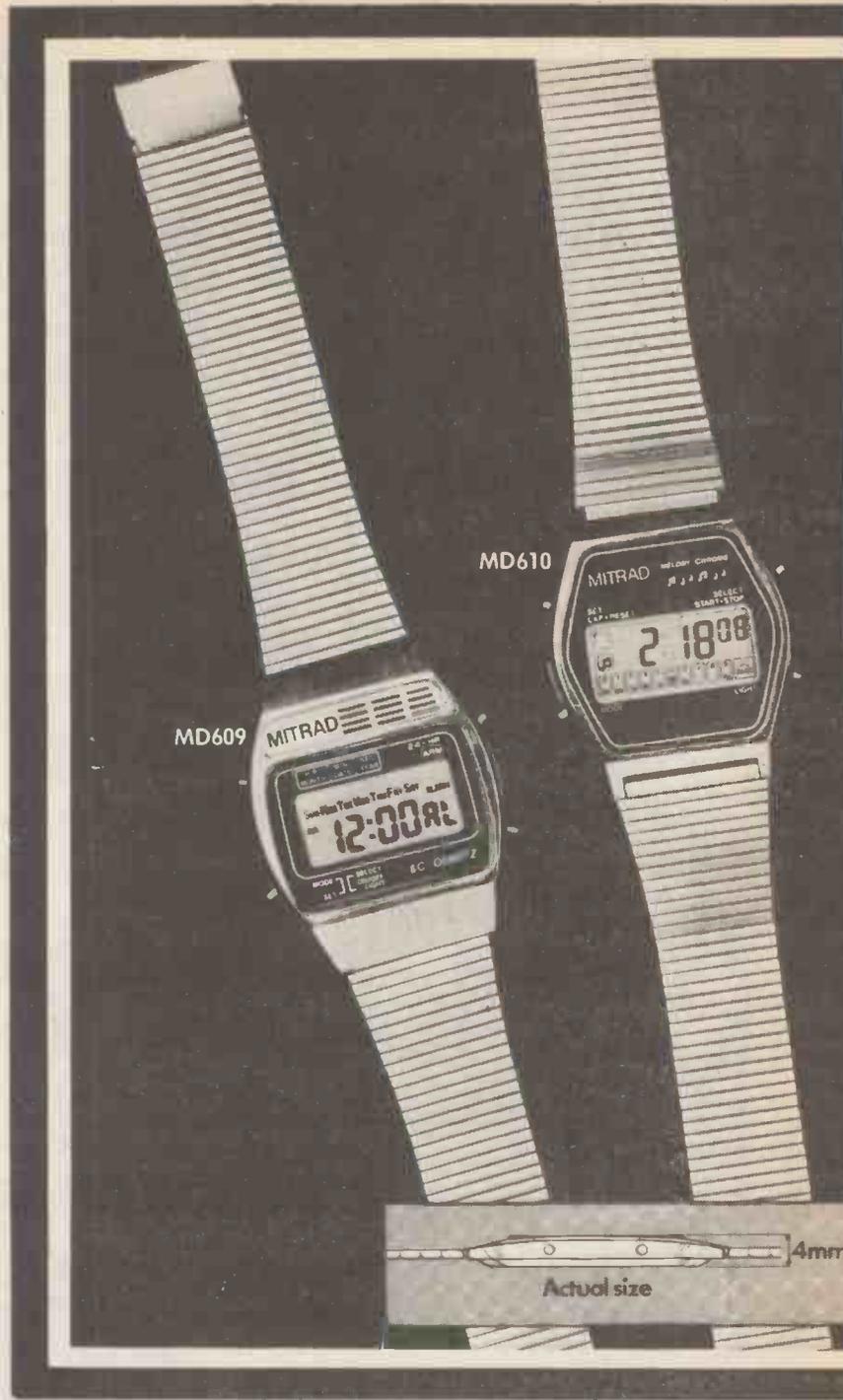
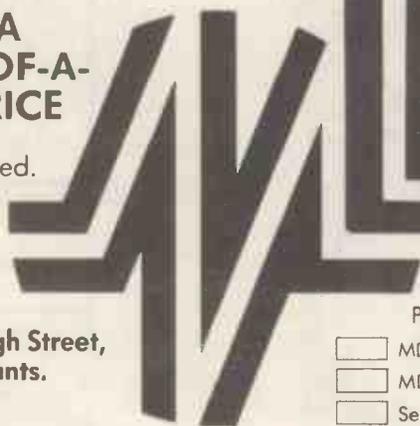
plus 85p p&p. Usually £89 or over.

- Displays hour, minute, second, month, day of the week and date in 12 hour indication – or 24 hour at the touch of a button.
- Button touch also displays month and year and dates for a designated month with Sunday dates flashing.
- Stores dates in memory up to 11 ahead, flashes 'MEMO' on designated dates.
- Illuminated time and calendar display.
- Display flashes when battery nears life end.
- Stainless steel case and wrist strap (adjustable).

In presentation case with instructions.

A LIFETIME WATCH AT A BARGAIN-OF-A-LIFETIME PRICE

Full refund if not completely satisfied.



Mitrad, 68-70 High Street, Kettering, Northants.
Tel: 0536 522024

This is a representative selection from the collection of guaranteed leading make and own brand watches offered through Mitrad's 7 day distribution system and backed by Mitrad's own service organisation. For complete product range, ring or write for catalogue. Trade price list available for bulk orders.

To Mitrad, 68-70 High Street, Kettering, Northants.
Please send me:

- | | |
|---|--|
| <input type="checkbox"/> MD609 watch(es) at £11.80 inc p&p | <input type="checkbox"/> MD606 watch(es) at £10.80 inc p&p |
| <input type="checkbox"/> MD610 watch(es) at £17.80 inc p&p | <input type="checkbox"/> MD607 watch(es) at £10.80 inc p&p |
| <input type="checkbox"/> Seiko Quartz watch(es) at £50.80 inc p&p | <input type="checkbox"/> MD608 watch(es) at £16.35 inc p&p |
| <input type="checkbox"/> MD605 watch(es) at £12.80 inc p&p | |

Total value of my order £ _____

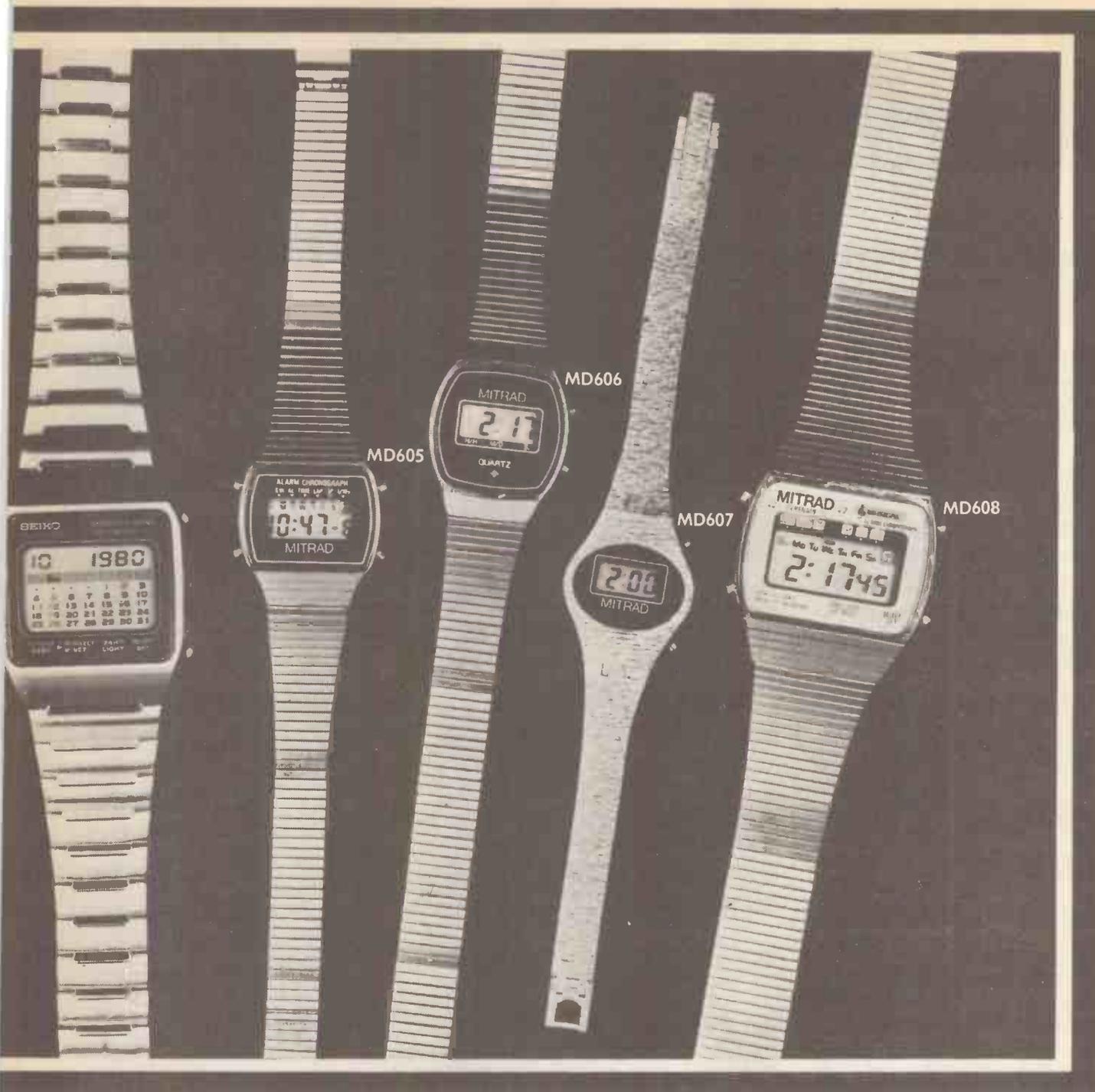
I enclose cheque/PO or debit my Access/Barclaycard No. _____

Name _____ Signature _____

Address _____ (block letters please)

☎ Credit Card holders may telephone (0536) 522024 24 hours a day stating Card Number for immediate attention. All orders despatched within seven days, subject to availability. Full refund if not completely satisfied.
Mitrad Registered in England No. 2554356.





MD609 Gentleman's super slim flag date alarm. Only 4mm case thickness. Continuous display of hours, minutes, seconds and day; optional display of date, month, year. 24 hour alarm, alarm mode indication. Back light. Infinitely adjustable stainless steel strap. Very latest technology.
£10.95 + 85p p&p

MD610 Gentleman's dual time melody alarm chrono. Only 5mm case thickness. Continuous display of hours, minutes, seconds plus date and mode indications. 'Running horse' chrono to 1/10 sec, 12 hour alarm plays 30 seconds of 'Yellow Rose of Texas'. Infinitely adjustable stainless steel strap.
£16.95 + 85p p&p

MD605 Ladies musical alarm chrono. Continuous display of hours, minutes, seconds; optional display of day, date, month. Auto calendar. Chronograph with lap timing facilities, to 1/10 sec. 24 hour alarm plays 30 seconds of Beethoven's 'Fur Elise'. Back light. Infinitely adjustable stainless steel strap.
£11.95 + 85p p&p

MD606 Ladies five function fashion LCD watch with 3 year battery. Continuous display of hours and minutes, with month/date and date/seconds available. Auto calendar. Only 6mm case thickness. Back light. Infinitely adjustable stainless steel strap.
£9.95 + 85p p&p

MD607 Ladies slim 'sugar coated' dress watch. Continuous display of hours and minutes; optional display of month and date. Auto calendar. Back light. Integral watch and strap. In gold or silver finish.
£9.95 + 85p p&p

MD608 Gentleman's musical alarm chrono. Continuous display of hours, minutes, seconds, plus day indication. Also month and date. Chronograph with lap timing facilities, to 1/10 sec. 24 hour alarm plays 30 seconds of Beethoven's 'Fur Elise' or can be set to awaken to a single note. Back light. Infinitely adjustable stainless steel strap.
£15.50 + 85p p&p

Building Site

Do you want to know all about printed circuit boards? Are they as difficult to make as they seem? Keith Brindley explains how easy they really are

OVER THE LAST month or two I have received several requests by readers, to give all the gen about printed circuit boards (PCBs) — why do we use them and how does the hobbyist set about making them him-self (or herself)?

Well, the answer to the first question is simple — we use them because they provide the most convenient and foolproof way of making connections between components, without the danger of short circuits and without the use of a large number of interconnecting wires. In **Figure 1** you can see photographs of the top and bottom of a typical PCB showing the copper track attached to the surface of the insulating board. It doesn't take much imagination to picture the project if all connections had to be made with wires. Nothing can beat the neatness of a PCB in project construction and this is the reason why HE and our sister publication ETI have *always* used PCBs in projects — for your benefit.

As for the second question, there is no mystique to home-made PCBs (the real art is in the foil pattern design). The process is a straightforward, scaled-down version of commercial processes and is suited to the hobbyist in both ease and expenditure. There is no need for elaborate equipment which would be out of the home constructor's price range and likewise you don't have to be an expert. Just a few simple hints should be all that's required to enable anyone to do-it-themselves.



Figure 1: Photographs of the bottom and top of a typical printed circuit board

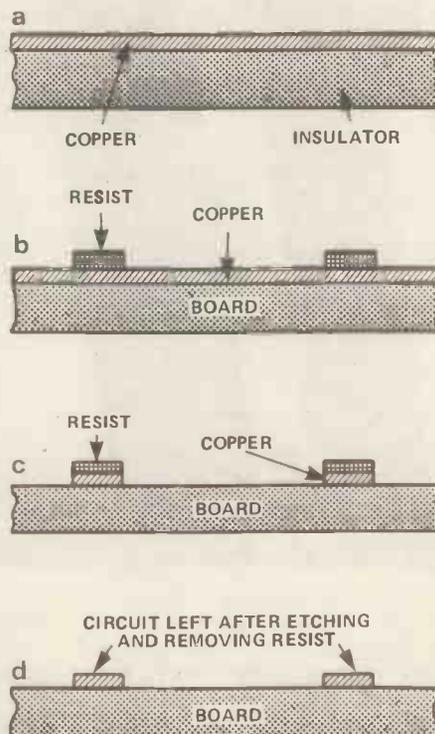


Figure 2: Above four stages in the life of a PCB

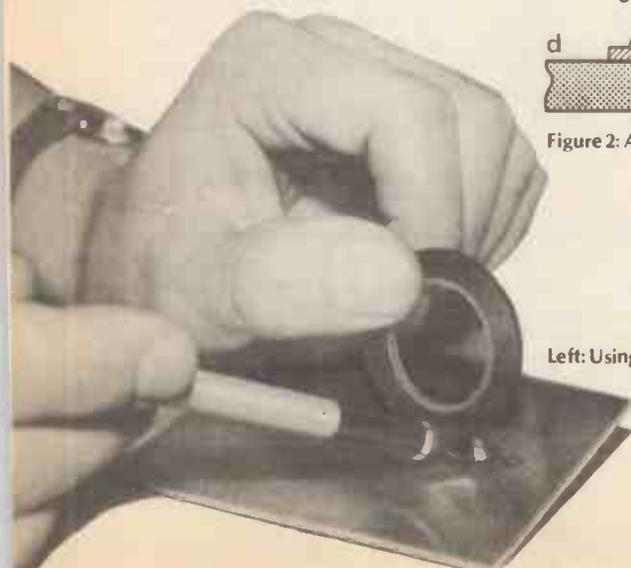
Brass Tacks And Copper Tracks

PCBs start off in life as copper-clad board, the general construction of which can be seen in **Figure 2a**. The idea is that unwanted areas of copper are removed by a copper-dissolving or etching agent (normally ferric chloride), leaving behind the wanted areas of copper (the foil pattern). It is this pattern that is used to make all the interconnections between components. The foil pattern obviously needs to be protected from the etchant whilst the board is in the etching bath, and this is done with the use of an etch-resistant material usually known as the 'resist'. **Figure 2b** shows this. The resist can be any one of several materials — even common-or-garden household paint can be used as long as it is etch resistant. **Figure 2c** shows the board after it has been etched; the unwanted copper areas have been removed, leaving only the foil pattern which is known as the track. Lastly the resist is removed and the board is ready for drilling and use.

Which Method To Choose

There are at least three main ways in which readers can make their own PCBs in the above manner at a reasonably low cost.

The first is the tracing method. Provided that you have the foil pattern in front of you, it is a simple matter to transfer the outline to a sheet of tracing paper using a soft pencil. Once the pattern has been drawn, turn it upside-



Left: Using the 'dots and tape' method of resist



Using HOBBYPRINTS as a resist. A burnisher can be used as in the photograph or alternatively a soft pencil works equally as well.

down and copy it on the reverse side. Place this over a clean piece of copper sheet and rub it over with the pencil. When the design has been transferred to the copper sheet fill in the track outlines with a fine brush with either enamel or cellulose paint. When the paint is dry the board is ready for etching.

The next method should be used when making boards which have ICs on them. The important point to remember is that the holes for the IC pins must be correctly aligned. This can be achieved by taping the board (copper-side up) to the underside of the traced pattern (for an HE project, tape the board to the underside of the page where the foil pattern appears). Now, with a sharp pointed scribe or similar tool, carefully mark through, onto the board, every hole position indicated on the paper. Remove the board and apply a resist to fill in the tracks around the holes according to the original pattern. Paint can be used as suggested above but this does

require a steady hand. Alternatively etch-resistant transfers (for component holes) and tape (for the track) can be used. These can be bought from any good drawing office supplier although, inevitably they cost slightly more than paint. Their advantage however, is that they can make a neater PCB.

The remaining method of PCB construction for the hobbyist is the use of our own HOBBYPRINTS. Month by month, HOBBYPRINTS provide a rub-down transfer method of reproducing on to PCB the whole etch-resistant foil pattern for immediate etching use. The photograph shows its use. You'll find an advertisement for HOBBY-PRINTS close to the foil pattern page every month and they are well worth the measly sum involved in their purchase.

Take Care

Etching a PCB need not be tricky but it can be messy if you don't take care. The etchant is usually Ferric Chloride, which can be bought at most chemists or

chemical wholesalers. Now this stuff is nasty. If you get it on your clothes they can literally fall apart. Use a plastic tray or an old food container for the etching bath and be careful how you pour it — try not to splash — if you do, wash immediately with cold running water. A good, fresh, strong solution of the stuff will etch your PCB in only a few minutes. A point to bear in mind at this stage is that as the reaction takes place a blackish deposit forms on the surface of the copper. If this is not removed then further reaction is slowed down. The deposit must be removed by either agitating the etching bath slowly backwards and forwards (extremely carefully) during the process or by making use of the surface tension of the fluid and floating the board copper-side-down on the surface. The deposit falls to the bottom of the bath leaving a constantly fresh copper surface for the reaction to occur. The only disadvantage is that you can't see the surface of the board to judge when the reaction has been completed.

Wash the board thoroughly after it has been etched and clean off the resist (using wire wool or sandpaper) to give a shiny clean copper surface. Finally, all component holes have to be drilled. One of the commercially-available, modellers' drills can be used for this, fitted with a 1 mm bit. Such drills cost around £10 but this is money well spent if you are going to construct more than just a couple of PCBs a year. Making your own boards will work out much cheaper than buying them ready-made.

And that's it! The next stage is the insertion of components to complete your project. Nothing to it really is there? — when you know how.

HE

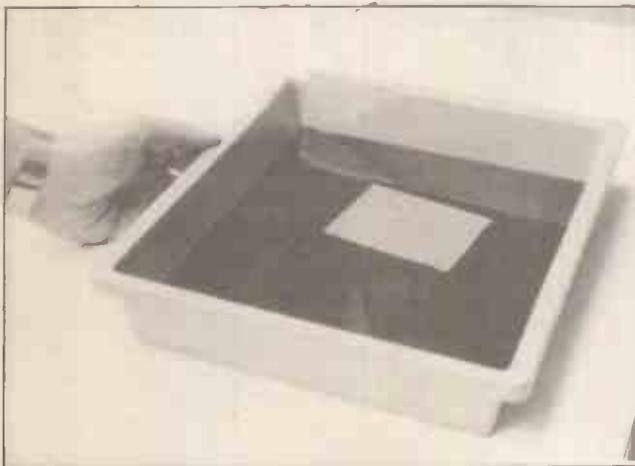


Figure 3. Etching a PCB by floating the board on the surface of the ferric chloride.

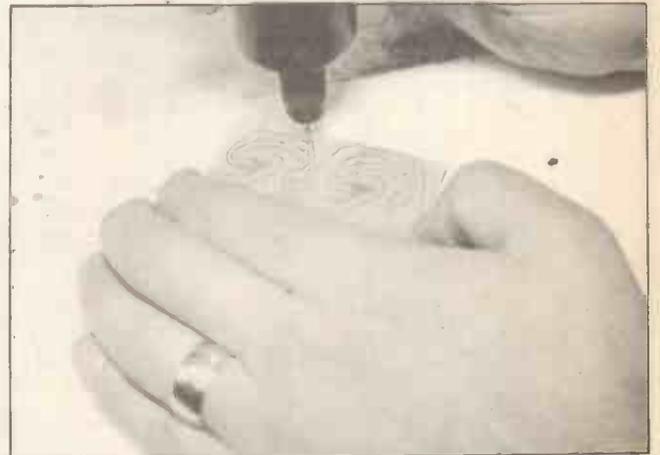


Figure 4. A modeller's drill fitted with a 1 mm bit can be used to drill all component holes.

AND THERE'S MORE WHERE THIS CAME FROM

It's a long time since one of our adverts was presented in 'list' form - but simply because we do not try to squeeze this lot in every time doesn't mean that it's not available. Our new style price list (now some 40 pages long) includes all this and more, including quantity prices and a brief description. The kits, modules and specialized RF components - such as TOKO coils, filters etc. are covered in the general price list - so send now for a free copy (with an SAE please). Part 4 of the catalogue is due out now (incorporating a revised version of pt.1).

LINEAR ICs - NUMERIC LISTINGS

TBA120S	1.00	KB4413	1.95
L200	1.95	KB4417	1.80
U237B	1.28	TDA4420	2.25
U247B	1.28	KB4420B	1.09
U257B	1.28	KB4423	2.30
U267B	1.28	KB4424	1.65
LM301H	0.67	KB4431	1.95
LM301N	0.30	KB4432	1.95
LM308H	0.96	KB4433	1.52
LM308N	0.65	KB4436	2.53
LM339N	0.66	KB4437	1.75
LM348N	1.86	KB4438	2.22
LF351N	0.38	KB4441	1.35
LF353N	0.76	KB4445	1.29
LM374N	3.75	KB4446	2.75
LM380N-14	1.00	KB4448	1.65
LM380N-8	1.00	NES5044N	2.26
LM381N	1.81	NES532N	1.85
ZN419CE	1.95	SD6000	3.75
NES44N	1.80	SL6270	2.03
NES55N	0.30	SL6310	2.03
NES56N	0.50	SL6600	3.75
NES60N	0.50	SL6640	2.75
NES62N	4.05	SL6690	3.20
NES64N	4.29	SL6700	2.35
NES65N	1.00	ICL8038CC	4.50
NES66N	1.60	MSL9362	1.75
NES70N	3.85	MSL9363	1.75
SL624	3.28	HALL1211	1.95
TBA651	1.81	HALL1223	2.15
UA709HC	0.64	HALL1225	1.45
UA709PC	0.36	HALL2202	1.45
UA710HC	0.65	HALL2017	0.80
UA710PC	0.59	HALL2402	1.95
UA7410C	0.66	HALL2411	1.20
UA7410N	0.27	HALL2412	1.55
UA7470N	0.70	LF13741	0.33
UA7480N	0.36	SN76660N	0.80
UA753	2.44		
UA758	2.35		
TBA810AS	0.75		
TBA820M	1.09		
TC9A02E	1.80	SAA1056	3.75
TDAL028	2.11	SAA1058	3.35
TDAL029	2.11	SAA1059	3.35
TDAL054	1.45	11C900D	14.00
TDAL062	1.95	LNI232	19.00
TDAL072	2.69	LNI242	19.00
TDAL074A	5.04	MSL2318	3.84
TDAL083	1.95	MSM5523	11.30
TDAL090	3.05	MSM5524	11.30
HALL137	1.20	MSM5525	7.85
HALL196	2.00	MSM5526	7.85
HALL197	1.00	MSM5527	9.75
TDAL120	1.20	MSM5527L	9.75
LM1303	0.99	ICM7106CP	9.55
LM1307	1.55	ICM7107CP	9.55
MC1310P	1.90	ICM7216B	19.25
MC1330	1.20	ICM7217A	9.50
MC1350	1.20	SP8629	3.85
LM1370	1.90	SP8647	6.00
HALL388	2.75	95H90PC	6.00
TDAL490	1.86	HDI0551	2.45
MC1496P	1.25	HD4015	4.45
SL1610P	1.60	HD42009	6.00
SL1611P	1.60	HD44752	8.00
SL1612P	1.60		
SL1613P	1.89		
SL1620P	2.17		
SL1621P	2.17		
SL1623P	2.24		
SL1624C	3.28		
SL1625P	2.17		
SL1626P	2.44		
SL1630P	1.62		
SL1640P	1.89		
SL1641P	1.89		
TDA2002	1.25		
TDA2020	3.00		
ULN2242A	3.05		
ULN2283B	1.00		
CA3080E	0.70		
CA3089E	1.84		
CA3090AQ	3.35		
CA3123E	1.40		
CA3130E	0.80		
CA3130T	0.90		
CA3140E	0.46		
CA3189E	2.20		
MC3357P	2.35		
LM3900N	0.60		
LM3909N	0.68		
LM3914N	2.80		
LM3915N	2.80		
KB4400	0.80		
KB4406	0.60		
KB4412	1.95		

FREQUENCY DISPLAY & SYNTHESISER ICs

SAA1056	3.75
SAA1058	3.35
SAA1059	3.35
11C900D	14.00
LNI232	19.00
LNI242	19.00
MSL2318	3.84
MSM5523	11.30
MSM5524	11.30
MSM5525	7.85
MSM5526	7.85
MSM5527	9.75
MSM5527L	9.75
ICM7106CP	9.55
ICM7107CP	9.55
ICM7216B	19.25
ICM7217A	9.50
SP8629	3.85
SP8647	6.00
95H90PC	6.00
HDI0551	2.45
HD4015	4.45
HD42009	6.00
HD44752	8.00

CMOS 4000 SERIES

4001	0.17
4000	0.17
4002	0.23
4008	0.80
4009	0.58
4010B	0.58
4011AE	0.20
4011B	0.20
4012	0.55
4013	0.55
4015	0.95
4016	0.52
4017	0.80
4019	0.60
4020B	0.93
4021	0.82
4022	0.90
4023	0.17
4024	0.76
4025	0.17
4026	1.80
4028	0.72
4029	1.00
4030	0.58
4035	1.20
4040	0.83
4042	0.85

TTL Nand LSN

7400N	0.13
74LS00	0.20
7401N	0.13
74LS01	0.20
7402N	0.14
74LS02	0.20
7403N	0.14
74LS03	0.20
7404N	0.14
74LS04	0.24
7405N	0.18
74LS05	0.26
7406N	0.28
7407N	0.38
7408N	0.17
74LS08	0.24
7409N	0.17
74LS09	0.24
7410N	0.15
74LS10	0.24
7411N	0.20
74LS11	0.24
7412N	0.17
7413N	0.30
7414N	0.51
74LS15	0.24
7416N	0.30
7417N	0.30
7420N	0.16
74LS20	0.24
7421N	0.29
74LS21	0.24
7423N	0.27
7425N	0.27
7427N	0.27
74LS27	0.44
7428N	0.35
74LS28	0.32
7430N	0.17
74LS30	0.24
7432N	0.25
74LS32	0.24
7437N	0.40
7438N	0.33
74LS38	0.24
7440N	0.17
74LS40	0.24
7441N	0.74
7442N	0.70
74LS42	0.99

7443N 1.15

7444N	1.12
7445N	0.94
7446N	0.94
74LS47	0.89
7448N	0.56
74LS48	0.99
74LS49	0.99
7451N	0.17
74LS51	0.24
7453N	0.17
7454N	0.17
74LS54	0.24
74LS55	0.24
7460N	0.17
74LS63	1.24
7470N	0.28
7472N	0.28
7473N	0.32
74LS73	0.38
7474N	0.27
74LS74	0.28
7475N	0.38
7476N	0.37
74LS76	0.38
74LS78	0.38
7480N	0.48
7481N	0.86
7482N	0.69
7485N	1.04
74LS85	0.99
74LS86	0.40
7489N	2.05
7490N	0.33
74LS90	0.90
7491N	0.76
74LS91	1.10
7492N	0.38
74LS92	0.78
7493N	0.32
74LS93	0.99
7494N	0.78
7495N	0.65
74LS95	1.14
7496N	0.58
74LS96	1.20
7497N	1.85
74LS107	0.38
74109N	0.63
74LS109	0.70
74110N	0.54
74111N	0.68

4043 0.85

4044	0.80
4046	1.30
4047	0.99
4049	0.52
4050	0.55
4051	0.65
4052	0.65
4053	0.65
4063	1.09
4066	0.56
4068	0.25
4069	0.20
4070	0.20
4071	0.20
4072	0.20
4073	0.20
4075	0.20
4076	0.90
4077	0.20
4078	0.20
4082	0.20
4093	0.78
4175	0.95
4503	0.69
4506	0.51
4510	0.99
4511	1.49
4512	0.98
4514	2.55
4518	1.03
4520	1.09
4521	2.36
4522	1.49
4529	1.41
4539	1.10
4554	1.53
4560	2.18
4566	1.59
4568	2.18
4569	3.03
4572	0.30
4585	1.10

VOLTAGE REGULATORS

78series	0.95
79series	1.00
78Mseries	0.65
78Lseries	0.35
79L05	0.85
78MGT2C	1.75
79MGT2C	1.75
7230N	0.65
L200	1.95
TDAL1412	0.75
NES553N	1.25
LM317MP	1.48
LM337MP	1.48

MICROMARKET

8080A/2	7.50
8212	2.30
8214	3.50
8216	1.95
8224	3.50
8251	6.25
8255	5.40
6800P	7.50
6810	5.95
6820	7.40
6850	4.95
6852	4.85
MC2708	7.50
2114	6.50
4027	5.78
2102	1.70
2112	3.40
2513	7.54
HM4716	4.50
81LS97	1.25

74LS112 0.38

74LS113	0.38
74LS114	0.38
74118N	0.83
74120N	1.15
74121N	0.42
74122N	0.46
74123N	0.73
74LS124	1.75
74LS125	0.38
74LS125A	0.57
74LS126	0.44
74128N	0.74
74132N	0.73
74LS132	0.78
74LS136	0.40
74LS138	0.60
74141N	0.56
74142N	2.65
74143N	3.12
74144N	3.12
74LS145	0.97
74174N	1.75
74148N	1.09
74LS148	1.19
74150N	0.99
74LS151	0.84
74LS152	0.52
74LS153	0.54
74LS154	0.96
74LS155	0.54
74LS155	1.10
74LS156	0.80
74LS157	0.65
74LS158	0.60
74LS159	2.10
74LS160	0.82
74LS161	0.30
74LS161	0.78
74LS162	1.30
74LS163	0.78
74LS164	1.30
74LS164	1.04
74LS165	1.05
74LS165	1.04
74167N	2.50

74LS169 2.00

74170N	2.30
74LS170	2.00
74LS171	1.20
74175N	0.87
74LS175	1.10
74176N	0.75
74177N	0.78
74181N	1.65
74LS181	3.50
74LS183	2.10
74184N	1.35
74185N	1.34
74LS190	0.92
74192N	1.05
74LS192	1.80
74193N	1.05
74194N	1.05
74196N	0.99
74LS196	1.10
74LS197	1.10
74198N	1.50
74199N	1.60
74LS247	0.93
74LS257	1.08
74LS260	1.53
74LS279	0.52
74LS283	1.20
74LS293	0.95
74LS365	0.49
74LS366	0.49
74LS367	0.43
74LS368	0.49
74LS374	1.80
74LS377	1.95
74LS379	1.30
74LS393	1.40

O Level Q & A

Now for some actual components. Nick Walton looks at the most basic building blocks of electronic circuits — Resistors and Capacitors

THIS MONTH we look at two fundamental electronic components; the resistor and the capacitor.

In electronics books and magazines hardly a page goes by without resistance rearing its little ohms sign, because any circuit will offer some sort of resistance to the flow of current. It is defined in terms of our two basic quantities, the ampere (flow of charge, or current) and the volt (the push giving energy to make the charge flow) dealt with last month. Logically the unit of resistance, the ohm, is defined as the resistance that allows a current of one amp to flow when a voltage of one volt is provided. Georg Simon Ohm's law states that current is directly proportional to voltage for steady temperature; that is, treble the voltage gives treble the current and so-on. This relationship was actually discovered by an Englishman, Henry Cavendish, who never bothered to publish his work. Perhaps just as well because when Ohm did so, it was so severely criticised that he lost his job as a school teacher in Germany.

Mathematically, Ohm's law says that:

$$\text{volt} = \text{amps} \times \text{resistance in ohms}$$

which is the same as:

$$\text{volts} = \text{amps} \times \text{resistance,}$$

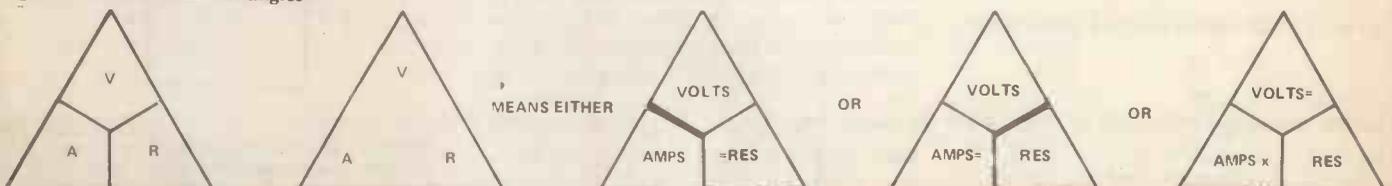
and

$$\text{amps} = \frac{\text{volts}}{\text{resistance}}$$

all of which can be summarised in the form shown in Fig.1.

Another helpful way of looking at resistance coming from the volts/amps idea is to regard, say, five ohms as five

Figure 1. The Ohm's Law Triangles



volts per amp; that is, a resistor which needs five volts to produce a current of one amp. Of course this assumes things do not get hot — which is fair enough in theory but not in practice. By the time you are thinking of a 12kR resistor as 12,000 volts for its statutory one amp current the poor little thing is probably sizzling quietly away — red-hot or better!

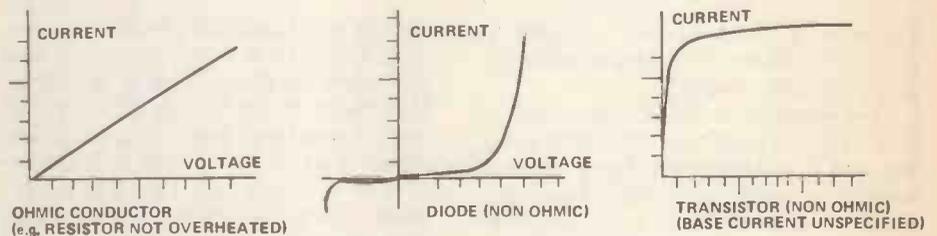


Figure 2. Ohmic and Non-Ohmic conductors

Few conductors obey Ohm's law with 100% obedience, but it is still an incredibly useful generalisation. Conductors which show a total disregard for it are called non-ohmic and include many electronic devices like diodes and transistors. A current-voltage graph of a well-behaved ohmic conductor shows a steadily rising straight line in keeping with the 'treble voltage, treble current' proportionality idea. Fig.2 shows this as well as diode deviations and transistor transgressions.

Sometimes, you have two or more resistors together; they may be in series, as indicated in Fig.3. Here, to get the total resistance you simply add them up, giving $R_{total} = R1 + R2$.

The other way of combining them is to 'branch' the circuit as in Fig.4,

where the resistors are connected in parallel. The resistance of the combination, R_{AB} , is contained in the formula:

This can be shown by realising that the total current i_{AB} must be the sum of what is flowing in R1 and R2 ($i_{AB} = i_{R1} + i_{R2}$) and then by using the Ohm's law triangle to express cur-

rent in terms of resistance and voltage. (Remember that the voltages across AB, R1 and R2 are all the same.) It is useful to bear in mind that with resistors in parallel the resistance of the combination is always less than the value of any individual one.



Figure 3. Two resistors R1 and R2 in series

Such talk of changing resistance leads to thoughts of how a variable resistor might be used. Variable resistors or potentiometers consist of a length (AB) of resistance material, sometimes straight, sometimes curved, constructed so that you can use all

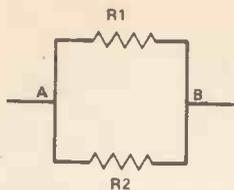


Figure 4. Two resistors R1 and R2 in parallel

or only a part of it (see Fig.5).

Now, if you put a fixed voltage (say 3 volts or 3V) across AB then you can tap off any value of output voltage up to 3V depending on the position of the slider. For example, with our 3V across AB we can get one volt if the slider is a third of

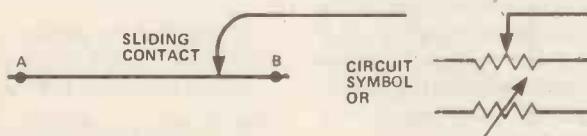


Figure 5. Variable resistance principle

the way up from B. This is called a potential divider or potentiometer or just 'pot' (quite legal!).

The variable resistor is also used in a series control system — the sort of thing you use to control the volume of your radio. You might, for example, have one stage of an amplifier in series with the next stage, and you control how much voltage is fed to the second stage by the variable resistor.

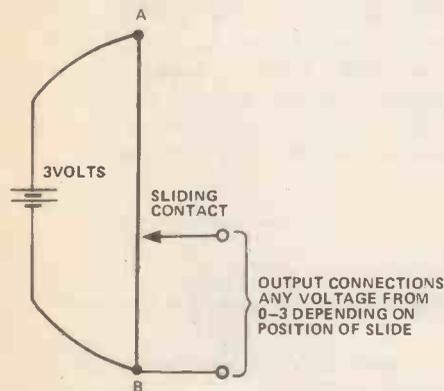


Figure 6. The voltage divider or potentiometer

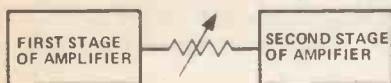


Figure 7. Variable resistor used as a series control

Colourful Codes

Finally, a colourful ending: a resistor's value is not written but denoted by three coloured bands. Each figure 0 to 9 has its own colour thus:

- | | |
|-------------|-------------|
| 0 is Black | 5 is Green |
| 1 is Brown | 6 is Blue |
| 2 is Red | 7 is Violet |
| 3 is Orange | 8 is Grey |
| 4 is Yellow | 9 is White |

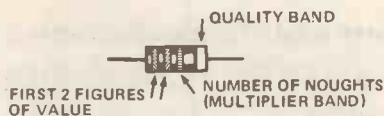


Figure 8. Secrets of the resistor colour code

The first two bands give the first two figures and the third band the number of noughts, as indicated in Fig.8. For instance a value of 47 000 R would have

the first two bands yellow (4) and violet (7) and then an orange band to tell you that there are three noughts to follow. The fourth band is a quality band is most frequently silver or gold. Silver means that its actual value is within 10% of what it should be. Gold is 5%. Three other colours of quality band may be encountered: salmon pink is 20%, red is 2% and brown is 1%.

Capacitors

The capacitor (old name condenser, ancient name Leyden jar) is a very different little fellow and can best be regarded as being two metal plates, close together but insulated from each other. If you put, say, negative charge (that is, electrons) on one plate, these will repel electrons from the other plate and you end up with an equal amount of positive charge on the other plate. Negative charge on one plate and positive charge on the other is equivalent to saying that you have a voltage across them, because if they were now connected to a resistor a brief current would flow until the charges had evened themselves out again (called discharging a capacitor). So connecting a capacitor to a battery as shown in Fig.9 charges up the capacitor.

There has been a brief flow of current as charge flowed from the battery onto the capacitor plates. It builds up until there is a voltage which exactly opposes the voltage the battery has to offer, at which stage there is no further current. This is why a capacitor can be used to block direct currents — a function known as a DC block. If we suddenly reversed the battery, the

capacitor would discharge and then charge up the opposite way round (Figs. 10a and 10b).

Continually doing this is none other than alternating voltage and the little squirt of current that results each time is

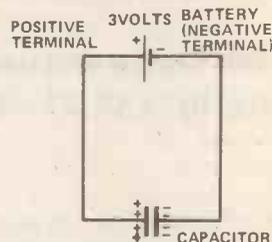


Figure 9. A capacitor being charged by a battery

our old friend *alternating current*. So while a capacitor will block direct current it is happy to let AC pass. Indeed it even has its own Ohms rating (called reactance) given by:

where $X_c = 3.14$ as in circles, f is the AC frequency and C is the value of capacitance, to be dealt with next.

Different-sized capacitors clearly need different amounts of charge to produce one volt between their plates. So a capacitor is rated by the number of coulombs of charge it needs to produce 1 V across it. This is expressed in coulombs per volt and one coulomb per volt is known as one Farad.

A one Farad (1F) capacitor would need one whole coulomb to produce one volt across its plates. Thus:

$$\text{Farads} = \frac{\text{coulombs}}{\text{volts}}$$

or

(where C is capacitance in Farads, Q is charge in coulombs and V is voltage in volts).

Actually a Farad is an inconvenient-

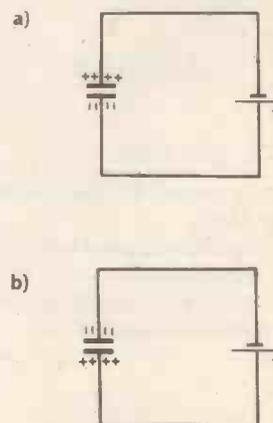


Figure 10. Discharging a capacitor by reversing the battery a) Just after the battery terminals have been reversed. b) Finally fully charged the other way

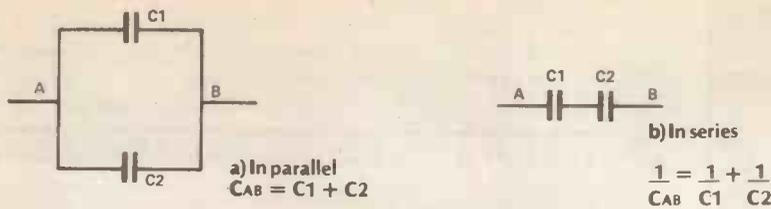


Figure 11. Combinations of capacitors a) In parallel b) In series (Note that this is the opposite to resistors)

ly large unit — the plates would have to be a few square miles in area — so the most common unit is a millionth (10^6) of a Farad, a microfarad or μF (muff). Sometimes this is still too large and a millionth of a microfarad is used, called a picofarad (10^{12} F, pF or puff). You occasionally see nanofarads (nF) used, and that's intermediate between muffs and puffs at 10^9 Farads. Nuff said.

Like resistors you can arrange capacitors in series or *parallel*: you add together the individual capacitances to get the total combination. When they are in series you have to add their reciprocals to get the reciprocal of the combination (see Fig. 11).

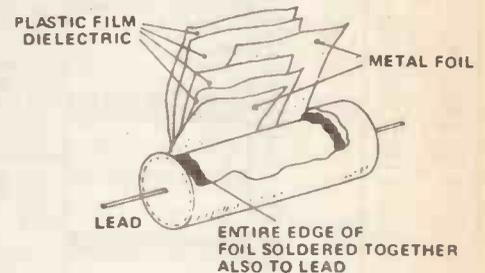
We are now ready to consider RC circuits; that is, a resistor and capacitor together in the same circuit. A charged capacitor allowed to discharge through

If you want to alter how long the capacitor took to discharge in such a circuit you could do so in two ways. You could either get a larger resistance in which case the charge would flow off the capacitor more slowly. (that is, smaller current), or you could begin with a much larger original capacitance which, for its voltage, was carrying a much larger charge. Indeed if you multiply together the R and C values (ohms x farads) you get what is called the 'time constant' of the circuit.

A careful (incredibly intelligent) look at the units of ohms multiplied by farads will reveal that they turn out to be seconds. So the time constant of a circuit with a $1000\mu\text{F}$ capacitor (10^3F) and a $20\text{k}\Omega$ resistor will be 20 seconds (20s). This is the time for the charge (or current) to drop to between a half and a

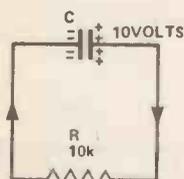
come in many different shapes and sizes, and with many practical capacitors the plates are rolled up Swiss-roll fashion. Try unrolling a paper capacitor some time. My daughters have discovered, that they make very smart dolly's loo rolls!

The plates can be very thin aluminium foil or a thin silver layer deposited on a plastic such as polystyrene, polyester or terylene.

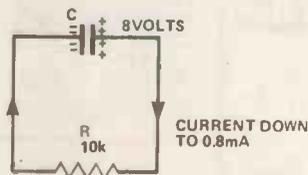


Construction of a polystyrene capacitor

For high values, about $1\mu\text{F}$ to $10\,000\mu\text{F}$ electrolytic capacitors ('elcos') are used. These consist of two sheets of aluminium foil separated by paper impregnated with an electrolyte like aluminium borate. A small current forms a very high-resistance aluminium oxide film on the surface of the plates and it is this which acts as the insulator between the plates. Connecting an electrolytic the wrong way round or exceeding the rated voltage can destroy the film. Result? Bang! Wochit!



(a) INITIAL CURRENT = 1mA



(b) LATER, CURRENT HAS FLOWED, i.e. CAPACITOR HAS LOST CHARGE SO ITS VOLTAGE IS REDUCED AND LESS CURRENT FLOWS

Figure 12. Capacitor discharge through a resistance

a resistor produces a fascinating chicken-and-egg situation on careful examination. Suppose a capacitor, charged to 10 V, starts to discharge across a $10\,000\Omega$ ($10\text{k}\Omega$) resistor (Fig. 12a). By Ohm's law the initial current is one milliamp (1mA). But as the charge starts to flow off the capacitor, less charge on the plates means less voltage across them and hence across the resistor. So the current flowing in the resistor drops (see Fig. 12b). A graph showing how current decreases as time goes by will look like the one in Fig. 13. In fact if the current took, say, ten seconds to drop to half the original value, it would take another ten seconds to drop to half that; thus halving its value every ten seconds. Such a slowing down is called an exponential decrease and is found to pop up all over the scientific scene, especially in radioactive decay and chemical reactions.

third — to be precise to 2.718 — though the significance of this weird number, 'e' to its friends, is quite another story.

Capacitor Construction

So far as construction goes, capacitors

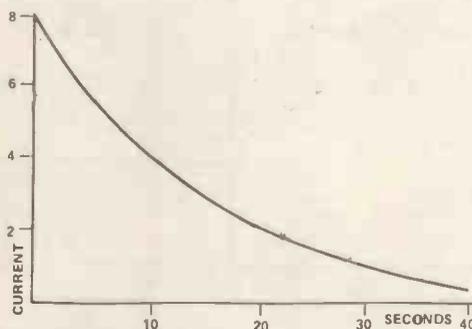


Figure 13. Current from a capacitor through a resistor. An exponential curve



A selection of capacitors

If you are still awake and totally confused, never mind — that's the lot for this month. Make sure you read Ian Sinclair on the digital bit, because that's all part of our course and I will not be duplicating it, though later I shall point out exactly what our course requires digitally. One other thing — start thinking about a project to build and about a case study on a topic you find interesting. Its all go! Watch those electrolytics — take care and see you next month.

HE

PRIME COMPONENTS LOW PRICES

All our micro chips are at micro prices. Don't be fooled by low prices. We do not offer for sale, surplus, sub-spec or rebranded devices. All our parts are guaranteed new, first quality, factory prime, full spec devices. It is also our policy to offer you the best of new devices that become available and these are featured regularly. Prices are exclusive of p&p and VAT - please refer to "Ordering Information" before ordering. Official orders from Schools, Colleges, Universities and Gov. Authorities accepted.

DTL		MEMORIES		CPU'S		
930	55p	2114	300NS	275p	6502	795p
935	85p	4116	200NS	300p	6504	795p
940	85p	4116	150NS	395p	6506	795p
944	65p	4215	4Kx11	CMOS	6800	695p
946	55p	450NS		995p	6802	995p
951	55p	6514	4K (1Kx4)	CMOS	8080A	525p
962	55p	RAM450NS		695p	8085A	1095p
967	55p	4050	40p		Z80	795p
9099	90p	4051	80p		Z8001	12500p
		4052	75p		Z8002	9500p
		4053	73p		WD9000B	19900p
		4054	111p			
		4055	121p			
		4056	121p			
		4057	112p			
		4058	112p			
		4059	112p			
		4060	112p			
		4061	112p			
		4062	112p			
		4063	112p			
		4064	112p			
		4065	112p			
		4066	112p			
		4067	112p			
		4068	112p			
		4069	112p			
		4070	28p			
		4071	28p			
		4072	25p			
		4073	25p			
		4074	25p			
		4075	25p			
		4076	88p			
		4077	23p			
		4078	29p			
		4079	30p			
		4080	25p			
		4081	89p			
		4082	68p			
		4083	68p			
		4084	68p			
		4085	130p			
		4086	68p			
		4087	68p			
		4088	68p			
		4089	68p			
		4090	68p			
		4091	68p			
		4092	68p			
		4093	68p			
		4094	225p			
		4095	225p			
		4096	225p			
		4097	110p			
		4098	110p			
		4099	180p			
		4100	25p			
		4101	25p			
		4102	112p			
		4103	68p			
		4104	68p			
		4105	68p			
		4106	68p			
		4107	68p			
		4108	68p			
		4109	68p			
		4110	68p			
		4111	68p			
		4112	68p			
		4113	68p			
		4114	68p			
		4115	68p			
		4116	68p			
		4117	68p			
		4118	68p			
		4119	68p			
		4120	68p			
		4121	68p			
		4122	68p			
		4123	68p			
		4124	68p			
		4125	68p			
		4126	68p			
		4127	68p			
		4128	68p			
		4129	68p			
		4130	68p			
		4131	68p			
		4132	68p			
		4133	68p			
		4134	68p			
		4135	68p			
		4136	68p			
		4137	68p			
		4138	68p			
		4139	68p			
		4140	68p			
		4141	68p			
		4142	68p			
		4143	68p			
		4144	68p			
		4145	68p			
		4146	68p			
		4147	68p			
		4148	68p			
		4149	68p			
		4150	68p			
		4151	68p			
		4152	68p			
		4153	68p			
		4154	68p			
		4155	68p			
		4156	68p			
		4157	68p			
		4158	68p			
		4159	68p			
		4160	68p			
		4161	68p			
		4162	68p			
		4163	68p			
		4164	68p			
		4165	68p			
		4166	68p			
		4167	68p			
		4168	68p			
		4169	68p			
		4170	68p			
		4171	68p			
		4172	68p			
		4173	68p			
		4174	68p			
		4175	68p			
		4176	68p			
		4177	68p			
		4178	68p			
		4179	68p			
		4180	68p			
		4181	68p			
		4182	68p			
		4183	68p			
		4184	68p			
		4185	68p			
		4186	68p			
		4187	68p			
		4188	68p			
		4189	68p			
		4190	68p			
		4191	68p			
		4192	68p			
		4193	68p			
		4194	68p			
		4195	68p			
		4196	68p			
		4197	68p			
		4198	68p			
		4199	68p			
		4200	68p			
		4201	68p			
		4202	68p			
		4203	68p			
		4204	68p			
		4205	68p			
		4206	68p			
		4207	68p			
		4208	68p			
		4209	68p			
		4210	68p			
		4211	68p			
		4212	68p			
		4213	68p			
		4214	68p			
		4215	68p			
		4216	68p			
		4217	68p			
		4218	68p			
		4219	68p			
		4220	68p			
		4221	68p			
		4222	68p			
		4223	68p			
		4224	68p			
		4225	68p			
		4226	68p			
		4227	68p			
		4228	68p			
		4229	68p			
		4230	68p			
		4231	68p			
		4232	68p			
		4233	68p			
		4234	68p			
		4235	68p			
		4236	68p			
		4237	68p			
		4238	68p			
		4239	68p			
		4240	68p			
		4241	68p			
		4242	68p			
		4243	68p			
		4244	68p			
		4245	68p			
		4246	68p			
		4247	68p			
		4248	68p			
		4249	68p			
		4250	68p			
		4251	68p			
		4252	68p			
		4253	68p			
		4254	68p			
		4255	68p			
		4256	68p			
		4257	68p			
		4258	68p			
		4259	68p			
		4260	68p			
		4261	68p			
		4262	68p			
		4263	68p			
		4264	68p			
		4265	68p			
		4266	68p			
		4267	68p			
		4268	68p			
		4269	68p			
		4270	68p			
		4271	68p			
		4272	68p			
		4273	68p			
		4274	68p			
		4275	68p			
		4276	68p			
		4277	68p			
		4278	68p			
		4279	68p			
		4280	68p			
		4281	68p			
		4282	68p			
		4283	68p			
		4284	68p			
		4285	68p			
		4286	68p			
		4287	68p			
		4288	68p			
		4289	68p			

Transistor Tester

Test NPN or PNP transistors quickly and easily with this cheap and simple-to-build project for beginners



OVERKILL: Have you ever heard that word? It means taking a design too far, pushing it from the sublime to the ridiculous by making it too complex when there is a much easier and more economical answer.

Well nobody can accuse our designers of 'over-killing' the HE Transistor Tester. If you take a close look at the circuit diagram you will see that the design is simplicity itself. Only 11 components make up the circuit. That doesn't mean that the HE Transistor Tester is too simple or that it can't be as good as more complicated designs. Far from it — our circuit is all that's necessary to make a good, reliable piece of test gear which is easy to build and exceptionally useful. Now you can test your transistors before use, making sure that they are fully operational. Think how many hours of fault-finding you can save yourself when building projects!

The circuit is built around a two-transistor circuit and uses LEDs to indicate when the transistor under test is operational. A simple potentiometer compensates for different transistor characteristics and its position can be calibrated to give a visual readout of the transistor's current gain.

To test a transistor, start with RV1 at maximum resistance, connect the transistor, and rotate RV1 just far enough to cause the appropriate LED to light. The approximate gain can then be determined from RV1's scale. If the LED remains either switched on or off (regardless of RV1's setting), the test device is almost certainly a dud.

How it Works

To simplify the NPN/PNP switching, the unit has separate circuits for testing the two types of device, and this is an economically sound approach because of the simplicity of each section.

If we consider the unit in the NPN mode first, a base current is fed to the test device via SW1, R1, and RV1. By means of RV1 this current can be varied over an approximate range of 0.4 mA at minimum resistance to 0.004 mA at maximum resistance. The current flowing in the collector circuit of the test device coupled to SK1 will be equal to the base current multiplied by the current gain of the device. If this current is about 4 mA or more, the voltage developed across R2 becomes higher than the base threshold voltage of Q1, biasing the latter into

conduction and causing LED1 to light.

In practice RV1 is adjusted for the lowest current that causes LED1 to light, and thus for a nominal 4 mA collector current. The setting of RV1 is then directly related to the current gain of the test device, with minimum resistance corresponding to a gain of 10 ($4 \text{ mA} \div 0.4 \text{ mA} = 10$) and maximum resistance to a gain of about 1000 ($4 \text{ mA} \div 0.004 \text{ mA} = 1000$). Potentiometer RV1 can be fitted with a scale so that current gain can be directly read off.

The PNP test circuit is much the same, but a few changes obviously have to be made to accommodate the change in polarity. Resistor R6 ensures that an excessive current cannot flow if RV1 is adjusted for minimum resistance with a very high-gain device in circuit.

Construction

Figure 2 shows the Veroboard layout and wiring of the tester, and this is all quite straightforward. Follow standard practice when using the Veroboard. If you're not too sure or your memory's a bit hazy, refer to the Construction sec-

tion of the Guitar Preamp, where its use is detailed.

It is advisable to fit RV1 with a large control knob as its scaling is not linear, and becomes cramped at lower gain settings. With the aid of a multimeter used on a resistance range the scale of

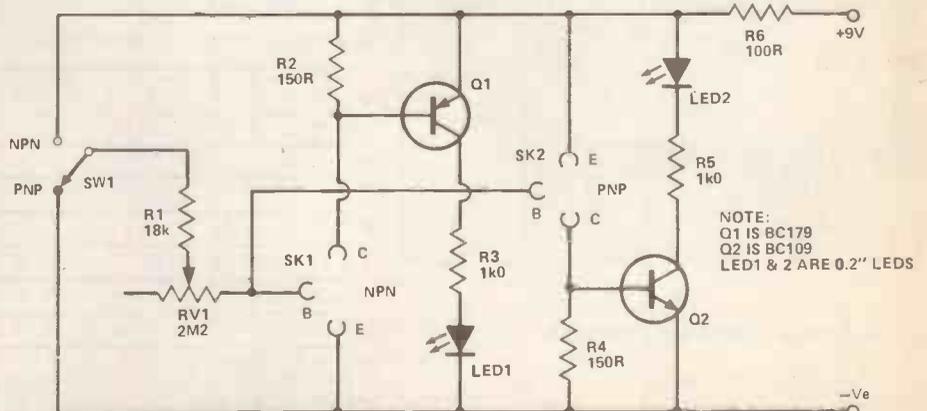
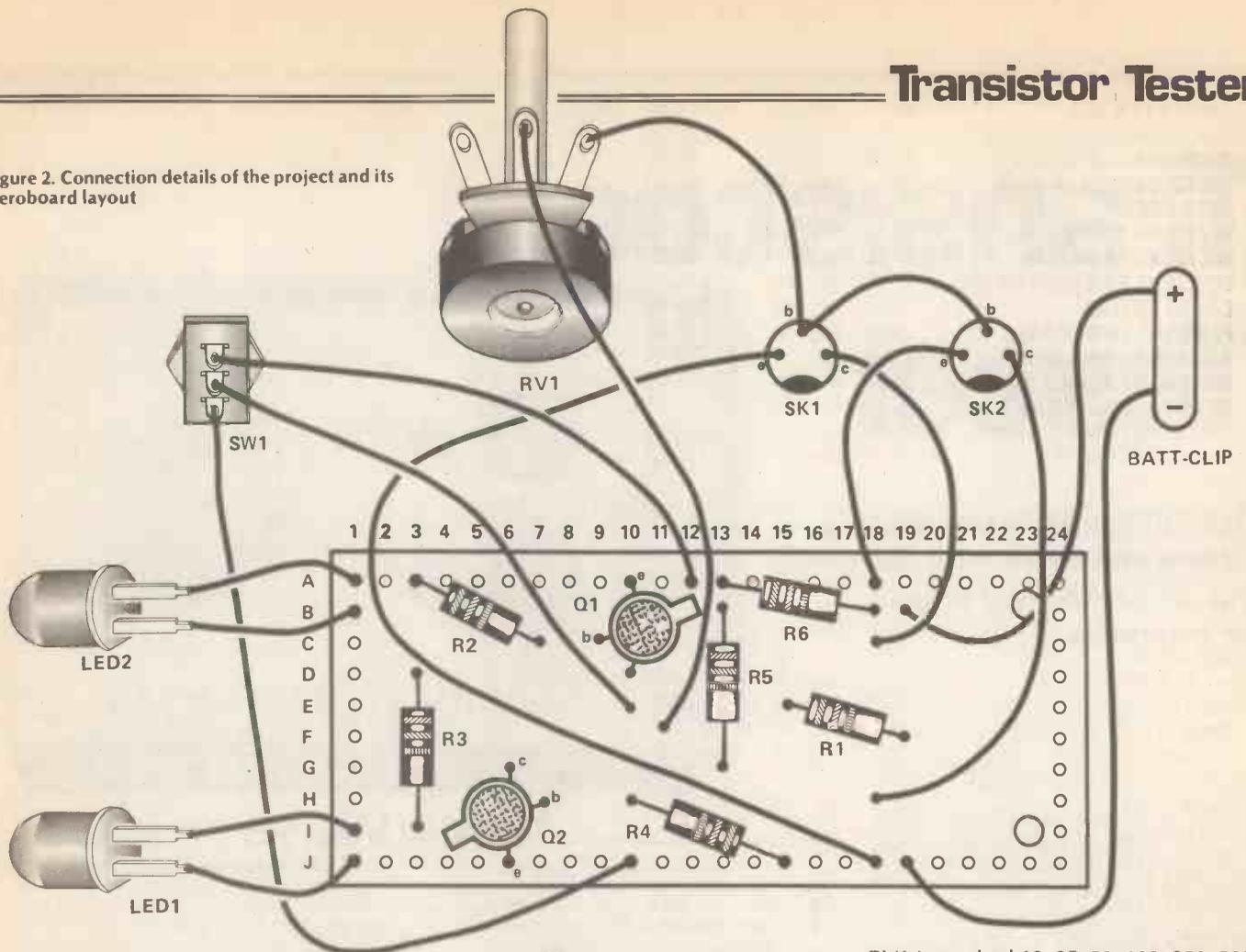


Figure 1. The circuit diagram of the HE Transistor Tester.

Transistor Tester

Figure 2. Connection details of the project and its Veroboard layout



Parts List

RESISTORS (All 1/4 W, 5%)

R1	18k
R2,4	150R
R3,5	1k0
R6	100R

POTENTIOMETERS

RV1	2M2 lin
-----	---------

SEMICONDUCTORS

Q1	BC179 PNP transistor
Q2	BC109 NPN transistor
LED 1,2	0.2 in LEDs

MISCELLANEOUS

SW1	single-pole, double-throw, toggle switch
SK1,2	3 way DIN sockets
	10 strip x 24 hole Veroboard
	pointer knob
	case to suit
	battery and clip

RV1 is marked 10, 25, 50, 100, 250, 500 and 1000 at settings which give a total resistance of 20k, 50k, 100k, 200k, 500k, 1M and 2M across R1 and RV1.

Many transistors will readily plug directly into the appropriate test socket (but be careful to connect the test devices correctly). A set of test leads can be made up so that less-cooperative devices can be checked. All that is required is a 3-way DIN plug connected to three crocodile clips by three short insulated leads of different colour.

HE

Buylines

You shouldn't have any problems in obtaining components for this project and the price for the bits and pieces (excluding the case, of course) will be about £5.

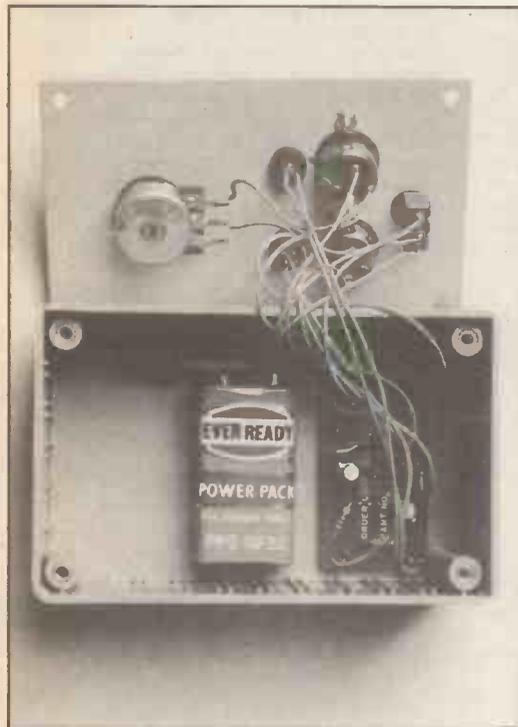
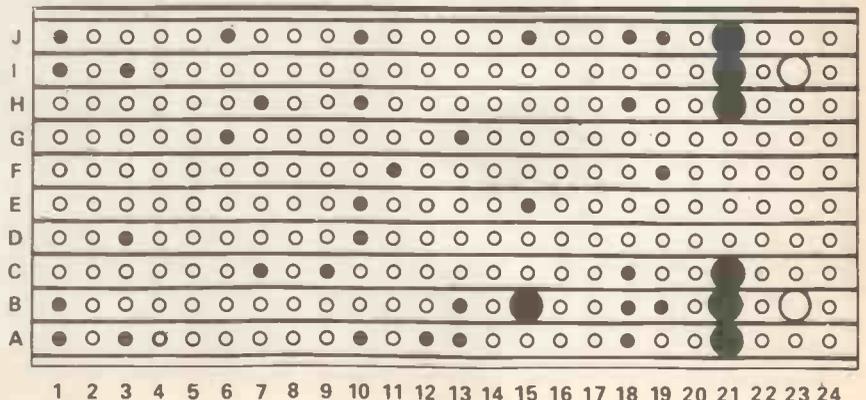


Figure 3. Above. Internal case photograph

Figure 4. Right. Underside details of the Veroboard showing track breaks. Make these before inserting the components



GUITAR PHASER	ZD85	Sept. '80	£9.60	HOBBYTUNE	ZD34	Oct. '79	£18.00
BENCH POWER SUPPLY UNIT	ZD87	Sept. '80	£25.00	MULTI OPTION SIREN	ZD36	Oct. '79	£10.50
DEVELOPMENT TIMER	ZD86	Sept. '80	£8.75	ANALOGUE AUDIO			
TOUCH SWITCH (on Vero)	ZD84	Sept. '80	£4.50	FREQUENCY METER	ZD35	Oct. '79	£15.00
AUTO PROBE	ZD83	Sept. '80	£3.00	COMBINATION LOCK	ZD29	Sept. '79	£12.50
REACTION TIMER	ZD82	Sept. '80	£26.50	★STARBURST	ZD30	Sept. '79	£14.50
MICROMIXER (on Vero)	ZD81	Sept. '80	£8.50	LAMP DIMMER	ZD31	Sept. '79	£6.50
EQUITONE CAR EQUALISER	ZD52	Aug. '80	£13.30	ULTRASONIC SWITCH	ZD32	Sept. '79	£21.00
GAS DETECTOR	ZD55	Aug. '80	£22.00	CONSTANT VOLUME AMPLIFIER	ZD28	Aug. '79	£11.50
PASS THE LOOP GAME	ZD56	Aug. '80	£12.00	INJECTOR TRACER	ZD27	Aug. '79	£4.50
RADIO TIMER (on Vero)	ZD57	Aug. '80	£5.50	LED TACHOMETER	ZD26	Aug. '79	£14.75
MOVEMENT ALARM (on Vero)	ZD54	Aug. '80	£5.00	BABY ALARM	ZD25	July '79	£13.50
OP. AMP CHECKER (on Vero)	ZD53	Aug. '80	£4.00	POINTS SWITCH	ZD24	July '79	£12.50
CAR BOOSTER (no speakers)	ZD50	July '80	£18.00	LINEAR SCALE OHMMETER	ZD23	July '79	£14.00
HAZARD FLASHER	ZD48	July '80	£10.50	SHARK	ZD22	July '79	£22.75
★PUSH-BUTTON VOLUME CONTROL	ZD47	July '80	£19.50	G.S.R. MONITOR	ZD19	June '79	£10.50
SOUND FLASH TRIGGER (on Vero)	ZD49	July '80	£3.50	ENVELOPE GENERATOR	ZD20	June '79	£11.79
2 WATT AMPLIFIER (on Vero)	ZD46	June '80	£3.90	DRILL SPEED CONTROLLER	ZD21	June '79	£7.00
METRONOME (on Vero)	ZD51	June '80	£3.50	WHITE NOISE EFFECTS UNIT	ZD18	May '79	£16.85
MICROBE R/C SYSTEM (less Servos)	ZD45	June '80	£17.50	PARKING METER TIMER	ZD17	May '79	£6.70
FOG HORN	ZD44	June '80	£4.50	DIGIBELL PROJECT	ZD16	May '79	£5.00
★EGG TIMER	ZD43	June '80	£6.50	VARIABLE POWER SUPPLY			
MINI CLOCK	ZD10	May '80	£26.00	0.30V 1 AMP	ZD15	May '79	£30.00
5080 PRE-AMP	ZD11	May '80	£32.00	TRANSISTOR GAIN TESTER	ZD76	April '79	£6.50
TRACK CLEANER	ZD12	May '80	£7.75	CISTERN ALARM	ZD75	April '79	£5.50
★R/C SPEED CONTROLLER	ZD3	April '80	£9.60	MODEL TRAIN CONTROLLER	ZD74	April '79	£26.00
HOBBY COM	ZD8	April '80	£28.60	PHOTOGRAPHIC TIMER	ZD73	March '79	£14.50
ELECTRONIC IGNITION	ZD2	April '80	£18.25	TONE CONTROL	ZD72	March '79	£9.00
DIGITAL FREQUENCY METER	ZD9	April '80	£27.75	CASANOVA'S CANDLE	ZD71	March '79	£7.50
SHORT WAVE RADIO	ZD80	March '80	£19.50	SHORT WAVE RADIO	ZD66	Feb. '79	£12.50
TOUCH SWITCH	ZD79	March '80	£5.00	SINE/SQUARE WAVE GENERATOR	ZD67	Feb. '79	£22.50
5080 PSU MODULE	ZD78	March '80	£29.50	SCRATCH AND RUMBLE FILTER MONO	ZD68	Feb. '79	£22.50
SYSTEM 5080A	ZD77	March '80	£15.00	SCRATCH AND RUMBLE FILTER STEREO	ZD69	Feb. '79	£25.00
PASSION METER	ZD6	Feb. '80	£5.00	CAR ALARM	ZD70	Feb. '79	£8.50
WIN INDICATOR	ZD42	Feb. '80	£9.00	FLASH TRIGGER (less flash gun)	ZD65	Jan. '79	£10.50
INFR RED REMOTE CONTROL	ZD7	Feb. '80	£19.35	TOUCH SWITCH	ZD63	Jan. '79	£5.50
SCALEXTRIC CONTROLLER	ZD41	Jan. '80	£52.50	VARI-WIPER	ZD64	Jan. '79	£8.00
CROSSHATCH GENERATOR	ZD4	Jan. '80	£11.25	GRAPHIC EQUALISER	ZD62	Jan. '79	£25.00
DIGI-DIE	ZD5	Jan. '80	£5.50	PUSH-BUTTON DICE	ZD61	Dec. '78	£6.00
RING MODULATOR	ZD1	Dec. '79	£8.50	AUDIO MIXER	ZD14	Dec. '78	£20.30
SCALEXTRIC CONTROLLER	ZD39	Dec. '79	£21.50	BEDSIDE RADIO	ZD58	Nov. '78	£12.50
BARGRAPH CAR VOLTMETER	ZD40	Dec. '79	£6.60	STEREO AMPLIFIER (HOBIT)	ZD59	Nov. '78	£52.50
GUITAR TUNER	ZD38	Nov. '79	£8.50	WAA-WAA PEDAL	ZD60	Nov. '78	£30.00
★R2 D2 RADIO	ZD37	Nov. '79	£8.60				
TANTRUM	ZD33	Oct. '79	£37.50				

IONISER KIT: ZD13. This negative ion generator gives you power to saturate your home with millions of refreshing ions, without fans or moving parts it puts out a pleasant breeze. A pure flow of ions pours out like water from a fountain filling your room. The result? Your air feels like fresh ocean air, crisp and wonderfully refreshing. All parts p.c.b. and full instructions £10. A suitable case including front panel neon switch, etc., available at £8 extra.

LATE EXTRA

Watchdog Intruder Alarm	ZD89	OCT. '80	£15.75
Temperature Controlled Soldering Iron	ZD90	OCT. '80	£9.00
Freezer Alarm (on Vero)	ZD91	OCT. '80	£8.50
Tug O' War Game	ZD94	OCT. '80	£12.50
Nobell Doorbell	ZD93	OCT. '80	£9.75
Kitchen Timer (on Vero)	ZD92	OCT. '80	£5.50
Light Dimmer	ZD88	OCT. '80	£5.00

All kits contain components as specified plus Texas I.C. sockets, where required, also connecting wire.

FAIRCHILD FLV150 red. 2 LEDs, 10 for £1.00, 100 for £7.50
DALY ELECTROLYTIC CAPACITORS 2000uF 100v £1.50
PHILIPS SCOPE Tube 5" CV2191/DG-13-2 £10

If you do not have the issue of H.E. which contains the Project, we can supply a reprint at 40p extra. Please add 30p post and packing. Add 15% VAT to total order. Callers please ring to check availability of kits.

T. POWELL

306 ST. PAULS ROAD, Highbury Corner
 LONDON N1. 01-226 1489

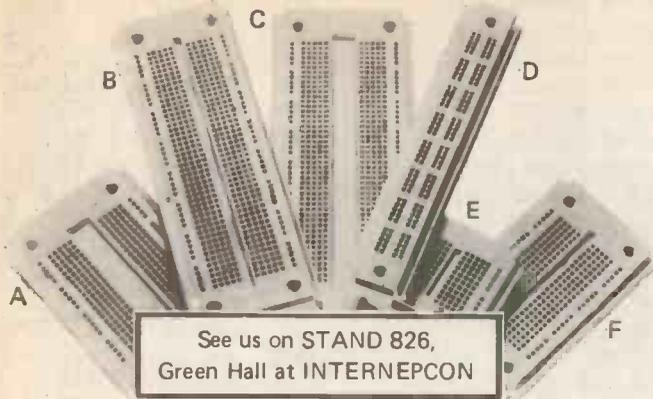
SHOP HOURS:
 MON.-FRI. 9-5.30 p.m.
 SAT. 9-4.30 p.m.



Minimum telephone Orders £5
 Minimum Mail Order £1

IT'S AS EASY AS A,B,C...

...ASK OUR DEALERS.



- A EXP 650 For microprocessor chips. **£3.60**
- B EXP 300 The most widely sold breadboard in the UK; for the serious hobbyist. **£5.75**
- C EXP 600 .6" centre channel makes this the Microprocessor Breadboard. **£6.30**
- D EXP 4B An extra 4 bus-bars in one unit. **£2.30**
- E EXP 325 Built in bus-bars accepts 8, 14, 16 and up to 22 pin ICS. **£1.60**
- F EXP 350 270 contact points, ideal for working with up to 3 x 14 pin DIPS. **£3.15**
- G PB6 Professional breadboard in easily assembled kit form. **£9.20** (Not illustrated.)
- H PB 100 Kit form breadboard recommended for students and educational uses. **£11.80** (Not illustrated.)

& IT'S AS EASY AS 1,2,3 with THE EXPERIMENTOR SYSTEM

SCRATCHBOARD
-BREADBOARD
-MATCHBOARD

1. EXP 300PC which includes one item. A matchboard pre-drilled PCB - £1.32
2. EXP 302 which includes three items. Three 50-sheet scratchboard workpads - £1.68
3. EXP 303 which includes three items. Two matchboards and an EXP 300 solderless breadboard - £8.60.
4. EXP 304 which includes four items. Two matchboards and EXP 300 breadboard and a scratchboard workpad - £9.30

The above prices do not include P&P and 15% VAT

TOMORROW'S TOOLS TODAY

CONTINENTAL SPECIALTIES CORPORATION

C.S.C. (UK) Limited, Dept.1400
Unit 1, Shire Hill Industrial Estate,
Saffron Walden, Essex CB11 3AQ.
Tel: Saffron Walden (0799) 21682.
Telex: 817477.



NAME _____

ADDRESS _____

I enclose cheque/PO for £ _____
or debit my Barclaycard, Access, American Express card
No. _____ Exp. date _____
or Tel: (0799) 21682 with your card number and your order will be in the
post immediately.

A EXP 650 £5.00	Qty. Reqd.	B EXP 300 £7.76	Qty. Reqd.
C EXP 600 £8.39	Qty. Reqd.	D EXP 4B £3.50	Qty. Reqd.
E EXP 325 £2.70	Qty. Reqd.	F EXP 350 £4.48	Qty. Reqd.
G PB6 £11.73	Qty. Reqd.	H PB 100 £14.72	Qty. Reqd.

Experimenter System

1 EXP 300 PC £2.38	Qty. Reqd.	2 EXP 302 £2.79	Qty. Reqd.
3 EXP 303 £11.04	Qty. Reqd.	4 EXP 304 £11.85	Qty. Reqd.

Boxed prices include P & P and 15% VAT
If no dealer in your area contact CSC direct. FREE catalogue tick box

Continental Specialties Corporation (UK) Limited, Dept. 1400
Unit 1, Shire Hill Industrial Estate, Saffron Walden, Essex CB11 3AQ.

AITKEN BROTHERS,
35 High Bridge, Newcastle Upon Tyne, NE1 1EW.
Tel: 0632 26729.

ARROW ELECTRONICS LTD.,
Leader House, Coptfold Road, Brentwood, Essex.
Tel: 0277 226470.

BASIC ELECTRONICS LTD.,
18 Epsom Road, Guildford, Surrey, GU1 3JN.
Tel: 0483 39984.

BI-PAK SEMICONDUCTORS,
P.O. Box 6, Ware, Herts.
Tel: 0920 3442.

F. BROWN & CO.,
45 George IV Bridge, Edinburgh, EH1 1EJ, Scotland.
Tel: 031 225 3461. Telex: 922131.

THE CHILDRENS SHOP & TACKLE BOX.,
73-75 High Street, Ryde, Isle of Wight.
Tel: 0983 63437.

CUBEGATE LTD.,
301 Edgware Road, London, W2 1BN.
Tel: 01 724 3565.

ETESON ELECTRONICS,
15b Lower Green, Poulton-Le-Fylde, Blackpool, FY6 7JL.
Tel: 0253 885107.

H. GEE ELECTRONIC SUPPLIES,
94a Mill Road, Cambridge, CB1 2BD.
Tel: 0223 358019.

LEEDS AMATEUR RADIO,
27 Cookridge Street, Leeds, LS2 3AG.
Tel: 0532 452657.

MARSHALLS,
108A Stokes Croft, Bristol.
Tel: 0272 426801.

85 West Regent Street, Glasgow, G2, Scotland.
Tel: 041 332 4133.

325 Edgware Road, London, W2.
Tel: 01 723 4242.

40 Cricklewood Broadway, London, NW2 3ET.
Tel: 01 452 0161.

RASTRA ELECTRONICS LTD.,
275-281 King Street, Hammersmith, London, W6.
Tel: 01 748 3143. Telex: 24443 RASTRA G.

SHUDEHILL SUPPLY COMPANY,
53 Shudehill, Manchester, M4 4AW.
Tel: 061 834 1449.

SPECTRON ELECTRONICS (M/C) LTD.,
7 Oldfield Road, Salford, M5 4NE.
Tel: 061 834 4583.

SWANLEY ELECTRONICS,
32 Goldsel Road, Swanley, Kent, BR8 8EZ.
Tel: 0322 64851.

TECHNOMATIC LTD.,
17 Burnley Road, London, NW10 1ED.
Tel: 01 452 1500. Telex: 922800.

TOMORROW'S TOOLS TODAY

Also ask your local stockist.
If no dealer in your area, contact CSC direct.

CONTINENTAL SPECIALTIES CORPORATION



C.S.C. (UK) Limited, Dept.1400
Unit 1, Shire Hill Industrial Estate,
Saffron Walden, Essex CB11 3AQ.
Tel: Saffron Walden (0799) 21682
Telex: 817477

Hobby Electronics, November 1980

H.E.'s HELPFUL HINTS PRESENTS...
THE PROF
 IN
HOW NOT TO SOLDER
 OR THE RETURN OF THE BLOB!

FIRST OF ALL WE'LL DEAL WITH 'TINNING THE BIT', THIS IS OBVIOUSLY A COMPLICATED JOB BUT...
 ...IT WARMS UP YOUR SOUP WONDERFULLY!

OBVIOUSLY YOU'LL BE WORKING WITH A LOT OF P.C.B.s...

ALWAYS LEAVE THE COMPONENTS STICKING UP AT ODD ANGLES...

...SO THEY CAN ACCIDENTALLY FLOP TOGETHER...
 ... WITH THE MOST INTERESTING RESULTS !!

GETTING A STRONG JOINT IS EASY~

A NICE BIG BLOB OF SOLDER WILL JOIN EVERYTHING!

ALWAYS FLICK THE SOLDER OFF THE BIT...
 IT GIVES YOU THAT RAKISH DEVIL-MAY-CARE LOOK!

BUT AS A LAST RESORT~ READ THE ARTICLE ON SOLDERING IN THE NEXT ISSUE...
 IT COULD SAVE YOU A LOT OF AGGRAVATION!

ELECTRON-KIT

DENSHI KITS SPECIAL OFFER



... fun and entertainment as well as education"

(EVERYDAY ELECTRONICS mag.)

The SR-3A kit (over 100 circuits) and the SR-3A de luxe kit (over 105 circuits) are available again, at little more than their 1977 prices!

Circuits are constructed by plugging the encapsulated components into the boards provided, following the instruction manual. Technical details are also given concerning each project. The components are used over and over again and you can design your own circuits too, or use the kit as a useful testing board.

No previous experience of electronics is required but you learn as you build — and have a lot of fun, too. The kits are safe for anyone.

SR-3A KIT

16 1/2 x 10 x 2 1/2" £29.95

Build over 100 projects including 3-TR reflex radio receiver, 3-TR radio receiver with RF amplifier, 2-TR reflex radio receiver, 3-TR amplifier for crystal mike, 3-TR amplifier for speaker/mike, 3-TR signal tracer, Morse Code trainer, 2-TR electronic organ, electronic metronome, electronic bird, electronic cat, electronic siren, electronic gun, 2-TR sleeping aid, high voltage generator, discontinuity warning device, water supply warning device, photoelectric alarming device, 3-TR burglar alarm, 3-TR water supply warning device, 3-TR water level warning device, 3-TR photo-electric alarming device, Morse Code trainer with sound and light, discontinuity warning device with sound and light, water level warning device with sound and light, electronic metronome with sound and light, buzzer with sound and light, wireless mike, wireless telegraph set, wireless discontinuity warning device, wireless water level warning device, wireless water supply warning device, and wireless photoelectric warning device, etc., etc.

SR-3A de luxe KIT

(Illustrated 16x14x3 1/2") £39.95

Similar to SR-3A, more components including solar cell and additional Speaker unit plus sophisticated control panel.

All kits are guaranteed and supplied complete with extensive construction manuals PLUS Hamlyn's "All colour" 160-page book "Electronics" (free of charge) whilst stocks last.

Prices include batteries, educational manuals, free book, VAT, P&P (in the UK), free introduction to the British Amateur Electronics Club.

Cheque/P.O./Access/Barclaycard (or 20p for illustrated literature) to DEPT. HE.

ELECTRON-KIT LTD.
RECTORY COURT, CHALVINGTON,
E.SUSSEX, BN27 3TD (032 183 579)

GMT Freepost B Birmingham B19 1BR
ELECTRONICS 021-233-2400

FREEPOST ON ORDERS
VAT INCLUSIVE PRICES
ADD 30p P&P
24 HR PHONE ANSWERING SERVICE

ALL PRICES IN PENCE EACH UNLESS OTHERWISE STATED

C-MOS (BUFFERED)				LINEAR				SEMICONDUCTORS			
HEF4000	22	HEF4044	105	HEF4512	136	CA3046	84	IN814	8	IC102L	12
HEF4001	22	HEF4045	117	HEF4516	127	CA3085E	77	IN4001	5	IC104	11
HEF4002	22	HEF4047	109	HEF4517	478	CA3102E	99	IN4002	5	IC184L	12
HEF4006	119	HEF4049	57	HEF4518	118	CA3140E	48	IN4004	7	IC212	11
HEF4007	22	HEF4050	57	HEF4519	69	CA3189E	293	IN4007	9	IC212L	12
HEF4008	100	HEF4051	87	HEF4520	918	LM301AN	34	IN4148	4	IC214L	11
HEF4011	22	HEF4052	90	HEF4521	225	LM338N	78	IN5402	15	IC214L	12
HEF4012	22	HEF4053	90	HEF4528	124	LM380N	104	2N2369	21	IC547	13
HEF4013	57	HEF4056	62	HEF4532	150	LM3818AN	198	2N2646	46	IC548	11
HEF4014	103	HEF4067	475	HEF4534	638	LM3900N	75	2N2926G	13	BC549	12
HEF4015	100	HEF4068	22	HEF4539	138	MCM301P	156	2N3053	19	BC557	15
HEF4016	57	HEF4069	22	HEF4585	122	NE531	131	2N3054	55	BC558	16
HEF4017	100	HEF4070	22	HEF4724	214	NE536T	259	2N3055	55	BCY70	15
HEF4018	100	HEF4071	22	HEF40097	113	NE555N	28	2N3070	9	BCY71	15
HEF4019	58	HEF4072	22	HEF40098	92	NE556N	65	2N3074	9	BD131	39
HEF4020	112	HEF4073	22	HEF40106	78	NE566N	171	2N3105	10	BD132	39
HEF4021	107	HEF4075	23	HEF40160	149	NE570N	485	2N3173	297	BD139	39
HEF4022	103	HEF4076	130	HEF40192	149	NE571N	505	2N3819	22	BD140	39
HEF4023	22	HEF4077	22			PC4135	146	2N3820	19	BF980	333
HEF4024	78	HEF4078	23			TA1205	86	2N3904	9	BFX85	29
HEF4025	72	HEF4081	23			TA1022	713	2N5457	39	BFY50	17
HEF4026	244	HEF4082	23			TD10348	239	2N5459	35	BFY51	17
HEF4027	57	HEF4083	80			LM3590AICR1	119	40673	88	BRV39	50
HEF4028	89	HEF4086	80			TL081CP	84	TL084CN	156	BSX20	21
HEF4029	113	HEF4093	43			UA741CN	20	IC108	14	CU860	2850
HEF4030	58	HEF4094	219			UA741CT	47	IC108C	18	TI31	54
HEF4031	250	HEF4104	204			UA7815CU	78	IC109	14	TI32	54
HEF4035	136	HEF4502	114			UA7815CU	87	IC109B	18	TI42C	76
HEF4040	107	HEF4505	71			UA7915CU	97	IC109C	20	TI42C	78
HEF4041	94	HEF4508	230			UA7815CS	38	IC148	10	TI2955	75
HEF4042	83	HEF4510	135			UA7815CS	38	IC158	10	TI3055	60
HEF4043	100	HEF4518	157			UA7815CS	38	IC177	17	TI843	36

CAPACITORS				Polyester Radial Leads				Electrolytic Radial Leads												
Electrolytic Axial				Dipped Type, C280/382 Style				Dipped Type, 10.2mm Pitch												
Cap 018 ± 5%				Cap 352				Cap 034 ± 5%												
µF	V	16	25	40	63	µF	352	380	µF	352	380	µF	V	10	16	25	35	40	50	63
1.0						.001			.1			.47								
1.8						.0015			.15			.68								
2.2						.0022			.22			1.0								
3.3						.0033			.33			1.5								
4.7						.0047			.47			2.2								
6.8						.0068			.68			3.3								
10						.01			1.0			4.7								
15						.015			1.5			6.8								
22						.022			2.2			10								
33						.033			3.3			15								
47						.047			4.7			22								
68						.068			6.8			33								
100						.1			10			47								
150						.15			15			68								
220						.22			22			100								
330						.33			33			150								
470						.47			47											
580						.58			58											
1000						1			100											
1500						1.5			150											
2200						2.2			2200											

RESISTORS				D.I.L. Sockets			
Carbon Film, Fixed				8 Pin Low Profile Socket Tin			
0.25W, E24 Values, 1% Tol., 10% Tol.				12 DIL SKT 8			
100k, 100k, 100k (Mult.)				14 Pin Low Profile Socket Tin			
0.5W, E12 Values, 1% Tol., 10% Tol.				16 Pin Low Profile Socket Tin			
Metal Film, Fixed							
0.5W, E24 Values, 1% Tol., 10% Tol.							
2.5W, E12 Values, 10% Tol., 5% Tol.							
Metal Glass, Fixed							
0.5W, E24 Values, 1% Tol., 5% Tol.							

MAINS TRANSFORMERS				Plastic Boxes - Boss Industrial Mouldings			
Secondaries may be connected in series or parallel to give wide voltage range				Moulded Box and Close Fitting Flanged Lid			
Primaries 270V, 240V				ABS Box, C/W Brass Bushes, and Lid in Orange			
8VA - Clamp Type Construction				Order Code			
Approx. 18% Regulation F.C. 54, H36, W35				L112 W82 D31 99 Case B1M2003 OR			
0-4.5V, 0-4.5V Secondaries				L150 W80 D50 121 Case B1M2005 OR			
0.5V, 0.6V				L180 W110 D80 233 Case B1M2006 OR			
0.12V, 0.12V							
0.15V, 0.15V							
0.20V, 0.20V							
20VA - Clamp Type Construction				Plastic Boxes with Metal Lids			
Approx. 16% Regulation F.C. 70, H48, W46				Recessed Top Box			
0-4.5V, 0-4.5V Secondaries				ABS Box, C/W Brass Bushes, in Orange			
0.4V, 0.4V				Term Aluminium Top Panel - Finished Grey			
0.12V, 0.12V				Order Code			
0.15V, 0.15V				L85 W56 D29 112 Case B1M4003 OR			
0.175V, 0.175V				L111 W71 D42 150 Case B1M4004 OR			
0.20V, 0.20V				L161 W98 D53 208 Case B1M4005 OR			

VERO ELECTRONICS PRODUCTS				SWITCHES			
3.5" x 5" .1" pitch Veroboard				Miniature Toggle - Honeywell			
3.75" x 5" .1" pitch Veroboard				SPDT C/O/H			
2.5" x 1" .1" pitch Veroboard (5)				SPDT Double Bias To Centre			
3.75" x 5" .1" pitch Plain Board				DPDT			
5.82" x 2.9" .1" pitch V40 DIP Board				DPDT C/O/H			
Spot Face Cutter				Miniature Push - C & K			
Pin Insertion Tool for .040 type pin				SP Push To Make, Momentary			
DS Pins .040 (100)				SP Push To Break, Momentary			
SS Pins .040 (100)							
Veroboard Kit (open, 2 wires, 25-com)							
Veroboard Combs (25)							
Veroboard Wire (2)							

GMT ELECTRONICS PROJECTS			KIT	BUILT UP
FREE-STANDING COMPLETE TELETXT UNIT - FULL SPEC			£199-90	£275-00
TELETXT DECODER BOARD + REMOTE HAND CONTROL			£135-90	£160-00
TELETXT COMPATIBLE TUNER AND P. S. U.			£ 46-90	£ 57-00
TELETXT COMPATIBLE PAL ENCODER + MODULATOR			£ 22-90	£ 35-00
F. E. T. OUTPUT 100W MONO POWER AMPLIFIER MODULE			£ 27-50	£ 35-00
X-BAND DOPPLER RADAR ALARM MODULE - MARK II			£ 35-90	£ 44-00
ONE AMP P. S. U. MODULE (SPECIFY 5 OR 12 VOLTS)			£ 7-50	£ 10-00
SIMULATED INERTIA MODEL TRAIN CONTROLLER			£ 22-50	£ 35-00
SIMULATED INERTIA SLOT RACER CONTROLLER			£ 27-50	£ 40-00
MODEL TRAIN STEAM SOUND SIMULATOR MODULE			£ N/A	£ 5-00

Talking Design

We've covered PWM theory: now for something practical. This month's article describes a high-quality PWM audio amplifier you can build

LAST MONTH I described a simple pulse width modulator which was capable of driving small DC motors and lamps. At the time I hinted that this technique was likely to become of major importance in audio amplifiers. This month, as a follow-up, a digital audio amplifier circuit is presented.

PWM amps are not new. Sinclair marketed a 10 W version in the sixties. What has precipitated the recent interest is the advent of digital recording techniques, and the increasing availability of fast switching transistors, especially the VFET.

To refresh your memories, a pulse width modulator is basically a square wave oscillator whose output mark-space ratio can be altered by an external voltage. If this voltage is an audio signal and the output frequency is sufficiently high, the average output voltage of the oscillator will be the audio signal. The obvious question is how high does the frequency have to be to encode the full audio band from 20 Hz to 20 kHz? Surprisingly, thanks to the work of Nyquist, the answer is only 40 kHz. Nyquist showed that a signal, in the form of modulation on a carrier wave, could be fully recovered as long as the carrier was at least twice the maximum frequency of the modulating signal.

Given that information it should be possible to produce a PWM amp with a beefy output stage running at well over 40 kHz that can deliver a signal to a normal loudspeaker. Such a digital amplifier has lots of advantages in terms of performance. If a push-pull output stage is employed, the power devices dissipate very little heat since they are either in saturation or in cut-off.

As long as the signal is linearly transferred into digital form no audio distortion can occur. Similarly, there is no crossover distortion or noise added to the signal. What has prevented all audio amplifiers from being built this way is the problem caused by the electromagnetic radiation at carrier frequency from the speaker leads. A se-

cond problem has been the shortage of devices.

When Sinclair marketed his PWM amp in the sixties, silicon transistors and logic ICs were expensive novelties. Nowadays there is a proliferation of ICs and transistors capable of being employed in such circuits.

The problem of carrier radiation is a vexed one. According to the Post Office, it is quite in order to send 200 kHz FM signals through mains wiring. In fact most domestic appliances produce RF radiation, as can be confirmed by anyone whose hi-fi equipment is upset by switching 'thumps'. The simplest way over this problem is to place a low-pass filter between the amp's output and the load. Using screened lead with the screen connected to earth is another precaution. With the amp described here RF radiation is not a real problem as long as the filter is incorporated.

Last month's circuit employed a comparator to produce PWM. This time the same result is obtained by using the

audio signal to alter the switching thresholds of a Schmitt trigger. This trigger is a device that has two switching thresholds, let's call them t_1 and t_2 (Fig.1). When the input voltage is less than t_1 the output is low. As soon as the voltage exceeds t_1 it goes high.

Low Down Volts

If the voltage is now reduced, nothing happens until it falls below t_2 . At this point the output goes low again. (Note that the two threshold voltages t_1 and t_2 are not equal.) This characteristic is known as hysteresis. The ZZ indicates a Schmitt device or function and these triggers are usually employed in digital circuits to convert slowly rising and falling waveforms to pulse trains suitable for logic systems. A Schmitt trigger can be made from an op-amp or comparator. Figure 1 also shows an astable similar to one employed last month but this time it is built around an op-amp.

On switch-on, capacitor C1 is discharged, holding the inverting input

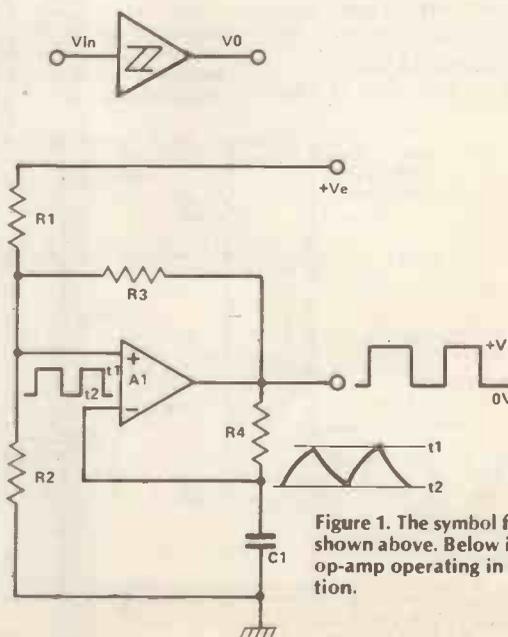


Figure 1. The symbol for a Schmitt trigger is shown above. Below is an astable using an op-amp operating in a Schmitt trigger action.

of A1 low relative to the non-inverting input. Since this is so, the output will be high. Now, if we make R1, R2 and R3 equal in value, then the non-inverting input will be held at $\frac{1}{3}V_{cc}$, because R3 is effectively in parallel with R1. In consequence, C1 will rapidly charge through R4 until the voltage at the inverting input exceeds $\frac{1}{3}V_{cc}$. At this point A1's output will start going negative. Positive feedback through R3 makes the output's transition from high to low extremely rapid.

A second stable voltage will now be found at the non-inverting input, equal to $\frac{1}{3}V_{cc}$. This time, R3 is effectively in parallel with R2. Capacitor C1 will now discharge via R4 and A1's output stage until the voltage on the inverting input falls below $\frac{1}{3}V_{cc}$. The output again goes high and the cycle repeats itself indefinitely.

Because of the influence of R3, A1 acts as a Schmitt trigger, t_1 and t_2 being $\frac{1}{3}V_{cc}$ and $\frac{1}{3}V_{cc}$.

Figure 2 shows how this simple circuit can be modified to encode an audio signal into PWM. The audio is simply imposed upon the non-inverting input, thus altering the threshold switching voltages. Resistor R5 prevents interaction between the audio signal and carrier as does R6. Capacitor C2 isolates DC voltages from the astable. Unfortunately, C1 charges exponentially via R4 so somewhat less hysteresis is applied by making R3 much larger than either R1 or R2. This has the effect of making the switching thresholds very close together and linearising the triangular waveform across C1 resulting from it being charged through R4.

To produce a good square wave at high frequencies an LF351 op-amp is used. This is a VFET device which features a high slewing rate, that is 13 V/ μ S.

The full circuit of the digital

amplifier is shown in Figure 3. Here, the op-amp drives a pair of transistors in a push-pull output stage. These transistors, a BC142 and BC143, are rated at 1 A collector current. As you can see they are connected, without base bias, as emitter-followers. When the output of the op-amp is high, Q2 is in saturation and provides current to the load via the low-pass filter L1, C5 and the output coupling capacitor C6. Incidentally, in class B amps the latter component is often of a lower value. This is a pity since the lower -3 dB point is defined by the size of this capacitor.

As you will remember, the impedance Z of a capacitor is given by:

$$Z = \frac{1}{2\pi FC}$$

where C is in farads and Z is in ohms.

Negative Feedback

The astable has a unity gain and so, to improve the sensitivity, an audio pre-amplifier stage has been added. This is built around Q1 which is used in the common-emitter mode. Negative feedback, however, is applied from the collector via R3. A collector current of 1 mA has been chosen to allow adequate drive. Resistor R7, therefore, drops 1 V whilst C3 decouples line ripple to ground. For linear drive the collector is operated at $17V/2 \approx 8V$. The value of R4, therefore, is given by $8V/10^{-3}A = 8k$, the nearest value being 8k2.

A BC149 is used for Q1 and this has a gain of 200 minimum at 1 mA. Base current I_B is therefore equal to:

$$\frac{10^{-3}A}{2 \times 10^2} = 5\mu A$$

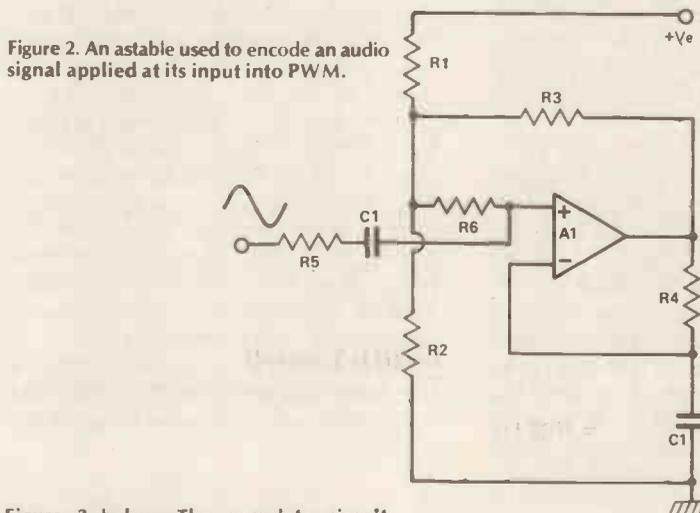
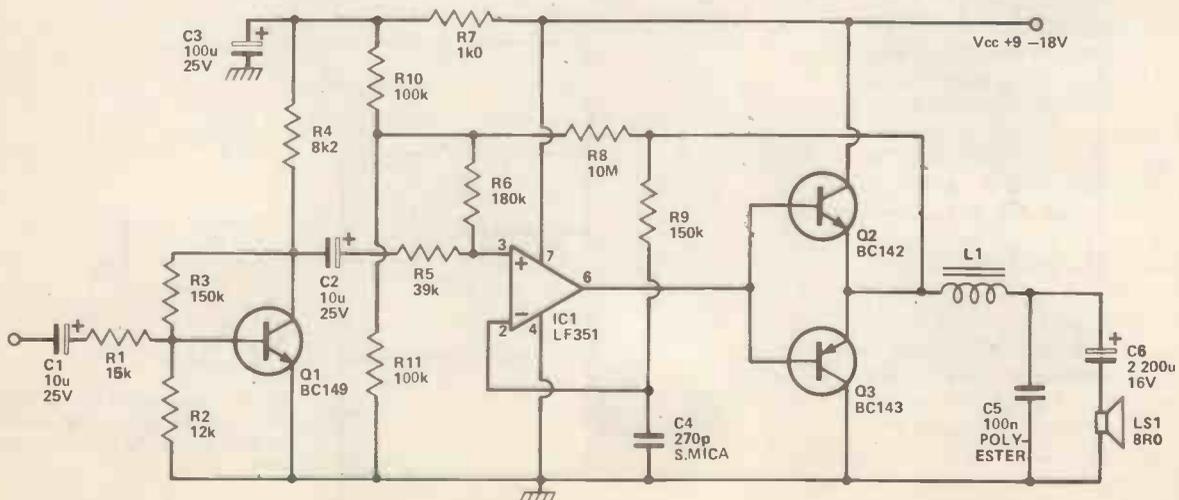


Figure 2. An astable used to encode an audio signal applied at its input into PWM.

Figure 3 below. The complete circuit diagram of the PWM amp combining the astable circuit of figure 2 with a push-pull output stage.



The base will be 0.65 V above ground and, taking $10 \times I_B$ through R2 and R3, the value of R3 is given by:

$$\frac{0.65}{5 \times 10^{-5}} = 1.3 \times 10^4 R,$$

12k being the nearest value.

Similarly, the value of R2 will be equal to the collector voltage minus the base voltage divided by $50 \mu A$, given by:

$$R2 = \frac{8 - 0.65}{5 \times 10^{-5} A}$$

$$= 147k,$$

150k being the nearest value.

Virtual Earth

Using a transistor in this way, with feedback from collector to base, forms a 'virtual earth amplifier'. This is because the feedback reduces the input impedance. The gain of the stage is set by the ratio of R3 to R1. For a gain of 10, sensitivity 900 mV, a value of 15k was chosen. Capacitor C1 simply isolates the input from DC from previous stages. A suitable Veroboard layout is shown in Fig.4. In the circuit shown in Fig.3 we have a classic high-pass filter formed by the speaker impedance Z and C. The lower -3 dB point can be calculated by rearranging the equation for f_1 given by:

$$\frac{1}{2 \pi C Z}$$

substituting:

$$f_1 = \frac{1}{2 \times 3.14 \times 2.2 \times 10^{-3} \times 8} = 9.05 \text{ Hz}$$

The minimum gain of the output transistors Q2 and Q3 is 30 at 1 A. In practice this is the absolute minimum likely to be encountered. The op-amp output can source or sink 25 mA. It follows that the worst-case minimum current that can be fed into the speaker is:

$$\pm 25 \text{ mA} \times 30 = 750 \text{ mA.}$$

Since the speaker impedance is 8R, the peak voltage under these conditions is equal to IR ; that is, $750 \text{ mA} \times 8R = 6 \text{ V}$, or 12 V peak-to-peak. Since the power output is given by V^2/R , one could be forgiven for thinking that the output power would be $(12 \times 12)/8 = 18 \text{ W}$. Unfortunately, you would be wrong!

The output power is the RMS voltage divided by the load. Assuming our output is a sinewave of 12 V peak-to-peak, the RMS value is found by dividing V_{pk-pk} by 2.8.

The output power (minimum) is therefore given by:

$$\left(\frac{12}{2.8}\right)^2 / 8R = 2.29 \text{ W RMS.}$$

Because of the small voltage drop that occurs across a saturated transistor, the output will be slightly less than this, namely 2 W.

Going back to our astable, the operating frequency has been set at 300 kHz. This gives a full power bandwidth of 10 Hz to 150 kHz.

Build It Yourself

The construction is quite straightfor-

ward and requires little comment except that it is necessary to ensure that all the semiconductors are correctly orientated and the breaks in the Veroboard tracks are not forgotten.

Although the circuit will operate from 9 V, batteries are not really suitable and any mains PSU offering an output voltage in the range indicated is better.

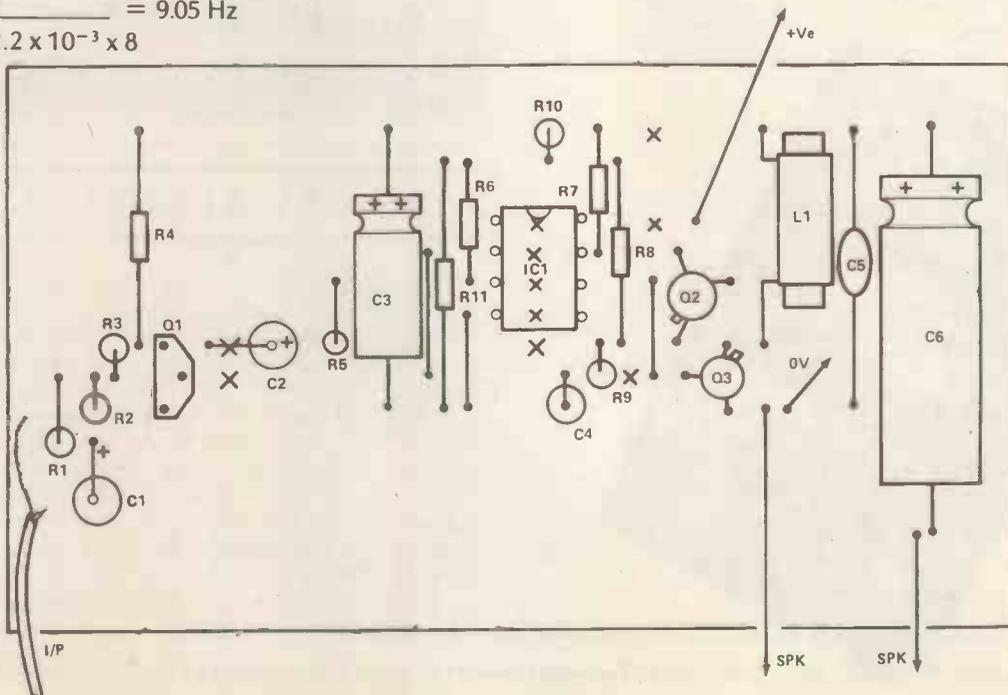
L1 consists of 60 turns of 0.56mm enamelled copper wire, pile-wound on a 1in length of $\frac{3}{8}$ in diameter ferrite rod.

When construction is completed, no adjustments need to be made to the circuit. All that is required is an input signal and a speaker.

Our regular monthly feature 'Talking Design' is not aimed at the absolute beginner. Before you tackle any of these projects you should be reasonably familiar with circuit construction techniques.

For a really comprehensive introduction to electronics why not read our special publication 'Into Electronics Plus'. You'll find details of this and all of our other 'Specials' elsewhere in this issue.

Figure 4. The Veroboard layout of the PWM amp. The small crosses (x) indicate breaks in the copper track underneath the board.



**NEXT
MONTH**

electronics today

INTERNATIONAL

Look out for the December issue
on sale November 7th.



TRANSCENDENT POLYSYNTH

Transcendent, a name familiar to ETI readers, turns up next month in the shape of our latest keyboard instrument project. The Transcendent Polysynth, designed by Tim Orr, is a polyphonic music synthesiser. It can be operated with one, two, four and even eight voices. Each voice is a synthesiser in itself, containing two VCOs, two ADSR units, one VCA and one VCF. The design features all the usual synthesiser functions — pitch bend, portamento, noise source, modulation oscillators, etc.

FOUR INPUT MIXER

Looking for the right musical mixture? Balance your decibels with the ETI four input mini mixer. It may be small, but size isn't everything (as a theatrical lady once said to a clergyman). Our box of tricks will mix it with the best of them.

PROGRAMMABLE DOORBELL

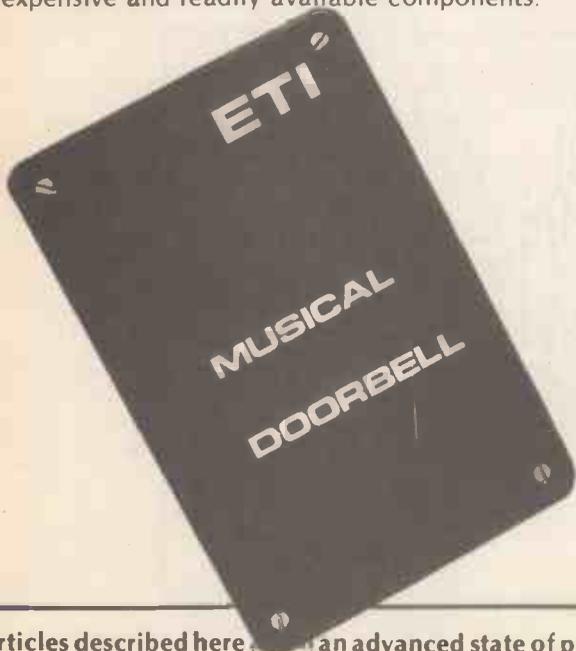
Variety's the spice of life — even where doorbells are concerned. If you've had enough of that boring old 'ding dong' noise coming from your front door, swap it for our programmable doorbell design. It doesn't use complex microprocessor control or expensive PROMs for storing tunes. It's simple to build, based on inexpensive and readily available components.



A useful addition to your test bench - the ETI Bench Amplifier

MUSICAL ALARM CLOCK

This battery-powered design is more than a mere alarm clock. To keep construction simple the clock section is based on a ready-built module. Although it's an electronic clock, we've included a sound generator to produce the comforting 'tick tock', just so you know that it's still there. The tick rate and volume are adjustable. Naturally it has all the usual alarm clock features — ten minute snooze function, backlight, etc. When the alarm condition is selected, it doesn't make a monotonous buzzing noise. A clever little chip in the innards can generate 24 different tunes — three groups of eight. You select which of the three groups you want and it randomly selects a tune to alarm you with.



Articles described here are in an advanced state of preparation. However, circumstances may dictate changes to the final contents.

POPULAR KITS AND PARTS

BURGLAR ALARM CONTROL PANEL

Contains labelled connection block, latching relay, test switch and removable key control switch. Simplifies the whole installation; all you have to do is to take wires to pressure pads and to alarm bell. Price **£6.90**. With complete diagram.

PRECISION MAINS-OPERATED CLOCK

For only **£1.72**. Sounds unbelievable but that's what you can have if you send your order right away. The clocks which have large clear dials were made by the famous Smiths Company for use with their domestic cooker switch and are brand new and guaranteed.

25-WATT MID-RANGE SPEAKER 5 1/2"

Made by Goodmans, so there's none better. 4 ohm coil. Price **£3.95**. Post £1.

8 OHM TWEETER

Made by Goodmans. 3 1/2" square 4" across fixings. Price **£1.72**. Post 30p.

WATERPROOF HEATING WIRE

As used for electric blankets, etc. This has dozens of other applications — in gloves or socks for people with poor circulation are obvious uses. One unusual use suggested by a customer is a 'grow' bag heater. The wire which consists of an element wound on glass fibre then PVC covered has a resistance of 60 ohms per yard. The price is **23p per yard**.

TELEPHONE PICK-UP coil attaches by suction to phone body, enabling conversation to be recorded, put through amp or headphones. Price **£1.15**.

LIGHT CHASER

Gives a brilliant display — a psychedelic light show for discos, parties and pop groups. These have three modes of flashing, two chase-patterns and a strobe effect. Total output power 750 watts per channel. Complete kit. Price **£16.98**. Ready made up **£4 extra**.

FISH BITE INDICATOR enables anglers to set up several lines then sit down and read a book. As soon as one has a bite the loudspeaker emits a shrill note. Kit. Price **£4.90**.

8 WAVEBAND SHORTWAVE RADIO KIT

Bandspread covering 13.5 to 32 metres. Based on circuit which appeared in a recent issue of Radio Constructor. Complete kit, includes case materials, six transistors, and diodes, condensers, resistors, inductors, switches, etc. Nothing else to buy, if you have an amplifier to connect it to on a pair of high resistance headphones. Price **£11.95**.

3" EDGEWISE PANEL METER

0.25 mA coil made for the G.P.O. A very useful instrument especially when panel space is limited. **£2.90**.

BLACK LIGHT. Can add a touch of novelty to a party or disco. We have in stock the Atlas 175 watt U.V. Lamps. These plug straight into a lampholder and need no control or starter gear. This is a black lamp about the size of the old-fashioned 200 watt lamp. Price **£10.35**.

PANEL METER 0.1mA

Japanese made full vision perspex front, flush mounting. Price **£3.45**.

SHORT WAVE CRYSTAL RADIO

All the parts to make up the beginner's model. Price **£2.30**. Crystal earpiece 85p. High resistance headphones (give best results) **£3.75**. Kit includes chassis and front but not case.

RADIO STETHOSCOPE

Easy to take find — start at the aerial and work towards the speaker — when signal stops you have found the fault. Complete kit **£4.95**.

INTERRUPTED BEAM KIT

This kit enables you to make a switch that will trigger when a steady beam of infra-red or ordinary light is broken. Main components — relay, photo transistor, resistors and caps. etc. Circuit diagram but no case. Price **£2.30**.

PUNCHED TAPE EQUIPMENT for controlling machine tools, etc., motorised 8-bit punch with matching tape reader. Ex computers believed in good working order, any not so would be exchanged. **£15** the pair. Carriage **£3**.

FRUIT MACHINE HEART. 4 wheels with all fruits, motorised and with solenoids for stopping the wheels with a little ingenuity you can defy your friends getting the "jackpot". **£9.95** + **£4** carriage.

DESOLDERING PUMP

Ideal for removing components from computer boards as well as for service work generally. Price **£6.35**.

4-CORE FLEX CABLE

White pvc for telephone extensions, disc lights, etc. 10 metres **£2**, 100 metres **£15**. Other multicores cable in stock.

MUGGER DETERRENT

A high-note bleeper, push latching switch, plastic case and battery connector. Will scare away any villain and bring help. **£2.50** complete kit.

HUMIDITY SWITCH

American made by Honeywell. The action of this device depends upon the dampness causing a membrane to stretch and trigger a sensitive microswitch. Very sensitive breathing on it for instance will switch it on. Micro 3 amp at 250V a.c. Only **£1.15**.

SAFE BLOCK

Mains quick connector will save you valuable time. Features include quick spring connectors, heavy plastic case and auto on and off switch. Complete kit **£1.95**.

V3 MICROSWITCHES

Over 50,000 in stock all 250 AC working, with 3 silver contacts for c/o circuits — 10 amp 25p each or **£20** per 100, 15 amp 35p each or **£30** per 100.

MAINS ADAPTORS

Why use expensive batteries — operate your radios and equipment from the mains with these units.

— Sinclair gives 9v - 100mA

— **£2.95**

— Altiz gives 6v 7.5 or 9v - 300mA

— **£3.95**

— Crown give 6v at 300 mA

— **£2.95**

— Nixie give 12v - 750 mA

— **£3.95**

These are all made up complete with mains lead in plastic cases. We can also supply Mains Transistor Power Pack. Kit for Voltage output anything from 3v to 16v up to 300mA — complete kit with double insulated mains transformer and full instructions — **£1.95**.



MULLARD UNILEX

A mains-operated 4 + 4 stereo system. Rated one of the finest performers in the stereo field this would make a wonderful gift for almost anyone. In easy-to-assemble modular form this should sell at about **£30**—but due to a special bulk buy and as an incentive for you to buy this month we offer the system complete at only **£16** including V.A.T. and postage.

FREE GIFT—Buy this month and you will receive a pair of Goodman's elliptical 8" X 5" speakers to match this amplifier.



VENNER TIME SWITCH mains operated with 20-amp switch, one on and one off per 24 hours repeats daily automatically correcting for the lengthening or shortening day. An expensive time switch but you can have it for only **£2.95**. These are new but without case, but we can supply plastic cases (base and cover) **£1.75** or metal case with window **£2.95**. Also available is adaptor kit to convert this into a normal 24-hour time switch but with the added advantage of up to 12 on/off per 24 hours. This makes an ideal controller for the immersion heater. Price of adaptor kit is **£2.30**.



DRILL CONTROLLER

Electronically changes speed from approximately 10 revs to maximum. Full power at all speeds by finger-tip control. Kit includes all parts, case, everything and full instructions. **£3.45**.

Made-up model **£1 extra**.



DELAY SWITCH

Mains operated—delay can be accurately set with pointers knob for periods of up to 2 1/2 hours. 2 contacts suitable to switch 10 amps—second contact opens a few minutes after 1st contact. **£1.50**.



NEW KITS

SUB-MIN MICROPHONE

Size only 1/2" x 3/4" x 3/16" so small enough for a bugging device, ex-hearing-aids but guaranteed. Price **£1.50**.

TRANSMITTER SURVEILLANCE

Tiny, easily hidden but which will enable conversation to be picked up with FM radio. Can be made in a matchbox—all electronic parts and circuit. **£2.30**.

RADIO MIKE

Ideal for discos and garden parties, allows complete freedom of movement. Play through FM radio or tuner amp. **£6.90**.

EXTRACTOR FANS

Ex-Computer made by Woods of Colchester; ideal also as blower, central heating systems, fume extraction, etc. Easy fixing through panel, very powerful 2,500 r.p.m. but quiet running. Choice of 2 sizes, 5" **£5.50**, 6" **£6.50**; post **£1** per fan.



3-CHANNEL SOUND TO LIGHT KIT

Complete kit of parts for a three-channel sound to light unit controlling over 2,000 watts of lighting. Use this at home if you wish but it is plenty rugged enough for Disco work.

The unit is housed in an attractive two-tone metal case and has controls for each channel, and a master on/off. The audio input and output are by 1/4" sockets and three panel mounting fuse holders provide thyristor protection. A four-pin plug and socket facilitate ease of connecting lamps. Special snip price is **£13.50** in kit form or **£16.50** assembled and tested.

— THIS MONTH'S SNIP —

Here's a super bargain for you. 100 twist drills; regular toolshop price over **£50**, yours for only **£10** including V.A.T. and post. With these you will be able to drill from the tiniest holes in p.c.b. right up to 1/4" for switches, etc. Don't miss this snip — send your order today.



MINI-MULTI TESTER

Deluxe pocket size precision moving coil instrument, jewelled bearings—2000 o.p.v. mirrored scale.

11 instant ranges measure:

DC volts 10, 50, 250, 1000.

AC volts 10, 50, 250, 1000.

DC amps 0-100 mA.

Continuity and resistance 0-1 meg ohms in two ranges.

Complete with Test Prods and instruction book showing how to measure capacity and inductance as well.

Unbelievable value only **£6.75** + **50p** post and insurance.

FREE Amps ranges kit to enable you to read DC current from 0-10 amps, directly on the 0-10 scale. It's free if you purchase quickly but if you already own a Mini-tester and would like one, send **£2.50**.

TERMS: Cash with order—but orders under **£10** must add 50p to offset packing, etc. **BULK ENQUIRIES INVITED - PHONE HAYWARDS HEATH 54563**

ACCESS & BARCLAYCARD ACCEPTED

J. BULL (Electrical) LTD.

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

IT'S FREE

Our monthly Advance Advertising Bargains List gives details of bargains arriving or just arrived—often bargains which sell out before our advertisement can appear—it's an interesting list and it's free—just send S.A.E. Below are a few of the Bargains still available from previous lines.

SUPER BREAKDOWN PARCEL with free gift of a desoldering pump, perhaps the most useful breakdown parcel we have ever offered. Consists of 50 newly all different computer panels on which you will find: over 300 ICs, over 300 diodes, over 200 transistors and many hundred other parts, resistors, condensers, multi turn pots, rectifiers, SCR etc. for only **£8.60**, which when you deduct the value of the desoldering pump, works out to just a little over 4p per panel. + **£1.27 VAT** + **£2** post (it's a big parcel).

AUTUMN IS ALMOST WITH US and if the year lives up to its reputation, we will have chilly evenings — so don't put off those heating jobs any longer. While stocks last, we will supply the tangential heater units at last season's prices—namely **£5.95** + **£1.50** post for the 2KW and **£6.95** + **£1.50** post for the 3KW. These prices include VAT but not the control switch, which is the three interlocked rocker type for the 2KW, price **0.85p** and the four interlocked rocker type for the 3KW, price **95p**.

12V MOTOR BY CROUZET — a powerful motor virtually impossible to stop by hand, size approx 2 1/4" long and 2 1/2" dia, this is a permanent magnet field type so is reversible simply by changing polarity and has a relatively constant speed with or without load. Fitted with a splined shaft which could directly engage a toothed gear wheel or to which a pulley could be attached. Ideal for large models, or small machines etc. Price **£3.95**.

12v MOTOR BY SMITHS INDUSTRIAL made for use in cars, these are series wound and become more powerful as load increases — they will in fact burn themselves out if over-loaded to stopping point — not polarity reversible — but if you are prepared to do a little unsoldering and rewiring then they will reverse at the flick of a switch. Series wound they will also work off a.c. mains through a step down transformer and if you use a variable voltage type then the motor speed can be varied by the voltage. Size approx 3 1/2" long by 3" dia these have a good length of 1/4" dia spindle — price **£3.50**. Ditto out double ended **£4**.

MAINS OPERATED LOW SPEED MOTORS 2 watts type as fitted into time switches, machine controllers etc. We have a good selection and can offer the following final speeds: 1 r 24 hrs, 1 r 9 hrs, 1 r 4 hrs, 1 r 2 hrs, 3 r 4 hrs, 1 r 12 hrs, 20 r 30 hrs, 1 r 2m, 4 m, 8 m, 15 m, 200 m, all at **£2.85**.

SPIT MOTORS. These are powerful mains operated induction motors with gearbox attached the final shaft is a 1/8" rod with square hole, so you have alternative coupling methods — final speed is approx. 5 revs per min, price **£3.25** post **£1.00**. We have similar motors but with final speed 110 rpm and 80 rpm same price.

WALL MOUNTING THERMOSTAT by Danfoss has a really pretty two tone grey case with circular white scale and dial. Setting temperature from 0-30c — 13 amp 250v contacts. Price **£4.60**.

EXTENSION SPEAKER CABINETS. Teak look black front, size 11" x 5" x 4 1/2" approx. Price **£2.00**. Post **£1.00**. We have larger ones. If you can call and collect these cabinets you can save yourself the quite considerable postage and you only have to buy a few to get a discount as well. The quantity discount for these is a special rate of 25% if you buy ten or more. Note these cabinets are very good quality (made for Rank Audio Systems) the grill material is Dacron.

MERCURY BATTERIES. Bank of 7 mercury cells type 625 which are approximately 3/4" dia. In plastic tube, giving a total voltage of 10.7. Being a plastic tube it is very easy to break up the battery into separate cells which could be used for radio control and similar equipment. Carton of 25 batteries is **£1.15** + **85p** post.

HALF-PRICE CABLE OFFERS. We have good stocks of:

Size	Type	Price	Carriage
mm	100 metres		
1.5	Single	£4.00	£1.75
1.5	Flat twin	£6.50	£2.75
1.5	Flat 3-core & E	£8.75	£3.50
4	Single	£7.50	
4	Flat twin	£11.50	£4.00
5	Flat 3-core	£32.50	£5.00
15	Twin & E	£79.00	£10.00

ONCE AGAIN IN STOCK ex-G.P.O. resistance bridge. It is in fact an electronic megger, which tests at a voltage of around 250, thus revealing any leaky points. These must have cost at least **£150** each to make. In a portable light weight case, size approx 9" x 9" x 3" with a carrying handle. Has two moving coil panel meters which give clear readings of resistance from fractions of an ohm right up to 100 megs and then to infinity. We have two versions of these instruments 1) is as good as new and checked and tested before despatch price **£22.50** + **£3.38** post **£2.50**. 2) Secondhand models complete and believed to be in working order but not checked nor guaranteed. **£12.50** + **£1.97** post **£2.50**.

MAKING A CONVERTER HEATER We can offer a bank of four 1 KW metal clad elements all mounted on a 3in square iron plate. By comparatively simple switching 8 heat outputs ranging from approximately 250 watts to 4000 watts can be achieved. The elements which have push on tag connectors, extend to a length of approx 1 1/2in from their mounting plate, so a relatively compact simple converter heater could be made using this. Price **£2.37** + **£1.50**.

G.P.O. HIGH GAIN AMP / SIGNAL TRACER. In case measuring only 5 1/2" x 3 1/2" x 1 1/2" is an extremely high gain (700B) solid state amplifier designed for use as a signal tracer on GPO cables etc. With a radio it functions very well as a signal tracer. By connecting a simple coil to the input socket a useful mains cable tracer can be made. Runs on standard 4 1/2v battery and has input, output sockets and on-off volume control, mounted flush on the top. Many other uses include general purpose amp, cueing amp etc. An absolute bargain at only **£1.85**. Suitable 50 ohm earpiece 85p.

OUR CAR STARTER AND CHARGER KIT has no doubt saved many motorists from embarrassment in an emergency you can start car off mains or bring your battery up to full charge in a couple of hours. The kit comprises: 250w mains transformer, two 10 amp bridge rectifiers, start/charge switch and full instructions. You can assemble this in the evening, box it up or leave it on the shelf in the garage, whichever suits you best. Price **£11.50** + **£2.50** post.

MOUTH OPERATED SWITCH. Made for washing machines to control water level etc, this is a sensitive low pressure device which operates three 1 pole changeover switches at different levels of pressure but all within a normal persons blowing capacity — blow gently into it and No. 1 switch operates, blow a little stronger and No. 2 operates, blow harder still and No. 3 operates. The switch is airtight so the weight of water or other fluid substance could operate it. Undoubtedly a switch with very many applications. Disc type construction, this is approx 3 1/4" dia x 1 1/4" thick — the air entry is a pipe approx 3/16" dia — electrical contacts we estimate a 10 amp c/o a 230 volt — connection by push on tags. Order ref. **RS-4**. Price **£2.88**.

BE PREPARED. For possible blackouts and interruptions in electricity supply this winter. Have some emergency lighting nearby. We still have the fluorescent outfits for operating 12in or 21in tubes from 12V car battery and the price is **£4.65** 80p post complete with tubes, please state which.

BLEEPERS 6 or 12v battery or transformer operated, ideal for using in most alarm circuits but for car and motor cycle alarms. These give a loud shrill note. American made by Delta Alarm. Price 87p. Large quantities available.

MOTORIZED LIGHT FLASHER. Christmas is coming, so you've got to think about your decorative lighting, to make this flash we can offer two motorized units both capable to 2000 watts of light. One 1/2 second flasher changes every 1/2 second and the 2 second flasher changes every 2 seconds. Either type **£6.90**.

**WE HAVE ALL THE NEW ATARI®
VIDEO GAME PROGRAM™
CARTRIDGES.**

ATARI £86 + VAT

SILICA SHOP

**TELEPHONE FOR FREE COLOUR
BROCHURE 01-301 1111**

ELECTRONIC GAMES

ATARI



SPECIAL PRICE

£86 + VAT

INTELLIVISION MATTEL



Available August 1980
This is the most advanced TV game in the world. Expandable next year into a full microcomputer. **COLOUR CATALOGUE AVAILABLE WITH DETAILS ON ALL THE CARTRIDGES**

£173.87 + VAT

CHESS COMPUTERS



NEW RANGE AVAILABLE AUGUST 1980
We specialise in computer chess machines & stock over 13 different models from **£20 to £300**

Send for further details.

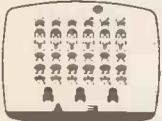
TELETEXT



RADOFIN TELETEXT Add on Adaptor

£199 + VAT

SPACE INVADERS



HAND HELDS + CARTRIDGES
ATARI - ACETRONIC
- PRINZTRONIC
RADOFIN - DATABASE etc.

We keep a full range!
Send for cartridge lists stating which machine you own.

BRIDGE COMPUTER



- ★ Plays 1/2/3 or 4 Hands
- ★ Problem Mode
- ★ Audio Feedback
- ★ Instant Response
- ★ Auto scorekeeping

BACKGAMMON COMPUTERS



OMAR 1
OMAR 2
CHALLENGER
GAMMONMASTER

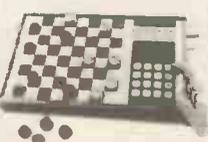
From **£38 to £108**. Send for further details.

27 TUNE DOOR BELL



£17.13 + VAT

DRAUGHTS COMPUTER



- ★ Solves Problems
- ★ Rejects illegal moves

2 level machine **£43 + VAT**
4 level machine **£77.78 + VAT**

LEISURE

- ★ CHEAP TV GAMES
- ★ TELEPHONE ANSWERING MACHINES
- ★ AUTO DIALERS
- ★ CALCULATORS
- ★ DIGITAL WATCHES
- ★ PRESTEL
- ★ HAND HELD GAMES

FREE CATALOGUE

For a free copy of our 32 page catalogue, send a 12p stamp to Silica Shop Ltd or Telephone **01-301 1111**

MAIL ORDER SERVICE - Free postage & Packing
TELEPHONE & MAIL ORDERS - accepted on Access * Barclaycard * American Express * Diners Club
CALLERS WELCOME - at our shop in Welling - Demonstrations daily
Open from 9am-5pm Mon-Sat (9am-1pm Wed)
GUARANTEE - Full 12 months + After Sales Support!
We have comprehensive brochures on all products. Please let us know what you are interested in and we will send you detailed brochures AND our own 32 page catalogue covering most games on the market.

SILICA SHOP
SILICA SHOP LTD., Dept. HE 11
102 Bellegrave Road
Welling, Kent DA16 3QF
Tel: 01-301 1111

Double Dice

Chance your luck with HE's latest game of fortune — for those readers who can't find the energy to shake'em — here's a pair you only have to touch



THE TIME OF YEAR approaches when more games are bought and played than at any other. A large percentage of these games need some system whereby a random number between 1 and 12 can be quickly and easily generated — the usual way of doing this is with a pair of dice. A good electronic dice project hasn't materialised in any of the hobbyist magazines recently and so we thought that the time was right for HE to produce a dice to beat all dice. Although quite ingenious in operation, the HE Double Dice is simplicity itself to build — apart from the display there are only 18 other components, and all parts mount on a small PCB.

The display is formed from individual LEDs, seven in each die, grouped together into the well-known dice formation. Five ICs perform all logic, control, counting and driving functions of the circuit and both die displays are completely random and non-synchronised.

The device is touch-controlled: simply placing a finger over the two contacts starts operation of the dice. The LEDs light up and are seen to flash at a fast rate (showing that the 1 to 6 sequence is in operation.) Upon removing the finger, the LEDs stop flashing and hold the last number displayed.

After a short time, all the LEDs extinguish, showing that the dice is ready for its next cycle of touching and

displaying. The display period is defined, mainly, by the value of capacitor C1, and using the value shown a period of about 5 seconds is obtained. Increasing its value lengthens illumination time and vice versa.

LEDs need a fair amount of current to give a reasonable illumination and if they remained on at all times, battery life would be severely limited. The self-cancelling function reduces the average current consumption of the circuit and therefore prolongs battery life.



Side view of the HE Double Dice showing the position of the LEDs

Construction

Start construction by inserting the six links into the PCB as shown in the overlay diagram of Fig.2. It is helpful to use a pair of long-nosed pliers to bend the link wires before insertion. Resistors, capacitors and IC sockets if used, should be put in now but leave the ICs till last.

Next, insert LEDs 1 to 14 into the board in the double dice formation. Mount them about 10 to 15 mm above the PCB so that they stand above the maximum height of the other components. Connect the switch, battery and touch contacts (two wires will do for test purposes), plug in the five ICs, switch on and test the project.

Housing the PCB in a case should not be a problem. Suggestions are: either mount your board on the underside of the case lid, drilling holes for the LEDs to mount into, or make a panel out of coloured transparent plastic (or similar) through which the LEDs will be visible.

You can make your touch contacts out of virtually any small pieces of electrical conductor — touch plates are available commercially, of course. We chose to use the heads of metal drawing pins inserted through the case lid. Soldered connections can be made underneath the lid to the board. If you do the same, remember that a metallic lid conducts and the contacts will have to be insulated from it.

Buylines

You shouldn't have any trouble in obtaining the components for this project.

Approximate price (excluding case and PCB) will be around £7.

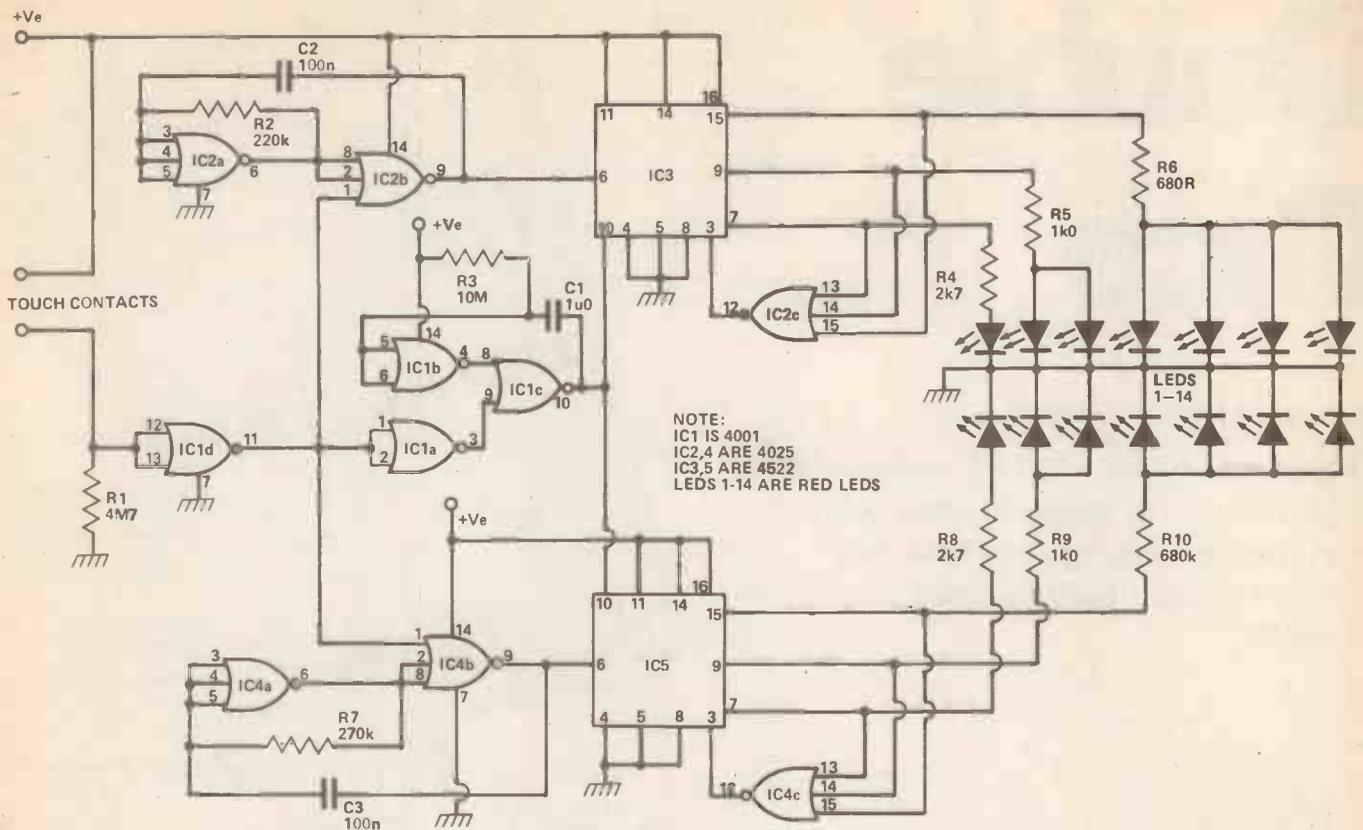


Figure 1. Circuit diagram of the amazing Hobby Electronics Double Dice

How it Works

The circuit of the HE Double Dice can be seen in Fig.1. By cross-referring to it, the operation of the dice may be more easily understood. Most of the circuit is duplicated for each dice (IC2, 3 and common components) — the action of the other dice is identical (using IC4 and 5 instead).

A	B	C	NUMBER DISPLAYED
OFF	OFF	ON	1
OFF	ON	OFF	2
OFF	ON	ON	3
ON	OFF	OFF	4
ON	OFF	ON	5
ON	ON	OFF	6

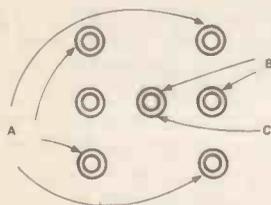


Figure 3.

The LEDs are formed on the PCB to a standard dice configuration as in Fig.3. In this diagram the individual points have been grouped together into three categories A, B

and C. By looking at the numbers on a dice in turn, a table can be drawn up, as in Fig.3 to show that all LEDs in any one category must be either on or off at the same time. Therefore, we can consider the groups as single logical levels in a set code. It just happens that the set code is required is part of the binary code, of which the part of interest is shown in Fig.4 against the corresponding denary, or ordinary number value.

DENARY NUMBER	BINARY NUMBER
0	0 0 0
1	0 0 1
2	0 1 0
3	0 1 1
4	1 0 0
5	1 0 1
6	1 1 0
7	1 1 1

↑
THE PART OF THE BINARY CODE WHICH IS OF INTEREST
↓

Figure 4.

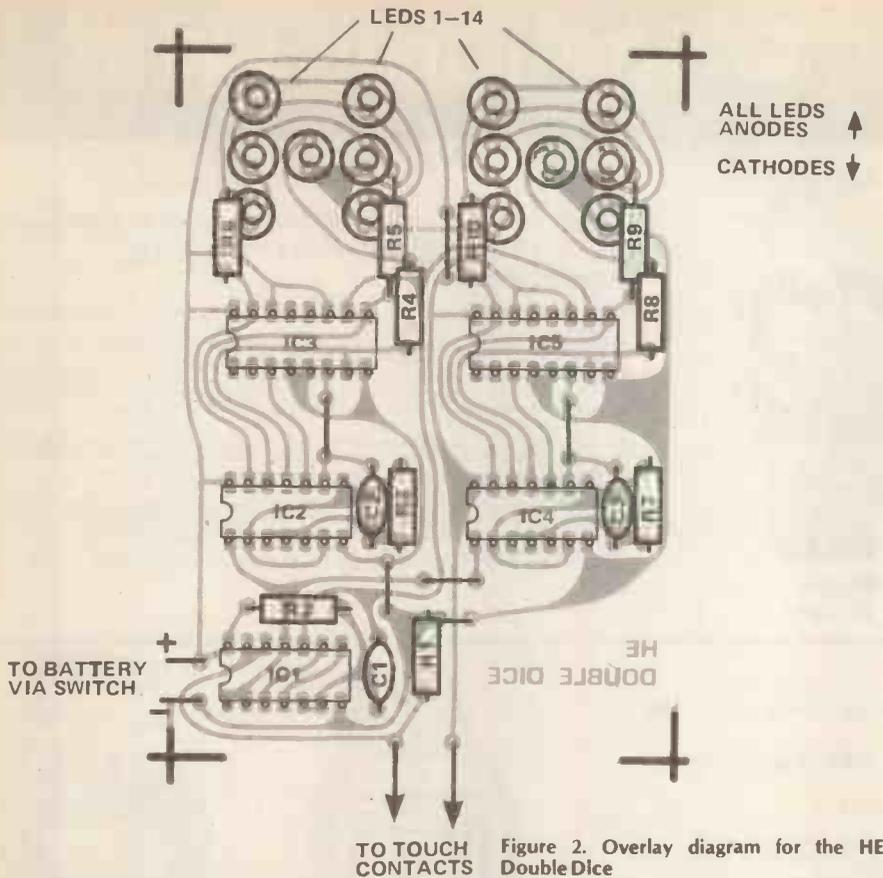
ICs which count in binary are readily available and the 4522 (IC3) does just that. It is a down counter, meaning that it starts its cycle at binary 15 and counts down to 0. On the next count after 0 it would (normally) reset to 15 and start the cycle over again. However, we have taken advantage of the fact that the 4522 is a programmable counter which can, on a command pulse, be programmed or set to a particular number in its cycle. In our circuit this number is 6 (represented by the logic levels at pins 14, 11 and 5, that is 1, 1, 0). The

command pulse is obtained from the output of IC2c, which is at logic 1 only when its three inputs are 0. These inputs are in parallel with the LED drive outputs of IC3 so that as the number 0 is displayed by the LEDs the counter automatically jumps to the number 6. The interval between the count to 0 and the display of 6 is so small that to the human eye it appears that the counter progresses naturally from 1 to 6.

IC2a and b form a simple astable multivibrator which produces a square wave of about 100 Hz and which clocks the counter whenever pin 1 of IC2 is at logic 0.

The part of the circuit which is common to both sides is that of IC1. Pins 12 and 13 of this IC are held normally low by R1, a very high resistance. The output of IC1d is therefore normally high (the gate is acting as an inverter). If a finger is placed on the touch contacts, skin resistance takes the input to this gate high, and the output, pin 11, goes low. This pin is connected to pin 1 of the astable which as detailed above, clocks the counter.

As well as enabling the astable, pin 11 is connected to the input of a monostable multivibrator with an 'on' period of about 5 seconds so that as a finger is put on the touch contacts the monostable enters its 'on' state. The output of the monostable is connected to pin 10 of the counter so that during the 'on' state the LED display is allowed to function. At the end of the 5 second on-period the monostable switches off and the display is disabled (the LEDs are held off) thus saving unnecessary battery wastage.



Parts List

RESISTORS (All 1/4 W, 5%)

R1	4M7
R2	220k
R3	10M
R4,8	2k7
R5,9	1k0
R6,10	680R
R7	270k

CAPACITORS

C1	1u0 polycarbonate
C2,3	100n polyester

SEMICONDUCTORS

IC1	4001 quad, 2-input NOR
IC2,4	4025 triple, 3-input NOR
IC3,5	4522 programmable BCD counter
LED1-14	miniature red LEDs

MISCELLANEOUS

single-pole, single-throw toggle switch
battery clip
case to suit
touch contacts

Figure 2. Overlay diagram for the HE Double Dice

HE

TRIACS

400V Plastic Case (Texas)

3A	49p	16A	95p
8A	58p	25A	190p
12A	85p		80p
6A with trigger			65p
8A isolated tab			18p

Diac

CMOS

4000	17p	4019	42p	4069	19p
4001	18p	4023	22p	4070	19p
4002	18p	4025	21p	4071	18p
4007	17p	4026	£1.30	4072	26p
4011	19p	4027	40p	4081	20p
4012	17p	4028	50p	4093	54p
4013	38p	4040	80p	4501	24p
4015	75p	4049	38p	4511	90p
4016	35p	4050	£1.00	4514	£1.80
4017	70p	4060	£1.08	4516	£1.80

AND NOW A DIMMER THAT MAKES TOUCH DIMMERS OBSOLETE

Two years ago TK Electronics launched a touchdimmer kit, the TD300K, which made knob controlled dimmers obsolete. This was such a great success that many magazines and more retailers soon produced similar designs. SO WHAT OTHERS MAY FOLLOW. TK have designed a touch dimmer kit with an Infra Red Remote Control enabling you to switch and control the brightness of your lights from the comfort of your arm chair etc. (as well as manually by touching the frontplate or by using the TDEK extension kit). As with all our kits, these units come complete with all components including RFI suppression, frontplate, a neon to help you find the switch in the dark and a neat box for the transmitter. The plastic frontplate has no metal parts to touch ensuring complete safety and enabling the plate to be covered with a decorative finish to blend with your room decor.

We have designed the light dimmer unit to fit a standard wall box, the transmitter to fit your hand and the price to fit your pocket.

In two years' time everyone will be selling remote control dimmers but you can have your TD300K kit NOW for only £14.30 for the dimmer unit and 4.20 for the transmitter.

For the more athletic of you the TD300K is still available available at £6.50 and the TDE K at £2. DON'T FORGET to add 40p P&P and 15% VAT to your total purchase.

MINI TRANSFORMERS

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

6.0-6V	80p
9.0-9V	85p
12.0-12V	90p

LEDs

0.1" Red	9p
0.1" Green	12p
0.1" Yellow	12p
0.2" Red	9p
0.2" Green	12p
0.2" Yellow	12p
Rectangular Red	3p
Rectangular Green	20p
Rectangular Yellow	21p

TK's SPECIAL OFFERS OF THE MONTH

Orders must be received by 30-11-80

SPECIAL OFFERS

3 1/2 digit Liquid Crystal Display, 0.5" digits, d.11 package. Can be backlit for viewing in the dark. £5.95
2N3442 Power Transistor 2 for £1.80

BOXES

Moulded in high impact ABS. Supplied with lids and screws. Black or white.
B2 95x71x35mm 85p
B3 115x85x37mm 95p

MINI KITS

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

MK1 TEMPERATURE CONTROLLER / THERMOSTAT
Uses LM3911 IC to sense temperature (80°C max) and triac to switch heater. 1KW £4.00

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

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

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

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

INTEGRATED CIRCUITS

555 Timer	21p
741 Op. Amp.	19p
AY-5-1230/2 Clock/Timer	£2.60
AY-3-1270 Thermometer	£4.50
ICL7106 DVM (LCD drive)	£8.20
LM377 Dual 2 VV Amp	£7.00
LM3795 Dual 6W Amp	£1.45
LM380 2W Audio Amp	£3.50
LM352 Dual/low noise Preamp	80p
LM386 250mW low voltage Amp	£1.00
LM1830 Fluid Level Detector	75p
LM2907 I-V Converter (8 pin)	£1.50
LM2917 I-V Converter (14 pin)	£1.40
LM3903 LED Flasher/Oscillator	£1.60
LM3911 Thermometer	60p
LM3914 Dot/Bar Driver	£1.20
MM74C911 4 digit display controller	£2.10
MM74C915 7 segment-BCD converter	£6.50
MM74C915 4 digit ctr. with 7 seg o/p	90p
S5668 Touchdimmer	£4.50
S9263 Touchswitch 16-way	£2.50
SN76477 Complex Sound Generator	£4.85
TBAB00 5W Audio Amp	£2.52
TBAB10AS 7W Audio Amp	68p
TDA1024 Zero Voltage Switch	£1.00
TDA2020 20W Audio Amp.	£1.20
ZN1034E Timer	£2.85
All ICs supplied with data sheets	£1.80
Data Sheets only 10p each device.	

REMOTE CONTROL COMPONENTS

LD271 IR Emitting Diode	36p
SF4205 Photodiode Detector	95p
SL480 IC Pulse Amp	£1.70
SL490 32 command encoder/transmitter	£2.40
ML922 10 channel receiver + 3 analogue outputs o/p	£4.20
ML926 16 channel receiver 4 momentary binary o/p	£1.40
ML928 16 channel receiver 4 latched binary o/p	£1.40
ML929 16 channel receiver 4 latched binary o/p	£1.40

Data Sheets per device 10p
These ICs can be used with Infra red, ultrasonic or radio links, depending on range, cost and speed of operation.

RC500K KIT

If you do not require a sophisticated multi-channel remote control, we have developed a simple single-channel on/off infra red transmitter and receiver kit. The transmitter unit comes complete with a hand-held box and requires a PP3 (9V) battery. The receiver includes a triac capable of switching up to 500W at 240V a.c. and comprises a pre-amplifier bistable latch and a mains power supply, making the unit completely self contained. The small size of the receiver enables the unit to be 'built into' all kinds of equipment from lamps to tape recorders. Range approximately 20ft. £12.50

ALL COMPONENTS ARE BRAND NEW AND TO SPECIFICATION. ADD VAT AT CURRENT RATE TO ABOVE PRICES. 40p P&P MAIL ORDER — CALLERS WELCOME BY APPOINTMENT

TK Electronics

(H.E.), 11 Boston Road, London, W7 3SJ
Tel: 01-579 9794

World famous for quality, reliability and value for money. 20,000,000 customers can't be wrong!

Now Casio, the new technological leaders, take a giant step forward in time with

THE ULTIMATE WATCHES



Analogue Display



Digital Display

You have to hand it to Casio for the best of both worlds!
AA81 LCD ANALOGUE / DIGITAL ALARM CHRONOGRAPH

- **LCD Analogue.** Independent display of hours and minutes, with synchronous digital seconds, can be used as a dual time.
- **Digital.** Independent display of hours and minutes, synchronous seconds, day and date.
- **Auto calendar.** Four year calendar is set for 28 days in February.
- **Professional stopwatch.** Measures net, lap and 1st & 2nd place times in units 1/100 second to 12 hours. A signal confirms start/stop operation and sounds at 10 minute intervals.
- **Daily reminder alarm.** Sounds at the pre-set time and an amazing "Star Burst" display flashes for 30 seconds. "Alarm on" symbol.
- **Countdown alarm.** Measures normal and net times from 1 minute to 60 minutes. 30 second alarm and "Star Burst" display. 10 minute signal. Star/stop signal.
- **Time signal.** Every half hour on the half hour. Every hour on the hour. Two tones.
- **Tone control.** Tone pitch can be varied in 10 steps.
- **Lithium battery.** Approx. 18 months life using alarm for 90 seconds and nightlight for 3 seconds daily \pm 15 secs/month accuracy. "Merry-go-round" demonstration display. Water resistant case 8.65mm thick. Mineral glass. Matching stainless steel bracelet.

ONLY £29.95 for around 40 functions. RRP £34.95

Tune in to Casio. 12 melodies will alarm you — the price won't!
12 MELODY ALARM CHRONOGRAPHS with countdown; date memories

- **Time display.** Hours, minutes, seconds, am/pm. 12 or 24 hour format.
- **Calendar.** Day, date and month auto 4 yrs. calendar.
- **Daily alarm.** 7 melodies, one for each day of the week, including "American Patrol."
- **Hourly time signal.** With "Big Ben" type tune. When date memories are set, the chosen melody is played instead of the time signal. Easily switched on or off.
- **Date memory.** Select "Trinkled" or "Wedding March" to be played instead of hourly chimes on the set day. Press the calendar button for additional renditions.
- **Birth day memory.** "Happy Birthday" is played instead of hourly chimes, or when the calendar button is pushed. The message "Happy" is also displayed.
- **Christmas memory.** On December 25th "Jingle Bells" is played instead of the hourly chimes, or when the calendar function is selected.
- **Countdown alarm.** From 1 second to 1 hour. At zero a chime sounds for 10 seconds and the count continues positively for 1 hour.
- **Stopwatch.** Net, lap and 1st & 2nd place times from 1/10 second to 1 hour. A signal confirms start/stop operation. A signal sounds at 1 minute intervals.

Picturesque moving display of every note played. One touch melody demonstration. Built-in speaker. Backlight. 2 year battery. Mineral glass. Water resistant case.
M-12 Resin case and strap, S/S trim. **M-1200** All stainless steel. 9.0mm thick case.



M12
 (£26.95)
£24.95



M1200
 (£34.95)
£29.95



W100
£19.95

W150C
£25.95
100 METRE WATER RESISTANT

W150B
£32.50

Get in the swim with Casio — 300 feet down!
100 METRE WATER-RESISTANT ALARM CHRONOS with countdown.

- **Amazing FIVE YEAR battery life.** Around 30 functions.
- **Timekeeping mode.** Continuous display of hours, minutes, seconds, am/pm, day date and month. 12 or 24 hour mode. Time is always visible, regardless of the display modes. Auto 4 year calendar set at 28 days for February.
- **Professional stopwatch.** Net, lap and 1st & 2nd place times from 1/100 second to 1 hour. A signal confirms start/stop operation, and sounds at 10 minute intervals.
- **Daily reminder alarm.** Sounds for 30 seconds at the pre-set time. "Alarm on" symbol.
- **Time signal.** Sounds every half hour on the half hour, and every hour on the hour. (Two tones). The time signal, with symbol, can be switched on or off.
- **Lithium battery.** Approx. 5 years life, using alarm for 100 seconds and nightlight for 3 seconds per day. \pm 15 seconds per month accuracy. Mineral glass.
- **100 METRE WATER RESISTANT CASES.** **W-100** Resin case 9.65, thick, resin strap. **W-150C** Metal case, resin strap. **W-150B** Metal case and S/S bracelet.

See also A250 on opposite page

Price includes VAT and P&P. Send your company order, cheque, P.O. or phone your ACCESS or BARCLAY-CARD number to:

TEMPUS

Dept. HE, FREEPOST, 164-167 East Road, Cambridge CB1 1DB. Tel: 0223 312866

JOIN THE KEYBOARD REVOLUTION!

WITH THE AMAZING NEW CASIOTONE 201

The natural fidelity of 29 instruments, preserved on one keyboard. Not an organ or synthesizer. The Casiotone 201 is a remarkable new concept in electronic keyboard instruments, using a totally new technology to reproduce an astonishing variety of musical sounds.



Pitch, timbre and harmonics of 29 instruments have been measured, digitalised and stored in electronic chip memory for faithful reproduction. A 4-sound memory function allows you to change between any 4 pre-selected instruments at a touch. In all modes this professional multi-instrument is polyphonic — it can play full chords of up to 8 notes together. The 29 white and 20 black keys span four octaves. The simple-to-use control panel has a 4-position Instrument Memory selector, Vibrato switch, Tone switch, and Volume control. Integral speaker. LINE OUT, AUX IN, ECHO TO and ECHO FROM Jacks. FOOT VOLUME pedal and SUSTAIN pedal options. Velvet black or Woodgrain. Dimensions: 3x33 1/2 x 9 1/2 inches. Weight: 15lbs. AC only.



CASIOTONE M-10. Four instruments on the move!
An instrument of the new age, encompassing the finest of the old. 8-note polyphonic playing of piano, organ, violin and flute. 32 keys, 19 white and 13 black, span two and a half octaves. Instrument selector switch. Vibrato switch. Volume control. Integral speaker. Output jack for external amplifier, headphones etc. Mains/battery capability. 2x16 1/2 x 5 1/2 inches. 3.5 lb.

RRP £79. ALL THIS FOR **ONLY £69**

Now Casio means digital music!

ONLY £245 (RRP £285)

Wait till you get your hands on it!

The future of music, for home or stage. As used by the internationally famous DOOLEYS

SEIKO

DUO DISPLAY

Independent analogue display of hours and minutes, with sweep second hand. Digital display of hours, minutes, seconds, am/pm (12 or 24 hour format). Day and date auto 4 year calendar function. 24 hour alarm with "alarm on" symbol and hourly chimes. 1/100 second stopwatch to 1 hour, normal and net. 2 year battery with battery life Indicator. Stainless steel. Water resistant. Hardlex glass.

JET 010 (illustrated)
Equivalent to HV013



ONLY £62.50

JET 018 (Equivalent to HV011)
JET 028 (Equivalent to HV005)
JET 994 Gold plated, champagne dial
JES 994 (Equivalent to HX008)

£62.50
£62.50
£92.50
£67.50

DFT 048

ALARM CHRONOGRAPH
Countdown timer.

Hours, minutes, seconds, alpha day and date. 24 hour alarm and hourly time signal. Stopwatch times in units of 1/100 second to 12 hours, net, lap and 1st & 2nd place. Countdown alarm timer up to 1 hour. Backlight. Stainless steel. Hardlex glass. Water resistant.

ONLY £37.50



DFT 038

100 METRE
Water resistant

Suitable for swimming, water skiing etc.

Functions as DFT 048 above.

£49.95



DER 048

ALARM CHRONOGRAPH

Solar powered
Weekly alarm
Countdown alarm

Hours, minutes, seconds, day, date and month. Weekly programmable alarm. Hourly chimes. Interval countdown alarm timer from maximum of 16 hours. Stopwatch times in 1/100 up to 20 minutes, then in seconds to 12 hours. Net lap, 1st & 2nd place timing. Double display function. Stainless steel. Hardlex glass. Water resistant.

ONLY £52.50

DER 018

100 METRE
Water resistant

Suitable for swimming, water skiing etc.

Functions as DER 048 above.

£69.95

All Seiko watches have an international 12-month guarantee.

WATCH THIS SPACEWAR

The bored room calculator CASIO MG-880

An ordinary calculator?? Absolutely enthralling. Action-packed speed game. You against the spaceships. Beat the highest score! 11-note melody maker, pre-programmed "When the Saints Go Marching In", "Mars, the Bringer of War". Instrument selector switch. Vibrato switch. Volume control. Integral Full memory, %, auto-power off. 1/2 x 2 1/4 x 4 1/2 inches.

(£12.95) **£10.95**



12 Pre-programmed melodies MELODY 90 (ML-90)



Clock, calendar, stopwatch, calculator, 11-note melody maker, %, square roots. Alarm 1: 7 tunes, one for each day. Alarm 2: A fixed tune. Date Memory, four anniversary tunes. Kiss touch keys. 1 year battery life. 7/32 x 2 1/2 x 4 1/2 inches.

(£22.95) **£19.95**

MELODY 81 (ML-81) RRP £22.95 **£19.95**

Clock, calendar, 2 melody alarms, countdown alarm, stopwatch, 11-note melody maker, calculator, %, square roots. 5/16 x 4 1/2 x 2 1/4". 14 months batteries.

All other Casio Calculators. P.O.A.

A250 Alarm chronograph

The same module as W-100 and W-150 watches but in a standard water resistant case. RRP £T.B.A.

ONLY £T.B.A.

S220 Chronograph

Very similar to A250 but with dual time facility in lieu of alarms and chimes. Countdown timer with repeat function. 7 YEAR BATTERY

ONLY £25



A250

F-300 Sports chronograph

Hours, minutes, seconds, am/pm, day and date, 4 year calendar (28 days for Feb.) Stopwatch measures in 1/100 second to 12 hours; net, lap, and 1st & 2nd place times. 2 year lithium battery. Resin case/straps. S/S trim. Mineral glass. Water res.

(£14.95) **£12.95**

110QS-37B

As F-300 but chrome plated case. S/S bracelet.

(£19.95) **£17.95**



F-80E Alarm chronograph

Hours, minutes, seconds, date, am/pm; or hours, minutes, alpha day, date, am/pm. 24 hour alarm, hourly chimes. Stopwatch from 1/10 second to 12 hours, net, lap and 1st & 2nd place. Nightlight. Resin case/strap. Mineral glass. Water resistant. 3 YEAR BATTERY.

(£17.95) **£15.95**

830S-41B

As F-80 but stainless steel encased. S/S bracelet.

(£22.95) **£19.95**

ALL OTHER CASIO WATCHES

Prices on application



CASIO LADIES WATCHES

Hours, minutes, 10-seconds, seconds (by flash) am/pm. Day, date month calendar. Stopwatch. Dual time.



87QL-13B
Chrome

£16.95



L-20
Chrome

£14.95



87QL-188

£27.95



L-10
Sports

£10.95



LA550
Alarm

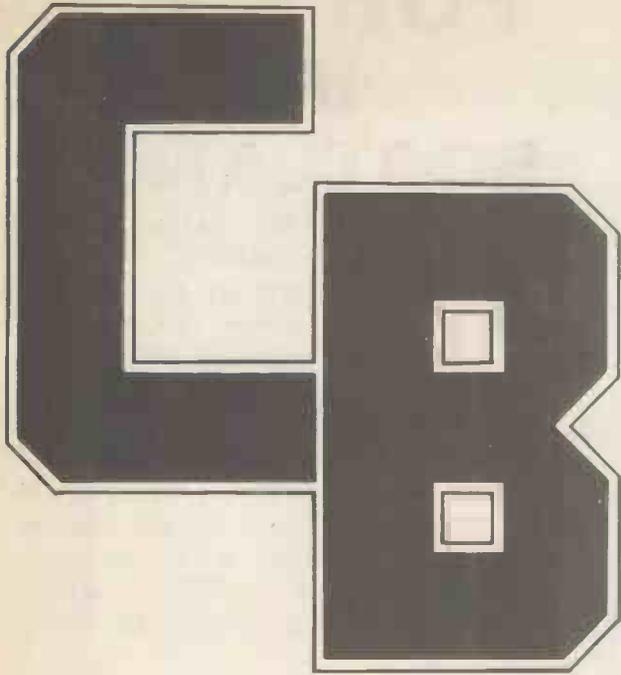
£P.O.A.



87QL-19B
Stainless Steel

£29.95

See opposite page for ordering details



Breaker One Four

Send any news, comments or information you have to:
Breaker One Four, Hobby Electronics, 145 Charing Cross
Road, London WC2H 0EE

There's not much happening on the legalisation scene this month but elsewhere CB accessory shops are opening almost daily. Rick Maybury has details

THIS HAS BEEN one of the quietest months for a long time. Although our spies tell us that 27 megs is busier than ever (all 40 channels full some nights!) the campaign has slowed down to a crawl. We contacted the Home Office to see how the Green Paper was faring. The gentleman we spoke to didn't want to commit himself to actual numbers but he did say that if he saw another letter about CB in the next ten years it would be too soon. By all accounts the HO are being inundated with responses, keep it up, we're sure they're getting the idea.

Usually we get to hear of a fair number of 'busts' during the month and even these seem to have tailed off: are the PO and HO giving it a rest?

The media are finally realising that CB is here to stay, and this is amply demonstrated by the sudden proliferation of CB magazines on the bookstalls. Everyone seems to be getting on the band wagon (pun intended). We welcome all these new magazines (with one doubtful exception), they are all doing a splendid job.

The accessory scene is also livening up, two new shops in the London area having been opened within a week or so of each other. The first is A Aerials in St James Street, Walthamstow. We hope to be getting down there in the next few weeks — look out for a report next month. The biggest shop to open for a long time was undoubtedly the Citizens Band Radio Centre in Harrow, and we were invited down to the opening — more about that later.

Cheap Rigs

We had two surprises this month in the shape of catalogues from companies advertising actual, genuine CB rigs for 27 MHz. In all fairness both companies stressed that these devices were not available in the UK but both openly admit that they do sell their wares over the counter in the Irish

Republic. The first company is called BIS Electronics. They quote a price of just £28 for the Sharp 2460 basic 40 channel rig in lots of 20. This is a trade price so add about 33% for the retail price. The second company is none other than Tandy, who have included about half a dozen rigs in their new catalogue. There are no prices for the rigs but again they are freely available in the Irish Republic. The catalogue does, however, give prices on Tandy's very creditable range of accessories including antennas, mikes and connectors etc.

The whole point of this is to show you just how much the equipment really does cost. A year ago we told you how our roving reporter was offered standard 40 channel rigs, brand new in their boxes, for just £3.00 each. Admittedly this was in the States but you get the idea. If the Government goes ahead with Open Channel on 928 MHz and limits the number of licences to just 150,000 in the first year, then no manufacturer will be able to make the gear for less than £200.00. If, say, half a dozen companies manufacture the rigs, then with a production run of just 25,000 each they cannot hope to bring the price down to a realistic level. After all, that number is barely more than a pre-production prototype run. Some Japanese companies can make that number of radios in a weekend: they couldn't justify the expense of setting up production lines for such a limited market. Oh well, back to more pleasant matters.

Midlands Radio Fair And Mass Eyeball

A group of businessmen in the Nottingham and Derby area are organising an event called the 'Midlands Radio Fair & Mass Eyeball'. This will be held on Sunday 9th November. The organisers tell us that it will be run along the lines of an Antique fair with trade stands, a bar (that sounds interesting!) and

SRU AUTOS



Citizen Band, Antennas and Accessories
for Marine, RV, Truck, Auto, Van
Motorcycles . . . Mobile and Indoor /
Outdoor Base Applications

10-4 Good Buddies



K40



Shakespeare

*Come to us for your
Car Spares — Accessories
Customizing Equipment*

**229 CHERTSEY ROAD
ADDLESTONE, SURREY**

**TEL.
CHERTSEY (STD 09328) 62556**

UNTIL C.B. IS LEGALISED WE
DO NOT SUPPLY RIGS

FOR C.B. IN SCOTLAND

*No one bigger!
No one cheaper!*

No false claims
(unlike certain
competitors!)
about our range of
stock and our
prices.

eg	Mag Mount (base loaded)	£9.95
	Monacor CB Converter	£10.95
	Hy-gain Twin Truckers	£19.95

We also stock, at discount prices, Shakes-
peare Rebel, Firestick, K40, Antenna
Specialist Range, Turner, DV27, DX27,
T27, B27, cable, plugs, Starduster, aerial
tuners, etc, etc, etc.

**VICTOR MORRIS LTD.
340 Argyle Street, Glasgow
041-221 8958**

All Post Free

"Simply ears ahead"

Bears take note
—no rigs

"SKYWAVE" FOR

COMMUNICATION ANTENNAS BY H.M.P.

**'Firestik'
ANTENNAS**

Shakespeare

**ALSO:
C.B.-V.H.F. AMATEUR AND
TEST GEAR ACCESSORIES
COMPONENTS AND SURPLUS**

**Telephone: Bournemouth 302080
73 Curzon Road, Boscombe
Bournemouth**

CALLERS WELCOME



catering facilities. The Nottingham/Derby area is one of the most active in terms of CB interest so the organisers expect a good turn out. You may even see the odd refugee from HE wandering about (probably near the bar) so why not pop along and see what's happening.

The venue will be the Festival Inn in Trowell Nottinghamshire. This is situated on the main Ilkeston-Nottingham road, (A609) about 6 miles from Nottingham, approximately 4 miles from Junction 25 on the M1 motorway. The Fair opens at 10am and will stay open till 5pm. If you want any more information then you can contact the organisers at:

TVC Ltd., Station Road, Long Eaton, Nottingham (Phone Long Eaton 62247).

CB Handbook and National Directory of Handles

This is what you've all been waiting for. The Hobby Electronics CB HANDBOOK AND NATIONAL DIRECTORY OF HANDLES is finally ready. After months of computerised compilation we have collated together thousands and thousands of registered handles into alphabetical and geographical categories. Each handle has been assigned a unique identification code consisting of numbers and letters so there shouldn't be any confusion in future over who was first. Included in the handbook section are features on CB law, all of the currently-used codes, addresses of all the local and national CB clubs and details of the National CB organisations. Most important of all is the registration form, enabling you to register your handle in the next edition which will be appearing in the next few months. Remember, registration is absolutely free: all you have to do is to get hold of a copy of the CB HANDBOOK AND NATIONAL DIRECTORY OF HANDLES. This special publication is available only from us, it will cost just £1.00 including post and packing or, if you can get along to the HE offices, only 85p. We will of course be happy to quote a discount for bulk orders. Get your copy early to avoid disappointment. Please allow 21 days for postal delivery.

Club Call

There can't be many areas without some form of CB club now but we're still getting news of new clubs. As always we're willing to give your club a mention if you just jot down a few details. Don't forget the address and a word or two about your membership and meeting place. Here is this month's selection.

Clog Town Breakers Club

Secretary: CBC
C/O Astley Bridge,
Bolton BL1 6PY
(Phone 0204 50046)

East Antrim CB Club

PO Box 4
Antrim
Northern Ireland

Grampian Breakers Club

Secretary: R.T. Strachan
59 Jasmine Terrace,
Aberdeen,
Scotland

Please note:

Open Channel CB Club.

F.W. McKeown is no longer the Chairman of the above club. The new Chairman is Mr S.J. Battersby. All correspondence should now be addressed to: The Secretary, OCCBC, 17 Coronation Street, Blackburn BB1 1BS.

Harrow has Jaws

As proof of the ever-increasing interest in CB, yet another accessory shop has been opened — Citizens' Band Radio Centre — at 331/7 Kenton Road, Harrow, Middlesex. It is a family business, run by David, Anita and Irving Jacobs.

David Jacobs spoke about some of the products: most interesting was the Jaws 2 transceiver. This is supplied in kit form (assembled PCB, case, knobs, brackets, screws, etc.). When assembled, it operates only as a receiver thus, it was claimed, meeting the requirements of the law. A full set of components, however, are available for this rig and it costs around £70. Prospective buyers are warned by staff of the legal position concerning CB.

According to David, sixty different types of aerial are on offer, including Avanti, PAL-Firestik and Shakespear. The linear amplifier range covers 25 W to 1kW. Most popular of these amps seemed to be the Lazer 1000 (switchable for 25, 50, 75 and 100W). Mikes included the popular K40, and Dacron and Alinca were among power supplies on show. It is planned to have a monitor receiver, model 733C, available 'before Christmas'. This will cover AM, FM (56 to 108 MHz) and CB (26.965 to 27.405 MHz) and is likely to cost around £15.



Stocked for service — view inside Citizens' Band Radio Centre during the press reception.



Bold display of CITIZENS' BAND is counterpoised with OPEN CHANNEL outside the shop.

Big Ears Telecommunication Ltd.

68 NARBOROUGH ROAD, LEICESTER
TELEPHONE 0533 546031



BIG EARS CB

IF YOU WANT IT WE'VE GOT IT

THE BIGGEST SELECTION IN THE COUNTRY

A.C.H. ACCESSORIES

Station Road
Cheadle Hulme
Manchester
061-485 3356

BOLTON GOODIES

Abinger Street
Burnley
Lancs.
0282 26250

COUNTRY COMFORT

40 Keys Hill
Atherstone
082-77-5998

EAST COAST SPEED & CUSTOM

Aylesham Road
Norwich
0603-401921

FURNESS ELECTRONICS

Barrow-in-Furness
Cumbria 261-69

GEAR CHANGE

398 Bath Road
Slough
061-86666

HOWLEY RACING

Winwick Road
Warrington
0925-51793

KEN'S CUSTOM CAR CENTRE

Fawcett Road
Southsea
0705-831238

SKYWAVE

Curzon Road
Boscombe
Bournemouth

PITSTOP

9 Carlton Parade
Orpington
Kent
01-622-4035

THE VAN SHOP

Roman Road
London
01-980-3534

WEEKEND D.I.Y.

Thorn Road
Stalnforth
Doncaster
0302-841001

WHEEL & CUSTOM

143 Rochdale Road
Bury
061-764-0554

WHEELS OF DOVER

Snaresgate Street
Dover
0304-207043

WHEELSPIN

15 Staines Road West
Sunbury-on-Thames
Middlesex
Sunbury 83346

The first major British CB enterprise

WE HAVE AN EXTENSIVE
RANGE OF CB ACCESSORIES
IN STOCK - ALL LEADING
MAKES INCLUDING:

ELECTRIC CB/AM/FM ANTENNAS, high quality,
complete with splitter: from **£29.84** inc. VAT

DC POWER SUPPLIES, various professional
brands, rated 3 amp to 30 amp. All fully
stabilised with overload
protection: from **£28.69** inc. VAT

FIRESTIK antennas by 'PAL'. All
models, colours, sizes etc: from **£9.14** inc. VAT

THE FAMOUS 'LAZER 1000' bi-lateral amplifier.
Four stages of power - up to
100 watts output! **£148.93** inc. VAT

ANTENNA SPECIALISTS MS 264 disguise
antenna - possibly the most popular CB antenna in the U.K. **£25.01** inc. VAT

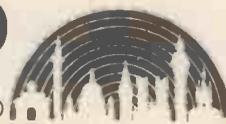
All the above are retail prices and subject to availability.

We wish to appoint a limited number of agents throughout
the U.K. - contact Marketing Dept.

For price list please send
8" x 5" sae envelope.

CITIZENS' BAND Radio Centre Ltd.

337 Kenton Road, Harrow, Middlesex. Tel: 01-907 1106/7.



We welcome trade enquiries.

It is at present an offence under the Wireless
Telegraphy Acts 1949 to 1967 to manufacture
and/or use Citizens' Band radio transceivers and
such equipment is not licensable for use in the U.K.



CB VIPS

Mura

Three for the price of one this month — our roving reporter has been to Mura Ltd where Elliot Kahan, David Gross and Ged Crow are running one of the most successful CB accessory shops in the country.

Mura started some two years ago, after Elliot and Ged had returned from a visit to the States. Naturally the lack of CB in this country inspired them to do something about it, they actually started operations with just three antennas! They adopted the name Mura from an American company of the same name, Mura Corporation, one of the largest manufacturers of CB accessories in the USA. Just after Christmas this year they opened their now famous shop in Church Road, Hendon. It didn't take long for them to build up a respectable retail business, mostly by word of mouth, customers now come from all over the country. Much of their business now originates from the nationwide chain of dealerships and few areas are without a Mura stockist. Indeed, whilst we were in the shop one gentleman was busily buying stock for a shop that he was about to open in North London. Some £2,000 changed hands in just under ten minutes. Although Elliot wouldn't be too specific, it would seem that they are enjoying a turnover in excess of this country's current balance of payment. CB must be one of the most successful growth industries in these troubled times.

If you can cast your minds back a couple of months you'll remember our first visit to Mura. At that time they were heavily into antennas (base station aerials a speciality). That is still very apparent, although they can now offer a very comprehensive range of mikes, SWR and test meters, mounting hardware and a rather interesting CB monitor. This particular model is one of the best we've seen: it even has a squelch and noise limiter control. At £14.95 it has got to be one of the best in terms of value for money, the only problem being that they

A number of CB magazines were on sale. David said that amateur radio (RSGB) publications had been selling faster than those on CB. In his view, CB was often the first step for some into ham radio, and said: "One in 10 are showing an interest in moving in that direction."

The question of the sale of high-power linear amplifiers (burners) was raised. In David's view, those who bought these had serious intentions of working long distances and would be already using a beam antenna (especially radio hams on 10 metres). CBers, he felt, preferred to stick to a high-efficiency aerial rather than use a burner. They realised, he said, that using a high-quality aerial was better than putting '1kW into a coat hanger'.

He saw Open Channel as: 'a means of stalling on behalf of the Government and Government bodies'.

He also said that experiments into the use of aerials for 928 MHz (the proposed OC frequency) were being undertaken by one of the Centre's overseas suppliers.

Irving Jacobs had grave doubts about 928 MHz, and saw little hope for British rig manufacturers if this became the accepted band. We would have, he said, 'the best of the boot' if 27 MHz was legalised, reaping the benefits of US experience on this waveband.

An associate company — Open channel radio GB Ltd. — has been formed to invest in rig manufacturers — once the proposed OC network comes into being.



From left to right: Ged Crow (seated) David Gross and Elliot Kahan.

only have a limited number of them so you'll have to hurry.

Getting back to the business, they have recently opened a small but worthwhile operation in Tottenham Court Road. That looks set to expand shortly, and Mura are currently thinking about opening another shop very soon.

We asked the lads what they thought about Open Channel. We needn't have bothered as they felt pretty much the same as everyone else. Though perhaps more shrewdly than most, they have already had some sample antennas for 928MHz. All they need now is some equipment to connect them too. As they pointed out at the time, that is one line that won't be selling too well for a long, long time.

Teach Yourself CB

We received a cassette tape the other day from a company called Bridair Audio Promotions Ltd. These enterprising people have produced the very first guide to British CB with their tape called 'Teach Yourself CB'. After slapping it in the HE cassette player we must admit that it sounded rather odd at first. After all, American CB slang explained by someone with a BBC newscaster's accent does sound awkward, to say the least. Actually it did grow on us and after hearing it a couple of times we've got to say that we're impressed. It has been professionally produced and although the commentary is slightly shorter than we would have liked there is a good selection of Country & Western music (all CB songs) to listen to. All in all a good introduction to British CB, there are lots of helpful hints and tips and it should get a lot of people get acquainted with two-way radio. We will be offering this tape as a special offer in our forthcoming CB publications. If you just can't wait then you can contact Bridair at:

Basement Studios, 158 New Bridge Street, Newcastle on Tyne, NE1 2TE.

Each 40-minute cassette costs £2.99 plus post and packing from the above address.

Times up again for another month. Stay lucky and see you in four weeks.

HE

CB RADIO ACCESSORIES

The Largest distributors of CB accessories in the UK.

Come and see the biggest and best selection of CB radio accessories including:-



MURA CBT 25
SWR/P/AIM



EXPANDER
500



K40
SPEECH
PROCESSOR

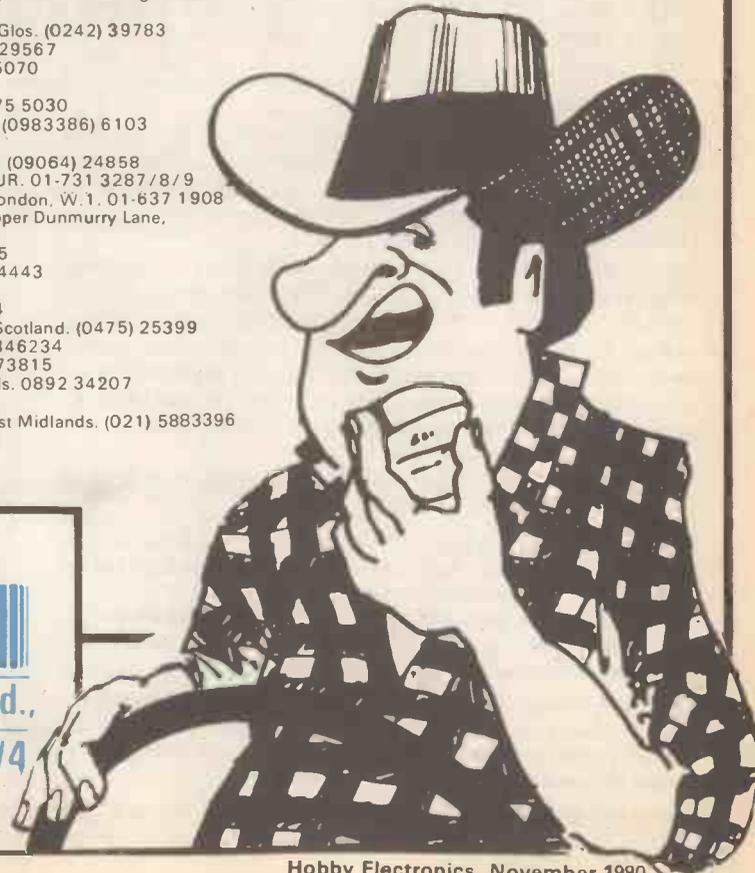


CB MONITOR

A LARGE SELECTION
OF ALL ACCESSORIES
ALWAYS IN STOCK

AGENTS THROUGHOUT THE UK

- ABERDEEN: Cheyne Electronics, Crossfields, Turiff, Aberdeenshire. (08885) 254
- BLACKPOOL: ADS Electronics, The Ladder Centre, 239 Dickson Road, Northshore, Blackpool.
- BURY, LANCS: B & H Electronics, 183 The Rock, Bury, Lancs. 061-761 6144
- BURY ST. EDMUNDS: Denver Autos (Skid Parish), Troston, Bury St. Edmunds, Suffolk. Honnington 506.
- CARLISLE: R & S Supplies, 29 Lamb Street, Upperby, Carlisle. Carlisle 38172
- CHELTHENHAM: Breakers Yard, 1 Moorend Terrace, Croft Street, Cheltenham, Glos. (0242) 39783
- COVENTRY: CB Specialists Coventry, 79 Far Gosforth Street, Coventry. 0203 29567
- EAST BARNET: Autospar, 271 East Barnet Road, East Barnet, Herts. 01-449 5070
- EDINBURGH: Custom Equipe, 131 Fountain Bridge, Edinburgh.
- GREENFORD: Sound Around, 114 Ruislip Road, Greenford, Middlesex. 01-575 5030
- ISLE OF WIGHT: Electronic Pastimes, 29 North Road, Shanklin, Isle of Wight. (0983386) 6103
- LEEDS: Hi-Fi Servicing, 26 Moreland Grove, Leeds 17. (0532) 686960
- LITTLEHAMPTON: Golden No's, 6 Bayford Road, Littlehampton, West Sussex. (09064) 24858
- LONDON (Fulham): Chelsea CB Centre, 73-77 Britannia Road, London SW6 2JR. 01-731 3287/8/9
- LONDON (West End): Sonic Sound Audio, 248-256 Tottenham Court Road, London. W.1. 01-637 1908
- N. IRELAND: George Ball Discount Sales, Unit 16, Kilwee Industrial Estate, Upper Dunmurry Lane, Dunmurry, Belfast. 0232 619725
- N. IRELAND: J. C. Patterson, The Corner House, Lisburn, N.1. 08462 2034/5
- N. IRELAND: McNaulty & Sons, Belmore St., Enniskellen, N. Ireland. (0365) 4443
- ORPINGTON: CB Shack, 16 Mount View Road, Orpington, Kent. (66) 32411
- SCOTLAND: Cheyne Electrical, Crossfields, Turriff, Aberdeenshire. 08885 254
- SCOTLAND (Greenock): Motor Accessory Centre, 1 Regent Street, Greenock, Scotland. (0475) 25399
- SHEFFIED: Steel City Custom, 132 Pennstone Road North, Sheffield. (0742) 346234
- STOKE-ON-TRENT: HSBC, 27 Hope Street, Hanley, Stoke-on-Trent. (0782) 273815
- TUNBRIDGE WELLS: Charlie Bravo, 103 Camden Road, Royal Tunbridge Wells. 0892 34207
- WATFORD: Component Centre, 7 Langley Road, Watford, Herts. (92) 45335
- WEST BROMWICH: GTTS Electronics, 63 Andrew Road, West Bromwich, West Midlands. (021) 5883396
- WIGAN: Car Radio, 8 Darlington Street, Wigan, Lancs. (0942) 43101
- WORCESTER: DAD, 23 Blackfriars Square, Worcester. (0905) 21919



Mura 
Mura Electronics (UK) Ltd.,

79 Church Road, Hendon, London NW4
Tel: 01 203 5277/8

★ POWERFET AMPLIFIERS ★

Conservatively rated, high quality designs with substantial heatsink/mounting bracket.

CA3080E	70p
CA3140E	45p
MC3401	30p
TL081	29p
TL082	55p
2102	80p
2114	340p
4001B	17p
4011B	17p
4013B	40p
4016B	40p
555	25p
709	15p
710	25p
733	50p
741	18p
78L05	29p
78L12	29p

Mains Toroidal transformer, 4.5v-0.45v, 300va £15.00 (£2 P&P)

POWERFETS

BD512 (60v, 1½A, Pchan.)	85p
BD522 (60v, 1½A, Nchan.)	80p
VN67AF (60v, 2A, Nchan.)	75p
2S149 (140v, 100w, Pchan.)	340p
2SK134 (140v, 100w, Nchan.)	340p

HI-FI ON TWO CHIPS

HA12017 (Preamp 0.001% distortion 83dB S/N in phono application)	99p
HA1397 (Poweramp 20 watts in 8Ω 0.02% distortion (typ) 1975p)	
Both with data and circuits	

PFA 80
80w into 8Ω
THD < 0.008%
S/N 120dB.
Kit £11.95.
Built £13.95.

PFA 120
120w into 8Ω
THD < 0.005%
S/N 120dB.
Kit £19.85.
Built £21.85.

SCOPE TRACE DOUBLER P.C.B.

Built CW shift, chan. select, chopper controls and instructions, useful display from DC to 10MHz. Runs from 9V battery £9.95

CAR AMP I.C. HA1388 Bridge amp delivers 18w 195p.
Heatsink for above 40p.

VCA High quality design offers attenuation from 0dB to 90dB. S/N 90dB. THD 0.01%. B.W. DC to 100KHz. Complete components set and circuit £2.50

J. W. RIMMER

Technical enquiries to 367 Green Lanes, London N4 1DY. Tel 01-800 6667

P&P 30p. Mail orders to 148 Quarry Street, Liverpool L25 6HD. Tel 051 428 2651.

Beasties



● C.B. AERIAL ● EVERYTHING BUT RIGS ● PLUGS ● SWR METERS ●

MOBILE ANTENNAE



MOBILE STEREO

Dept. HE, 360 York Road, London, SW18
Telephone 01-870 7362

Free fitting on all units purchased from us

● BASE ANTENNAE ● RAIN CAPS ● MICROPHONES ● CB SUPPRESSORS ●

WE ARE SOUTH LONDON'S IN CAR ENTERTAINMENT SPECIALISTS.

WHATEVER YOUR AUDIO PROBLEMS ARE, COME TO US AND WE'LL CURE THEM.

★ Come and have a cup of coffee while we fit your stereo

★ Wide range of fitting kits and aerials ★

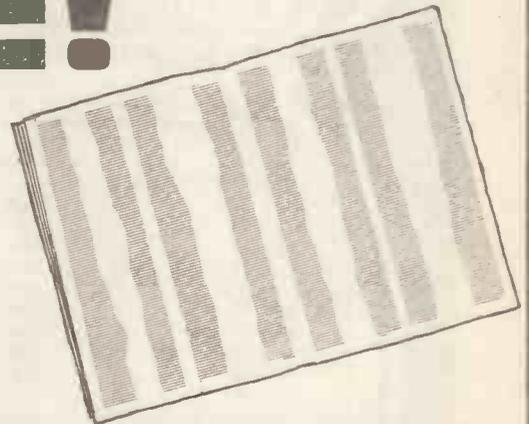
BOOST 20RF ● IMPEDANCE MATCHER

IT'S HERE!

CB HANDBOOK & NATIONAL DIRECTORY OF HANDLES

Yes, at last the great day has arrived. The Hobby Electronics CB HANDBOOK & NATIONAL DIRECTORY OF HANDLES is finally ready. Each Handbook contains literally thousands of registered Handles, each with a 'Rough 20' and a unique registration code. In the handbook section we have collated the most up to date CB Club listing, all of the major CB organisations and all of the most frequently used codes. We have even included a short article on the current law relating to CB. For those of you that missed the chance to register your handle in this edition, we have included a form for you to fill in so that your Handle can appear in the next edition. Hopefully it will be published in the next few months and remember, registration is absolutely FREE!

Each issue costs just 85 pence or £1.00 including post and packing from our usual address. Remember, The CB HANDBOOK is available only from us so order early to avoid disappointment.



Please supply..... Handbooks

I enclose a cheque/PO for £.....

Name _____

Address _____

Send this form, together with your cheque or Postal Order to:

Modmags (Sales Office)

CB Handbook

145 Charing Cross Road

London WC2H 0EE

HOBBYPRINTS

If you have never used HOBBYPRINTS before, then you don't know what you've been missing. HOBBYPRINTS are an etch-resistant rub-down transfer. Just place the appropriate HOBBY-PRINT over a clean piece of copper clad PCB material and rub. It's as simple as that. Once the design has been transferred, immerse the board into the Ferric Chloride. 15 minutes later you will be rewarded with a perfect PCB prepared from our original artwork, so you can have no worries about making a mistake. By the way, HOBBYPRINTS are ideal for making PCBs by Ultra-Violet exposure.

HOBBYPRINT SHEETS ARE AVAILABLE FOR ISSUES FROM NOV. 78 RIGHT UP TO THIS ONE. ALL SHEETS COST £1.20 ALL INCLUSIVE OF POST AND PACKING AND VAT. ORDER BY SHEET LETTER AND ISSUE MONTH (SEE BELOW).

ISSUE	SHEET REF.	ISSUE	SHEET REF.
Nov. 78	A	Sept. 79	K
Dec. 78	B	Oct. 79	L
Jan. 79	C	Nov. 79	M
Feb. 79	D	Dec. 79	N
Mar. 79	E	Jan. 80	P
Apr. 79	F	Feb. 80	P
May 79	G	Mar. 80	Q
Jun. 79	H	Apr. 80	R
Jul. 79	I	May 80	S
Aug. 79	J	Jun. 80	T

For your HOBBYPRINT refer to the chart above and send your cheque or postal order to:
HOBBYPRINTS,
Modmags Sales Office,
 Hobby Electronics,
 145 Charing Cross Road,
 London WC2H 0EE.

BARGAIN CORNER

Show us that you could have purchased for less within one month of your purchase and we will refund the difference!

CAR AUDIO

● **New 7 Channel Stereo Graphic Equaliser/Booster Amplifier.** 17 watts R.M.S. per channel frequency response 20Hz to 30,000Hz ± 12 D6 cut/boost on each channel, complete with fitting kit. You would pay £45 elsewhere. **For a limited period** we offer the unit for the incredible price of **£26 (+ £1.20 post).**

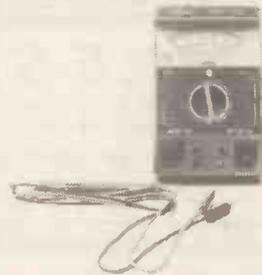
● **Suitable Speakers for above.** Adjustable angle, shelf-mounting, power handling 30 watts max. **£16 (+ £1.20 post).**



● **Model Stereo Cassette/Radio.** M.W., stereo FM and stereo cassette player, 8 watts per channel, fast forward and autostop, includes fitting kit and **FREE SPEAKERS.** Sold elsewhere for up to 185 (believe it or not). Our price **£45 + £1.50 post.** (For negative earth cars only).

MULTIMETERS

● **DT 1314 A** superb 38 range meter. Special features include 50KΩ/VDC movement, 10 amp DC Scale, resistance up to 100 MΩ, 2 ranges for testing batteries, long extraflex leads, batteries included. Usually sold for **£35.** **FOR LIMITED PERIOD £25 + 75p post.**



● **DT1004 20 KΩ/VDC** movement, 16 ranges and off position, mirror scale, protected movement, battery included. Usually sold for **£16,** our price **£12 + 50p post.**



METAL DETECTORS:

● **Induction Balance Model.** Highly sensitive model with speaker and meter, 7-inch search head and telescopic stem. Usually sold for **£39.95.** Our price **£24.50 + £1.20 post.**

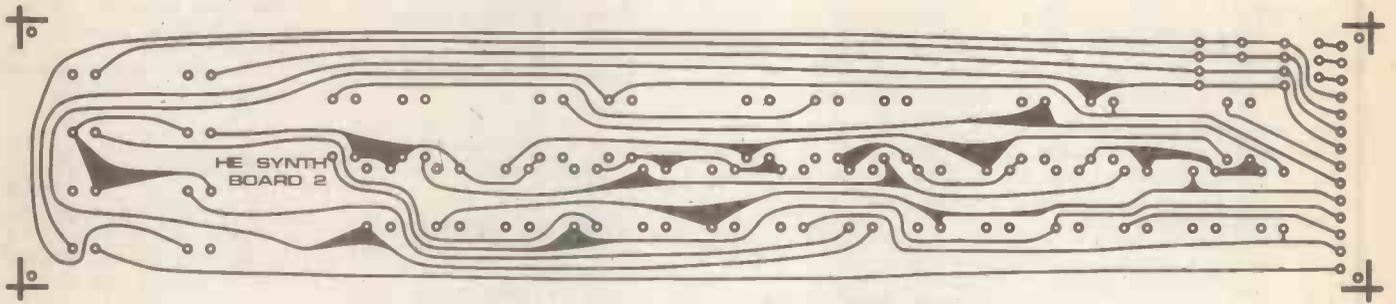
● **Yet another stock clearance bargain:** A remarkable little BFO detector which will detect a coin in 6-inches of soil. A perfect machine to see if you really have the patience to take the hobby up seriously. **£10 (+90 pence post).**

All goods guaranteed one year. 10 day money back offer on all undamaged goods. Goods ex-stock at time of going to press. Send S.A.E. for details.

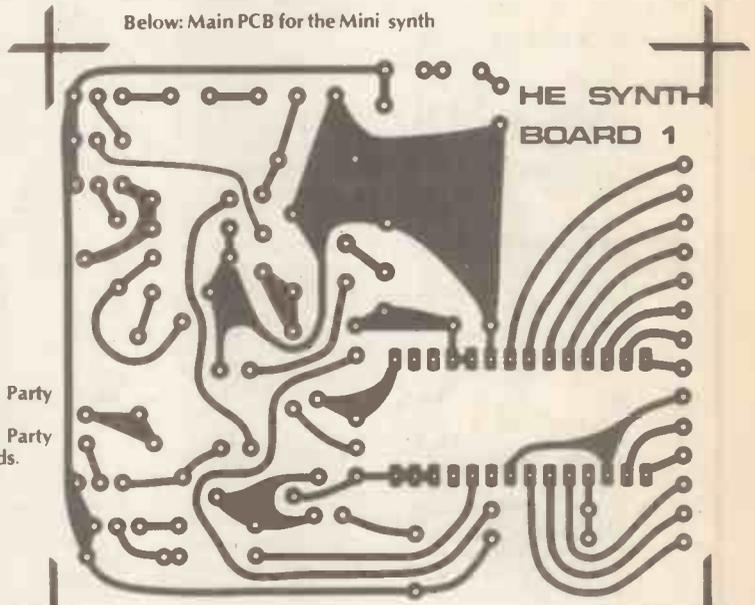
MINIKITS ELECTRONICS LTD

88H HAINAULT ROAD
 LEYTONSTONE
 LONDON E11 1EH

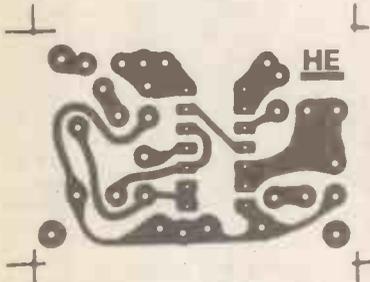
PCB Foil Patterns



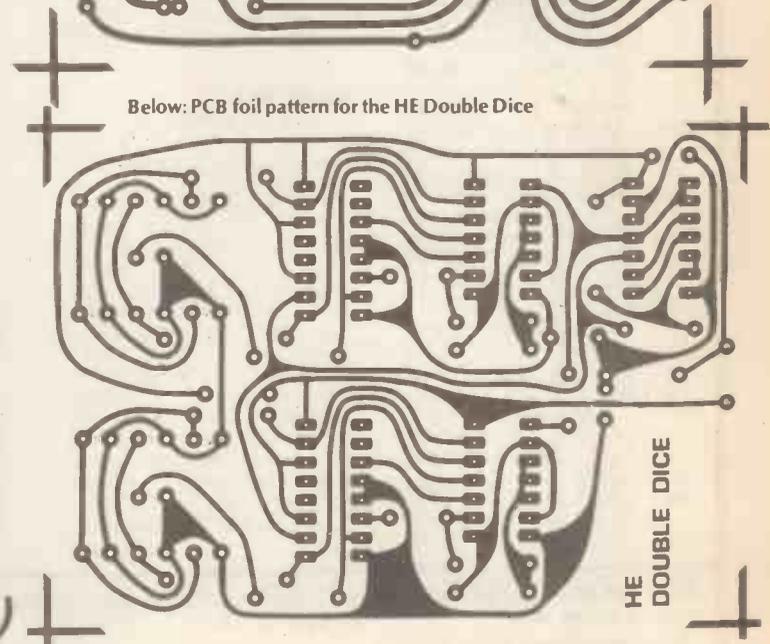
Mini synth keyboard (Note this is shown 60% full size)



Below: Main PCB for the Mini synth

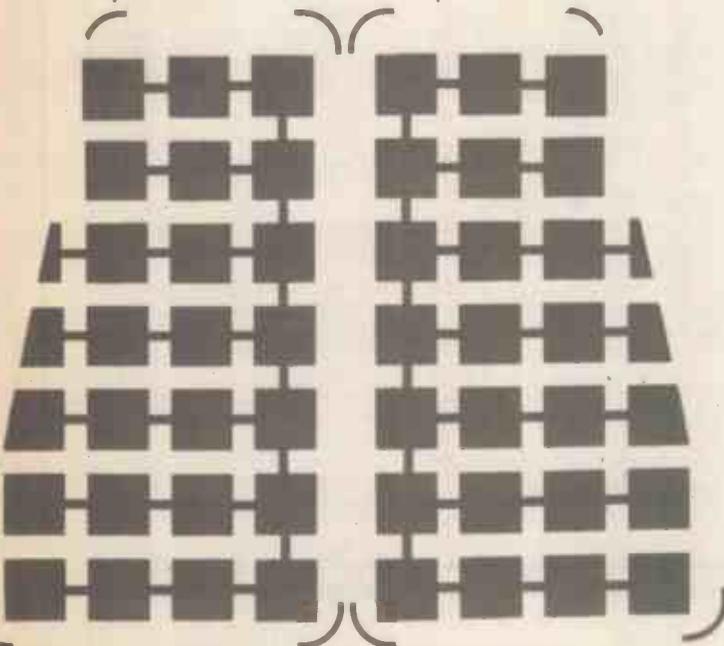


Left: PCB pattern for the Party Grenade.
Below: Foil pattern for the Party Grenade touch contact boards.



Below: PCB foil pattern for the HE Double Dice

HE
DOUBLE DICE



Books from the HE Book Service

28 Tested Transistor Project

Richard Torrens. The projects can be split down into simple building blocks which can be recombined for ideas of your own. **£1.55**

Electronic Projects for Beginners

F. G. Rayer. Divided into 'No Soldering Projects,' Radio and Audio Frequency, Power Supplies and Miscellaneous. **£1.65**

Practical Electronic Calculations and Formulae

F. A. Wilson. A valuable reference for the home and laboratory, containing all the most frequently used, and some of the less well-known, electronic formulae and calculations. **£2.55**

Popular Electronic Projects

R. A. Penfold. A collection of the most popular types of circuits and projects using modern, inexpensive and freely available components. **£1.75**

POPULAR ELECTRONICS BOOKS

Sinclair, I. R., Introducing Electronic Systems **£1.95**
 Sinclair, I. R., Introducing Amateur Electronics **£1.65**
 Sinclair, I. R., Electronic Fault Diagnosis **£3.55**
 Sinclair, I. R., Repairing Pocket Transistor Radios **£2.60**
 Sinclair, I. R., Oscilloscope In Use **£3.10**
 Sinclair, I. R., Understanding Electronic Components **£4.20**
 Sinclair, I. R., Understanding Electronic Circuits **£4.20**
 Kitchen, H. T., Handtools For Electronic Workshop **£2.95**
 Kitchen, H. T., Electronic Test Equipment **£5.20**
 Capel, V., How To Build Electronic Kits **£2.35**
 Darr, J., How to test almost everything electronic **£3.70**
 Brown, R. M., How to read electronic circuit diagrams **£5.60**

AUDIO

Earl, J., Audio Technicians Bench Manual **£3.70**
 Earl, J., Pickups and Loud Speakers **£3.70**
 Earl, J., Tuners and Amplifiers **£3.20**
 Earl, J., Cassette Tape Recorders **£5.40**
 Earl, J., ABC of Hi-Fi **£4.35**
 Capel, V., Microphones In Action **£3.15**

Digital IC Equivalents and Pin Connections

Adrian Michaels. Covers most popular types and gives details of packaging, families, functions, country of origin and manufacturer. **£2.85**

Radio Stations Guide

B. Babani and M. Jay. An invaluable aid to everyone with a radio receiver helping them to obtain maximum entertainment, value and enjoyment from their set. **£1.75**

IC 555 Project

E. A. Parr. Circuits are given for the car, model railways, alarms and noise makers. Also covers the related devices 556, 558 and 559. **£2.05**

Second Book of CMOS IC Projects

R. A. Penfold. Following in the success of the original CMOS projects book we present the second volume covering all aspects of CMOS technology from multivibrators to triggering devices. **£1.80**

Capel, V., Improving Your Hi-Fi **£3.65**

Capel, V., Creative Tape Recording **£4.20**

Hellyer, H. W., Tape Recorders **£4.45**

Sinclair, I. R., Audio Amplifiers For Home Construction **£2.85**

RADIO CONTROL

Drake, J., Radio Controlled Helicopter Models **£4.20**

Jeffries, C. R., Radio Control For Model Yachts **£3.85**

Safford, E. L., Radio Control Manual **£2.60**

COOKBOOKS

Tracton, K., BASIC Cookbook **£4.10**

Lancaster, D., TTL Cookbook **£7.00**

Lancaster, D., RTL Cookbook **£4.65**

Lancaster, D., CMOS Cookbook **£8.20**

Jong, W., IC Op Amp Cookbook **£10.00**

Lancaster, D., T.V. Typewriter Cookbook **£7.75**

Lancaster, D., Cheap Video Cookbook **£7.00**

Jong, W., IC Timer Cookbook **£7.50**

Lancaster, D., Incredible Secret Money Machine (a how to cook book for setting up your computer or technical business) **£4.95**

Electronic Security Devices

R. A. Penfold. Full of constructional circuits covering the most basic security systems to the Ultrasonic and Doppler Shift systems. **£1.75**

How To Build Your Own Solid State Oscilloscope

F. G. Rayer. The book contains concise practical instructions so that even an inexperienced hobbyist can construct a fairly sophisticated instrument with the minimum of difficulty and expense. **£1.80**

50 FET (Field Effect Transistor) Project

F. G. Rayer. Contains something of interest for every class of enthusiast. Short Wave Listener, Radio Amateur, Experimenter or audio devotee. **£1.55**

Linear IC Equivalents and Pin Connections

Adrian Michaels. Gives most essential data for popular devices. **£3.10**

QUESTIONS AND ANSWERS

SIMPLE AND CONCISE ANSWERS TO MANY QUESTIONS WHICH PUZZLE THE BEGINNER.

Coker, A. J., Q & A On Electric Motors **£1.90**

Hellyer, H., Q & A On Radios and T.V. **£1.90**

Hibberd, R., Q & A On Integrated Circuits **£1.90**

Jackson, K., Q & A On Electricity **£1.90**

Brown, C., Q & A On Hi-Fi **£1.90**

Brown, C., Q & A On Transistors **£1.90**

Brown, C., Q & A On Electronics **£1.90**

Reddihough, J., Q & A On Colour T.V. **£1.90**

Miller, H., Q & A On Electric Wiring **£1.90**

CONSTRUCTOR GUIDES

Graham, P., Simple Circuit Building **£2.70**

Colwell, M., Electronic Diagrams **£2.70**

Colwell, M., Electronic Components **£2.70**

Colwell, M., Printed Circuit Assembly **£2.70**

Ainslee, A., Practical Electronic Project Building **£2.70**

Colwell, M., Project Planning and Building **£2.70**

BEGINNER'S GUIDE

Sinclair, I. R., Beginner's Guide To Tape Recording **£3.45**

Essential Theory for the Electronics Hobbyist

G. T. Rubaroe gives the hobbyist a background knowledge tailored to meet his specific needs. **£1.55**

Beginners Guide to Building Electronic Projects

R. A. Penfold. Covers component identification, tools, soldering, constructional methods and examples of simple projects are given. **£1.55**

50 Projects using IC CA3130

R. A. Penfold. Describes audio projects, RF project, Test Equipment, Household and miscellaneous circuits. **£1.25**

50 Circuits Using 7400 Series ICs

R. N. Soar. The author has managed to compile no less than 50 interesting and useful circuits using this range of devices, covering many different aspects of electronics. **£1.65**

Sinclair, I. R., Beginner's Guide To Integrated Circuits **£3.45**

Sinclair, I. R., Beginner's Guide To Audio **£3.45**

King, G. J., Beginner's Guide To Radio **£3.45**

King, G. J., Beginner's Guide To Television **£3.45**

King, G. J., Beginner's Guide To Colour T.V. **£3.45**

Guilou, F., Beginner's Guide To Electric Wiring **£3.45**

PROJECT BOOKS

Marston, R.M., 110 Cosmos Digital IC Projects For The Home Constructor **£3.95**

Marston, R. M., 110 Wave Form Projects For The Home Constructor **£3.95**

Marston, R. M., 110 Op Amp Projects For The Home Constructor **£3.95**

Marston, R. M., 110 Semiconductor Projects For The Home Constructor **£3.95**

Marston, R. M., 110 Thyristor/SCR Projects For The Home Constructor **£3.95**

Marston, R. M., 110 Electronic Alarm Projects For The Home Constructor **£3.95**

Marston, R. M., 110 Integrated Circuits Projects For The Home Constructor **£3.95**

Marston, R. M., 20 Solid State Projects For The Car and Garage **£3.20**

Marston, R. M., 20 Solid State Projects For The Home **£3.20**

Note that all prices include postage and packing. Please make cheques, etc. payable to Hobby Electronics Book Service (in sterling only please) and send to:

Hobby Electronics Book Service
 Modmags Ltd
 145 Charing Cross Road
 London WC2H 0EE

* Prices may be subject to change without notice.

Multitesters 100,000 opv

AC volts:- 0 - 5 - 10 - 250 - 1000
 DC volts:- 0 - 0.5 - 25 - 10 - 50 - 250 - 1000
 DC current:- 0 - 10ua - 25ua - 500ua - 0 - 5 ma - 50 ma
 - 500 ma - 10 amp
 AC current:- 10 amp
 Resistance:- 0 - 20 ohms - 200 ohms - 5 K ohms - 200 K ohms - 50 K ohms - 200 K ohms - 5 meg ohms - 50 meg ohms

As a transistor tester
 HFE:- 0 - 5 (NPN) - (PNP)
 ICO:- 0 - 5 ua (NPN - PNP)
 Dims:- 178x 140 x 70 mm
 Please add 30p P.P. per unit order as MT 20

Multitester 1,000 opv

AC volts:- 0 - 5 - 150 - 500 - 1000
 DC volts:- 0 - 15 - 150 - 500 - 1000
 DC current:- 0 - 1 ma - 150 ma
 Resistance:- 0 - 25 K ohms - 100 K ohms
 Dims:- 90 x 61 x 30 mm
 Please add 30p P.P. per unit order as MT

Multitester 20,000 opv

AC volts:- 0 - 10 - 50 - 100 - 250 - 500 - 1000
 DC volts:- 0 - 0.5 - 5 - 25 - 125 - 250 - 500 - 1000
 DC current:- 0 - 50 ma - 0.5 ma - 250 ma
 Resistance:- 0 - 3 K ohms - 300 K ohms - 3 meg ohms
 Deibels:- - 20 to +63 db
 Dims:- 127 x 90 x 32 mm
 Please add 30p P.P. per unit order as MT 7

Headphones

High velocity mylar diaphragms. Coiled lead. Finished in a combination of bright aluminium.

Impedence:- 8 ohms
 Frequency response:- 15 - 22000 HZ
 Weight:- 350 gms

Please add 30p P.P. per unit order as PH 12

ARROW AUDIO CENTRE
 20 NORTH BAR BANBURY OXON OX16 0TF.
 TELEPHONE BANBURY (0295) 3677
 TERMS: CHEQUE/PO WITH ORDER. CALLERS WELCOME

ELECTRONICS

A NEW AND EXCITING HOBBY!!

BIG, WELL ILLUSTRATED BOOK
 Ideal for beginners - gives lots of general information - explains how to build lots of projects :
 Intercom, Rain Alarm, Radios, Organ, Parking Light etc. All parts supplied and can be re-used on special deck provided, so **NO SOLDERING** is required. Just needs 4½V battery.

£17.50 inc. VAT & Post
 Also
ADVENTURES WITH MICROELECTRONICS
 - Explore the world of silicon chips -
 All components & Deck, £27.95 inc VAT & Post.
 Component Catalogue & Bargain List 75p

GREENWELD
 443F Millbrook Road, Southampton SO1 0HX

AVOID DANGER from RADIATION WITH OUR RADIATION DETECTOR

General Information:

Pocket dosimeters provide an accurate, reliable and immediate method of measuring the integrated dose of radiation received by those exposed to ionising radiation. The dose may be read at any time and in any place, providing a source of light is available.

Principle:

The dosimeter is an ionisation chamber type using a quartz fibre electroscope as the indicating element. A microscope is used to project the image of the moving quartz fibre element on to a graticule scale. The quartz fibre is mounted on a wire electrode, which in turn is supported by a high quality insulator. When the instrument is charged, positive charges distribute themselves over the wire electrode and quartz fibre causing the fibre to bend away from the electrode. The fibre will take up a position depending on the amount of charge on the system.

When the surrounding air in the ionisation chamber is ionised negative ions will be attracted to the positively charged electrode thereby reducing its charge. The resulting fibre movement will be related directly to the quantity of radiation producing the ionisation. The fibre movement can thus be calibrated directly in roentgen units and the rate of movement of the fibre will be proportional to the roentgens received per unit time.

Construction:

The microscope, electroscope and ionisation chamber are housed in an outer skin which may be of brass or aluminium. At one end of the tubular case is fixed a charging assembly, and at the other an eye-piece window. These two assemblies are soldered into the outer case to ensure a hermetic seal.

Each dosimeter is provided with protective end cap translucent window so that the cap need not be removed for reading.

Dosimeters meet vibration, drop, salt spray, humidity, water immersion and temperature tests.

BE PREPARED, EVERY HOME SHOULD HAVE ONE

YOU CAN'T SEE IT HEAR IT FEEL IT BUT YOU CAN DETECT IT

Features:

- THESE UNITS WILL READ AUTOMATICALLY THE AMOUNT OF RADIATION IN THE AIR
- THIS INSTRUMENT IS ONLY A LITTLE LARGER THAN A FOUNTAIN PEN
- CLIPS ON TO YOUR TOP POCKET
- WEIGHS LESS THAN 3 OZ.
- CONTAINS THREE LENSES
- FULLY CHARGED, TESTED AND GUARANTEED REFURBISHED BY US
- TWO FREE RE-CHARGING VOUCHERS WITH EVERY UNIT
- BRITISH DESIGN AND MANUFACTURE, RUGGED CONSTRUCTION
- MANUFACTURER'S LIST PRICE OF SIMILAR MODEL IS OVER £25
- A SOUND INVESTMENT
- BUY NOW WHILST STOCKS AVAILABLE. DELIVERY BY RETURN POST

Recommended for: Civil Defence, Fire, Hospital, Medical and general use

SECTIONAL DRAWING

ACTUAL SIZE: 115 x 14mm

Labels on the left: PROTECTIVE CAP, MARKER SLEEVE, POCKET CLIP, MICROSCOPE BODY, IONISATION CHAMBER, CAPACITOR, PROTECTIVE CAP (CAPTIVE)

Labels on the right: WINDOW, EYE LENS, GRATICULE, FIELD LENS, CASE TUBE, OBJECTIVE LENS, QUARTZ FIBRE, ELECTRODE, CHARGING BELLOWS, CHARGING PIN

SAVE £15

ALL YOURS FOR ONLY **£10.95** incl. post paid

TWO FREE RE-CHARGE VOUCHERS WITH EVERY DETECTOR

Manufacturer's current list price similar model is over £25

**BARGAINS FOR THE ELECTRONIC HANDYMAN
BRANDED L.E.D. DIGITAL
ALARM CLOCKS**



Returned to Service
Department within
guarantee period.

1. With alarm repeat S.R.S.P. of £17.00. Offered at £3.95, inc. VAT, or 3 for £9.95, inc. VAT.
2. With luxury lamp and repeat alarm. S.P.S.P. £31.00. Offered at £7.95 inc. VAT each, or 3 for £19.95 inc. VAT.

These will be sold as received from our customers with the existing fault(s) and without guarantee.

U.K. only

Discounts available on large bulk purchase.

**PRESCOTT CLOCK & WATCH CO.
LTD.**

PRESCOTT HOUSE, HUMBER ROAD, LONDON
NW2 6ER

WANTED. Second book of Hi-Fi loudspeaker enclosures by B. B. Babani. Please ring 0297 52566.

SMALL REED SWITCHES 10p. Magnets 8p and 15p. Reed Relays 6v, 9v, 12v 40p. 30 untested I.C.S. 35p. Postage 22p. — Grimsby Electronic Components, Lambert Road, Grimsby, Humberside. List 15p.

ZX80 GAMES. Free Game sent on request. Send s.a.e.: Mastercode, Simon Says, Dr. Who, Alien Invader. The 4 on cassette, £3. — Bobker, 29 Chadderton Drive, Unsworth, Bury, Lancs.

Earn £20-£100 p.w.

In your spare time

by introducing the revolutionary new

Flip-Caller telephone to your friends.

Features micro-chip controlled

push-button dialling and memory

recall. Sells itself. Generous

commission. For details write to Dept. HE

IDL SUPERPHONE

P.O. Box 31, Twickenham TW2 5RL



MINIATURE MICROSWITCH. Complete with level actuator. Suitable for burglar alarm projects etc. £1 each inc. V.A.T. and P.R. — Clere Electronics Ltd., Kingsclere, Newbury, Berks. 635 298574.

FOR QUICK AND EFFICIENT SUPPLY OF ELECTRONIC COMPONENTS, tools and books, give us a try! Write, stating components required and we will quote price. Orders always pursued in full. — K. E. Wilson, 24 Ladbroke Road, London, W.11.

If it's a case of making your project look good, then use one of ours.

Simply send a S.A.E. for Details and prices.



TRADE ENQUIRIES
INVITED.

H.M. ELECTRONICS

271a/275a Fulwood Road,
Broomhill
Sheffield S10 3BD

CLASSIFIED

RATES

- 1-3 insertions £5 per scc
- 4-11 insertions £4.50 per scc
- 12 insertions £4 per scc
- 18p per word (Min. 15 words)
- Box No on application

All advertisements in this section must be pre-paid
Closing Date: 1st Fri. month preceding publication

Advertisements are accepted subject to the terms and conditions printed on the advertisement rate card (available on request).

SEND TO: HE CLASSIFIED, 145, CHARING CROSS ROAD, LONDON WC2H 0EE. TEL: 01-437 1002 Ext. 26

DIGITAL WATCH BATTERY REPLACEMENT KIT



These watches all require battery (power cell) replacement at regular intervals. This kit provides the means. We supply eyeglass, non-magnetic tweezers, watch screw-driver, case knife and screwback case opener. Also one doz. assort. push-pieces, full instructions and battery identification chart. We then supply replacement batteries — you fit them. Begin now. Send £9 for complete kit and get into a fast-growing business. Prompt despatch.



BOLSTER INSTRUMENT CO. HE11
11 Percy Avenue, Ashford, Middx. TW15 2PB

MIXED. 100 TRANSISTORS £3 50. 25 I.C.s £1 50. Post paid. Early radios. Valves. Electronics bargain lists 15p. Sole Electronics, (H/E), 37 Stanley Street, Ormskirk, L39 2DH.

OSCILLOSCOPE £12. Easy build converter plugs into TV aerial socket and converts to large screen oscilloscope. (Components cost under £12). Circuit and plans £3. — Kerr, 27 Coles Road, Milton, Cambridge CB4 4BL. (Callers by appointment).

PRINTED CIRCUITS

Make your own simply, cheaply and quickly! Golden Fotolak Light Sensitive Lacquer — now greatly improved and very much faster. Aerosol cans and full instructions. £2.25. Developer 35p. Ferric Chloride 55p. Clear Acetate sheet for master 14p. Copper-clad Fibre-glass Board approx. 1mm thick £1.75 sq. ft.

Post/packing 60p.

WHITE HOUSE ELECTRONICS
Castle Drive, Praa Sands
Penzance, Cornwall

SUPERBOARD II

STILL the best value in Home Computers.

Just compare the features:

- ★ 8K floating point BASIC in ROM
- ★ Full ASC11 keyboard
- ★ Standard cassette/TV interface
- ★ RS232 printer interface
- ★ 4K user RAM
- ★ Expandable to 32K & dual mini floppy

AVAILABLE NOW from:

C.T.S.

**31/33 Church Street,
Littleborough, Lancs.**

Please ring or write for latest prices
Tel: Littleborough (0706) 74342 any time

SPARE PARTS

SERVICE MANUALS
PHONE ORDERS NOW

Most makes inc. Sony, J.V.C., Hitachi etc.

HI-FI HOSPITAL (GRS) LTD.
100 Uxbridge Road, W7
01-840 1890

TOTAL OF 25 INTERESTING TOPICS.

Including sirens, test-equipment, electronic music, semi-conductor equivalents and other useful information. £1.60 to: P. McGee, 62 Reva Road, Liverpool L14 6UB.

CB — CB — CB — CB

**40 CHANNEL RIGS
VARIOUS MODELS
FULLY GUARANTEED**

£65 per unit

Delivery within 1 week!

Telephone Cork (0002) 28571
FOR INFORMATION RE ORDERING ETC.

AD INDEX

AHLERS ELECTRONIKA	2
ALCON INSTRUMENTS	34
AMBIT INTERNATIONAL	48
ARROW AUDIO CENTRE	81
BIG EARS	74
BI-PAK SEMICONDUCTORS	40
BK ELECTRONICS	22
BNRS	17 & 37
J. BULL ELECTRICAL	63
CAMBRIDGE LEARNING ENTERPRISES	23
CBRC	74
CSC	56
DISPLAY ELECTRONICS	12
DONDENE	81
ELECTRONI-KIT	58
ELECTROVALUE	6
GMT ELECTRONICS	58
GREENWELD	81
HEATHKIT	26
ILP	4 & 5
MACLIN-ZAND	11
MAGENTA	38
MAPLIN	84
MARSHALLS	43
MICRO CIRCUITS	52
MINIKITS	78
MINIMAT TECHNICAL LTD.	70
MITRAD	44 & 45
MOBILE STEREO	77
VICTOR MORRIS	72
MURA	76
NIC MODELS	22
T. POWELL	55
J. W. RIMMER	77
SILICA SHOP	64
SKYWAVE	72
SRU AUTOS	72
STEVE'S ELECTRONICS	6
C.N. STEVENSON	22
SURETRON	26
SWANLEY	70
TECHNOMATIC	28
TEMPUS	68 & 69
TK ELECTRONICS	67
VERO	6
WATFORD	7
WEBB ELECTRONICS	70
WHEELS OF DOVER	70
WINTJOY	70 & 83

CB

ANTENNAS AND ACCESSORIES



CB and monitor antennas CB Accessories



*Citizen Band Fibreglass Antennas and Accessories
for Marine, RV, Truck, Auto, Van and Motorcycle*

Watch for the new film
"SMOKEY AND THE BANDIT II"
starring **BURT REYNOLDS** and
'Firestik' ANTENNAS!

CB MOBILE ANTENNA SERIES

Shakespeare®

and the Shakespeare fiberglass Super
Big Stick™ base station antenna



SWR METERS, NOISE SUPPRESSION FILTERS, T.V.I. FILTERS, CO-
PHASORS, ANTENNAS, LEADS AND NUMEROUS OTHER
ACCESSORIES.



Microphones, Power Supplies, SWR Meters, Linear Amplifiers, Preamplifiers,
Antennas, Frequency Counters etc., etc.

TELEX

MICROPHONES AND HEADSETS

TURNER®

ANTENNAS AND MICROPHONES



CB MOBILE AND BASE STATION ANTENNAS

K40

SPEECH PROCESSORS AND BASE LOAD ANTENNAS



Ton Ahlers Elektronika

Mobile and base antennas, power supplies and
accessories

WINTJOY Ltd.

*103 High Street, Shepperton,
Middlesex TW17 9BL, England.*

Tel:

Walton-on-Thames (STD 09322) 48145

COMMUNICATIONS EQUIPMENT DISTRIBUTORS

**UK RETAIL OUTLETS IN SELECTED
AREAS STILL BEING SOUGHT**



**SEND £1 FOR A
COMPREHENSIVE CATALOGUE**



MAPLIN

announce the opening of their new LONDON shop

259-261
King St.
Hammersmith
London W6
01-748 0926



- * Excellent metered parking
- * Close to Hammersmith Underground Station for Piccadilly, District & Metropolitan Lines
- * Bus no's 260·266·704·27·91 267·290 stop outside



Opens Tuesday 16th September, 1980

Opening Hours 9.45 am to 5.30 pm Tuesday to Saturday (Closed Monday)

Maplin mail-order –
Now better than ever!

- * Up to 8% discount for use with next order
- * All prices include VAT
- * Same day service on in-stock lines
- * Over 95% of our stock lines in stock
- * Large range of all the most useful components
- * First class reply paid envelope with every order
- * Quality components – no rejects – no re-marks
- * Competitive prices
- * Your money is safe with a reputable Company

On price, service, stock, quality and security, it makes sense now more than ever to make **Maplin** – your first choice for components every time!

Post this coupon now for your copy of our 1979-80 Catalogue price 70p

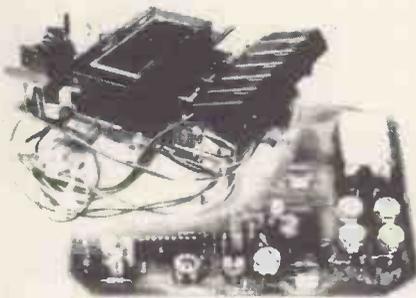
Please send me a copy of your 280 page catalogue. I enclose 70p (plus 46 p&p). If I am not completely satisfied I may return the catalogue to you and have my money refunded. If you live outside the U.K. send £1.35 or ten International Reply Coupons. I enclose £1.16.

Name _____

Address _____

HE/11/80

Stereo Cassette Tape Deck



Utilising the superb JVC deck made for Tandberg and a ready-made pre-aligned, tested and guaranteed module, this cassette deck has a superb sound and a high quality specification. We've got everything you need (except cabinet) including full instruction leaflet for only £39.95. Order as XY36P (Cassette Recorder Kit)

Space Invaders

Fight the space invaders, be a polaris captain or a spaceship commander. Full colour action on your own TV set and over 450 games to play.

Basic console with Combat cartridge (AC00A) £99.50 + £2.50 carriage

All cartridges available including:

Space Invaders (AC26D)	£29.95	Adventure (AC22Y)	£23.95
Indy 500 (AC24B)	£34.50	Skydiver (AC13P)	£16.95
Chess (8levels) (AC28F)	£34.50	Breakout (AC05F)	£16.95
Golf (9holes) (AC18U)	£16.95	Slot Racers (AC19V)	£16.95
Air Sea Battle (AC01B)	£16.95	Programming (AC27E)	£34.50
Space War (AC02C)	£16.95	Olympics (AC04E)	£16.95
Brain Games (AC16S)	£16.95	Street Racer (AC14Q)	£16.95
Outlaw (AC03D)	£16.95	Keyboards per pair (AC29G)	£11.95

All prices include VAT and carriage except where shown.

MAPLIN

Maplin Electronic Supplies Ltd

All mail to: - P.O. Box 3, Rayleigh, Essex SS6 8LR.
Telephone: Southend (0702) 554155.

Shop: 284 London Road, Westcliff-on-Sea,
Essex. (Closed on Monday)
Telephone: Southend (0702) 554000.



Catalogue now available in all branches of WHSMITH Price £1.00

22 Pros Mark